

**ÉCOLÉ ÉLÉMENTAIRE ANTONINE-MAILLET
NEW ELEVATOR AND OFFICE RENOVATIONS
615 Ridgeway Ave, Oshawa,
Ontario L1J 2W3
CONSEIL SCOLAIRE VIAMONDE**



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Project No.: 25116
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Set No.:
Issued:

Specifications

CSV École élémentaire	List of Contents	Section 00 01 11
Antonine-Maillet Renovations		Page 1
615 Ridgeway Ave		
Oshawa, Ontario		January 2026

<u>Section</u>	<u>Title</u>	<u>Pages</u>
00001	List of Drawings	2
00002	Room Finish Schedule	2
00003	Door and Frame Schedule	3
00004	List of Consultants	1

Division 00 - Procurement and Contracting Requirements

00226	Designated Substances Report	61
00710	General Conditions	1

Division 01 - General Requirements

01001	General Requirements	10
01011	Summary of Work Single Contract	4
01021	Allowances	2
01040	Coordination	4
01300	Submittals	3
01310	Construction Schedule	3
01400	Quality Control	4
01510	Temporary Utilities	3
01535	Temporary Facilities	3
01601	Material and Equipment	11
01655	Facility Start-Up	4
01711	Cleaning	3
01721	Project Record Documents	7
01730	Operation and Maintenance Manual	2
01750	Spare Parts + Maintenance Materials	3
01770	Take-Over Procedures	3
01780	Closeout Submittals	8

Division 02 - Existing Conditions

02070	Sitework, Demolition and Removal	2
02223	Excavating, Trenching and Backfilling	9
02 81 00	Hazardous Materials	7
02 82 00.01	Asbestos Abatement – Type 1 Precautions	10
02 82 00.02	Asbestos Abatement – Type 2 Precautions	14
02 82 00.03	Asbestos Abatement – Type 3 Precautions	20

Division 03 - Concrete

03100	Concrete Forming and Accessories	6
03200	Concrete Reinforcing	6
03300	Cast-in-Place Concrete	14
03345	Concrete Floor Finishes	2
03350	Concrete Finishing	4

Division 04 - Masonry

04050	Masonry Procedures	6
04100	Mortar + Grout for Masonry	

CSV École élémentaire	List of Contents	Section 00 01 11
Antonine-Maillet Renovations		Page 2
615 Ridgeway Ave		
Oshawa, Ontario		January 2026

04150	Masonry Accessories	3
04160	Masonry Reinforcing and Connectors	4
04220	Concrete Unit Masonry	3
<u>Division 05 - Metals</u>		
05500	Metal Fabrications	6
<u>Division 06 - Wood, Plastics, and Composites</u>		
06100	Rough Carpentry	7
06200	Finish Carpentry	6
06400	Millwork	9
<u>Division 07 - Thermal and Moisture Protection</u>		
07840	Fire Stopping	4
07900	Sealants	7
<u>Division 08 - Openings</u>		
08111	Steel Doors and Frames	10
08210	Wood Doors	3
08710	Finish Hardware	8
	Hardware List	1
08800	Glazing	9
<u>Division 09 - Finishes</u>		
09130	Suspension System for Acoustical Ceilings	4
09250	Gypsum Board	8
09410	Portland Cement Terrazzo	8
09665	Resilient Tiles	6
09511	Acoustical Panels and Tiles	3
09911	Interior Painting	21

Division 14 – Vertical Transportation Elevator Installation
See Elevator Specifications index following

Mechanical
See Mechanical index following

Electrical
See Electrical index following

Section 14 00 00 General	<u>1</u>
1 General	<u>1</u>
1.1 Basic Requirements	<u>1</u>
1.2 Scope	<u>1</u>
1.3 Maintenance: warranty period	<u>1</u>
1.4 Maintenance Control Program	<u>1</u>
1.5 Definitions of terms	<u>1</u>
1.6 Operation and maintenance manual	<u>2</u>
1.7 Coordination with other trades	<u>4</u>
1.8 Fixture type: vandal resistant	<u>4</u>
1.9 Progress payments	<u>5</u>
1.10 Acceleration of the Work	<u>5</u>
1.11 Acknowledgments	<u>5</u>
1.12 Assignments	<u>5</u>
1.13 Certificates of inspection	<u>6</u>
1.14 Changes in Work	<u>6</u>
1.15 Clean-downs	<u>6</u>
1.16 Claims for extra cost	<u>7</u>
1.17 Codes and ordinances	<u>7</u>
1.18 Completion schedule	<u>8</u>
1.19 Contract Documents	<u>8</u>
1.20 Defective work and non-performance	<u>8</u>
1.21 Drawing and sample submittals	<u>9</u>
1.22 Electrical diagrams	<u>10</u>
1.23 Environmental considerations	<u>10</u>
1.24 Equipment insurance	<u>10</u>
1.25 Equipment moving	<u>10</u>
1.26 Failure to perform	<u>11</u>
1.27 Generic maintenance	<u>11</u>
1.28 Hoistway protection	<u>11</u>
1.29 Inability to complete contract	<u>11</u>
1.30 Information with proposal	<u>11</u>
1.31 Inspection and acceptance	<u>12</u>
1.32 Key switches	<u>12</u>
1.33 Labour laws	<u>12</u>
1.34 Liability insurance	<u>12</u>
1.35 Liens and affidavits	<u>13</u>
1.36 Materials and workmanship	<u>13</u>
1.37 Measurements	<u>13</u>
1.38 Operation by persons with physical disabilities	<u>13</u>
1.39 Operating certificate	<u>14</u>
1.40 Operating environment	<u>14</u>
1.41 Organization chart	<u>14</u>
1.42 Overtime premium	<u>15</u>

1.43	Owner's General Terms and Conditions	<u>15</u>
1.44	Parts	<u>15</u>
1.45	Patents	<u>15</u>
1.46	Payment withheld	<u>16</u>
1.47	Personnel	<u>16</u>
1.48	Preliminary information	<u>16</u>
1.49	Protection of the Work and property	<u>17</u>
1.50	Regular hours of work	<u>17</u>
1.51	Removal of rubbish	<u>17</u>
1.52	Request for payment	<u>17</u>
1.53	Singular and plural	<u>17</u>
1.54	Special tools and access codes	<u>18</u>
1.55	Subcontractors	<u>18</u>
1.56	Submission of proposal	<u>18</u>
1.57	Taxes	<u>18</u>
1.58	Technical seminar	<u>19</u>
1.59	Trade marks	<u>19</u>
1.60	Unit inspection by the Consultant	<u>19</u>
1.61	Warranty of work	<u>19</u>
1.62	Withdrawal or rejection of proposals	<u>20</u>
1.63	Work by other trades	<u>20</u>
1.64	Work site protection	<u>20</u>
1.65	Work under division 02 (Site Preparation)	<u>20</u>
1.66	Work under division 03 (Concrete)	<u>20</u>
1.67	Work under division 04 (Masonry)	<u>21</u>
1.68	Work under division 05 (Metals)	<u>21</u>
1.69	Work under division 07 (Thermal and Moisture Protection)	<u>21</u>
1.70	Work under division 08 (Doors and Windows)	<u>21</u>
1.71	Work under division 09 (Finishes)	<u>21</u>
1.72	Work under Division 22 (Plumbing)	<u>22</u>
1.73	Work under Division 23 (Mechanical)	<u>22</u>
1.74	Work under division 26 (Electrical)	<u>22</u>
2	Separate prices	<u>25</u>
2.1	Separate price submission requirements	<u>25</u>
2.2	Maintenance: five years	<u>25</u>
2.3	Clean-downs	<u>25</u>
Section 14 01 20 Maintenance		<u>1</u>
1	General	<u>1</u>
1.1	General requirements	<u>1</u>
1.2	Scope	<u>1</u>
2	General requirements	<u>1</u>
2.1	Definition of terms	<u>1</u>

2.2	Owner's General Terms and Conditions	2
2.3	Purpose	2
2.4	Routine maintenance	2
2.5	Contract duration	2
2.6	Contract cancellation	3
2.7	Unit removed from service	3
2.8	Work included: general.	4
2.9	Work not included: general.	4
2.10	No obsolescence	5
2.11	Extra to contract work.	6
2.12	Tariffs, duties and taxes	7
2.13	Special tools and access codes	7
2.14	Minimum standard	7
2.15	Reliability	7
2.16	Reliability: action plan and reporting.	8
2.17	Suspension means replacement	8
2.18	Regular hours of work	8
2.19	Account representative.	9
2.20	Defective work and non-performance.	9
2.21	Codes and ordinances	9
2.22	Regulatory authority submissions.	10
2.23	Protection of the Work and property.	10
2.24	Liability insurance.	10
2.25	Assignments.	11
2.26	Directives	11
2.27	Deficiencies not corrected	11
2.28	Submission of proposal	11
2.29	Request for payment	11
2.30	Delay in making repairs	12
2.31	Personnel	12
2.32	Designated substances	12
2.33	Labour disruptions	13
2.34	Coordination with Owner	13
2.35	Rules of work: elevators	14
2.36	Software and firmware updates	14
3	Maintenance procedures	15
3.1	Maintenance Control Program	15
3.2	Controller: remote reset	16
3.3	Repairs.	16
3.4	Mis-adjustment.	17
3.5	Safety devices	17
3.6	Equipment defects	17
3.7	Call-back service	17
3.8	Maintenance: assistance for inspections & testing	18
3.9	Fire service testing	19

3.10	Safety inspections	<u>19</u>
3.11	Manufacturers' parts	<u>19</u>
3.12	Substitute parts	<u>19</u>
3.13	Parts stocked locally	<u>20</u>
3.14	Parts available as required	<u>20</u>
3.15	Building log	<u>20</u>
3.16	Maintenance log book	<u>21</u>
3.17	Time tickets	<u>21</u>
3.18	Accidents and claims	<u>21</u>
3.19	Electrical diagrams	<u>21</u>
3.20	Consultant's inspections	<u>22</u>
3.21	Maintenance tasks (rope replacements)	<u>22</u>
4	Performance	<u>23</u>
4.1	Performance data	<u>23</u>
4.2	Performance data measurement method	<u>23</u>
4.3	Maintenance tasks: hydraulic elevators	<u>24</u>
Section 14 26 23 Limited-Use / Limited-Application (LULA)		<u>1</u>
1	General	<u>1</u>
1.1	General requirements	<u>1</u>
1.2	Type	<u>1</u>
1.3	Data	<u>1</u>
1.4	Dimensions	<u>3</u>
2	Products	<u>3</u>
2.1	Hydraulic: pumping machine unit	<u>3</u>
2.2	Hydraulic fluid: biodegradable	<u>5</u>
2.3	Hydraulic: silencing devices	<u>6</u>
2.4	Hydraulic: main line strainer	<u>6</u>
2.5	Hydraulic: time protective device	<u>6</u>
2.6	Hydraulic motor starting	<u>7</u>
2.7	Jack unit: roped hydraulic	<u>7</u>
2.8	Governor: automatic reset	<u>8</u>
2.9	Hydraulic piping	<u>9</u>
2.10	Hydraulic pit shut-off valve	<u>9</u>
2.11	Solid-state hardware	<u>9</u>
2.12	Auxiliary slowdown devices	<u>10</u>
2.13	Position transducer	<u>10</u>
2.14	Controller	<u>11</u>
2.15	Computing devices	<u>12</u>
2.16	Power interruption restart	<u>12</u>
2.17	Control circuits grounding	<u>13</u>
2.18	Main floor elevator markings	<u>13</u>
2.19	Entrance floor markings	<u>13</u>

2.20	Floor marking: hoistway	13
2.21	Door type: two speed side opening	14
2.22	Door friction	14
2.23	Entrance: fire rating	14
2.24	Entrances	14
2.25	Entrance installation	14
2.26	Entrance finish: stainless steel	15
2.27	Entrances: door hardware	15
2.28	Car door restrictor	16
2.29	Car and hoistway door safety retainers	16
2.30	Hoistway entrance lunar key access	16
2.31	Reopening devices and detection of objects	17
2.32	Door operator (linear or harmonic)	17
2.33	Car door equipment	19
2.34	Car station	20
2.35	Signal lights	21
2.36	Automatic cab lighting and fan control	21
2.37	Floor passing and stopping tones	22
2.38	Car position indicator	22
2.39	Emergency lighting	23
2.40	Telephone: hands-free operation	24
2.41	Two-way communication system	25
2.42	Web-based monitoring service	28
2.43	Closed circuit camera security system	29
2.44	Hall call security: lockout keyswitch	30
2.45	Hall push button stations: single riser	30
2.46	Hoistway access switch	31
2.47	Cab ventilation	31
2.48	Cab: standard finishes	31
2.49	In car lanterns and gongs: applied	32
2.50	Car inspection devices	33
2.51	Sliding guides	33
2.52	Guide rails	33
2.53	Fascias	34
2.54	Car platform	35
2.55	Car frame	35
2.56	Cab installation	35
2.57	Emergency lowering	36
2.58	Car balance	37
2.59	Load weighing device	37
2.60	Pit equipment	37
2.61	Limit switch dowelling	37
2.62	Car ride	38
2.63	Painting	38
2.64	External connections	38
2.65	Travelling cable	38

2.66	Electric wiring	39
3	Execution	40
3.1	Operation: simplex	40
3.2	Operation: load non-stop	40
3.3	Operation: call response.	40
3.4	Operation: dispatch recovery	40
3.5	Operation: call initiation	41
3.6	Operation: high & low call return.	41
3.7	Operation: fault recovery	41
3.8	Operation: independent service	42
3.9	System clock	42
3.10	Door protective device by-pass (nudging).	43
3.11	Door open pause time	43
3.12	Operation: door protective device.	44
3.13	Noise level: door operation.	44
3.14	Noise level: cab	44
3.15	Cab fan: operation	44
3.16	Noise level: control and machine room.	45
3.17	Transmitted vibration	45
3.18	Levelling	45
3.19	Speed control: hydraulic	46
3.20	Test data form: hydraulic	46
3.21	Operating time	47
3.22	Firefighters' Emergency Operation: Phase 1 automatic recall	47
3.23	Seismic Requirements: elevator	48

INDEX OF SPECIFICATIONS

01 33 23	SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
01 79 00	DEMONSTRATION AND TRAINING
02 41 00	DEMOLITION
22 05 00	COMMON WORK RESULTS FOR PLUMBING
22 05 15	PLUMBING SPECIALTIES AND ACCESSORIES
22 05 23	GENERAL-DUTY VALVES FOR PLUMBING PIPING
22 05 53	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
22 07 00	PLUMBING INSULATION
22 11 16	DOMESTIC WATER PIPING
22 13 00	FACILITY SANITARY SEWERAGE
22 42 00	COMMERCIAL PLUMBING FIXTURES
23 05 00	COMMON WORK RESULTS FOR HVAC
23 05 13	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
23 05 48	VIBRATION AND SEISMIC CONTROLS FOR HVAC
23 05 53	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 05 93	TESTING, ADJUSTING AND BALANCING FOR HVAC
23 07 00	HVAC INSULATION
23 09 00	INSTRUMENTATION AND CONTROL FOR HVAC
23 21 13	HYDRONIC PIPING
23 23 00	REFRIGERANT PIPING
23 25 13	WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEM
23 31 13	METAL DUCTS
23 33 13	DAMPERS
23 34 00	HVAC FANS
23 37 00	AIR OUTLETS AND INLETS

23 72 00	AIR TO AIR ENERGY RECOVERY EQUIPMENT
23 81 29	VARIABLE REFRIGERANT FLOW HVAC SYSTEMS
23 82 00	CONVECTION HEATING AND COOLING UNITS
26 05 00	COMMON WORK RESULTS FOR ELECTRICAL
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
26 22 00	LOW-VOLTAGE TRANSFORMERS
26 24 16	PANELBOARDS
26 28 16.02	MOULDED CASE CIRCUIT BREAKERS
26 28 23	DISCONNECT SWITCHES - FUSED AND NON-FUSED
26 51 00	INTERIOR LIGHTING

List of Drawings

Architectural Drawings

WK Lim & MP Liu Architects Inc.
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Vaughan, Ontario L4K 5K7
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<u>No.</u>	<u>Title</u>	<u>Date</u>	<u>Revision</u>
A0	Title Sheet, Renovation Notes	November 2025	March 3, 2026
SP1	Site Plan, Legend	November 2025	March 3, 2026
A1	Ground Floor & Second Floor Key Plans	November 2025	March 3, 2026
A2	Enlarged Ground Floor Plan	November 2025	March 3, 2026
A3	Enlarged Second Floor Plan, Interior Elevation & Millwork Details	November 2025	March 3, 2026
A4	Enlarged Ground Floor Reflected Ceiling Plan	November 2025	March 3, 2026
A5	Enlarged Second Floor Reflected Ceiling Plan and Section	November 2025	March 3, 2026
A6	Sections and Details	November 2025	March 3, 2026
A7	Sections and Details	November 2025	March 3, 2026

Structural Drawings

Gracarr Engineering
2243 Crestmont Drive,
Oakville, ON L6M 5J5
Tel: (647) 869-7556

<u>No.</u>	<u>Title</u>	<u>Date</u>	<u>Revision</u>
S01	Notes and Schedules	December 2025	March 2, 2026
S02.1	Partial Foundation Plan	December 2025	March 2, 2026
S02.2	Partial Second Floor Framing Plan	December 2025	March 2, 2026
S02.3	Partial Roof Framing Plan and Details	December 2025	March 2, 2026
S03.1	Sections and Details	December 2025	March 2, 2026

Mechanical Drawings

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588 Edward Ave, Unit 25
Richmond Hill, ON L4C 9Y6
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Fax: (905) 787-8771

<u>No.</u>	<u>Title</u>	<u>Date</u>	<u>Revision</u>
M-1	Key Plan, Symbols List, Equipment Schedules & Details	January 2026	March 2, 2026
M-2	Ground & Second Floor – Plumbing & Heating – Existing & Demolition Work	January 2026	March 2, 2026

M-3	Ground & Second Floor – Plumbing & Heating – New Work	January 2026	March 2, 2026
M-4	Ground HVAC – Existing & Demolition Work	January 2026	March 2, 2026
M-5	Ground & Second Floor – HVAC – New Work	January 2026	March 2, 2026
M-6	Part of Roof Layout – New Work	January 2026	March 2, 2026
M-7	Controls	January 2026	March 2, 2026
M-8	Controls & Details	January 2026	March 2, 2026

Electrical Drawings

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<u>No.</u>	<u>Title</u>	<u>Date</u>	<u>Revision</u>
E-01	Key Plan, Electrical Legend and Light Schedule	January 2026	March 2, 2026
E-1	Ground and Second Floors Lighting – Existing and Demolition Plan	January 2026	March 2, 2026
E-2	Second Floor Equipment Power – Existing and Demolition Plan	January 2026	March 2, 2026
E-3	Ground and Second Floors Lighting – New Work	January 2026	March 2, 2026
E-4	Ground & Second Floors Power & Systems – New Work	January 2026	March 2, 2026
E-5	Roof Floor – Power Plan	January 2026	March 2, 2026
E-6	Fire Alarm Details and Elevator Shaft Details	January 2026	March 2, 2026
E-6-1	Fire Alarm Riser and Zone Schedule	January 2026	March 2, 2026
E-6-2	Fire Alarm Details and Elevator Shaft Details	January 2026	March 2, 2026
E-7	Ground Floor – Fire Alarm Existing/Demolition Plan	January 2026	March 2, 2026
E-8	Second Floor - Power and Systems – Existing & Demolition Plan	January 2026	March 2, 2026
E-9	Ground Floor - Fire Alarm System – New Work	January 2026	March 2, 2026
E-10	Second Floor – Fire Alarm System – New Work	January 2026	March 2, 2026

END OF SECTION

	PROJECT NAME	École élémentaire Antonine-Maillet New Elevator and Office Renovations	PROJECT NO:	25116
	PROJECT ADDRESS	615 Ridgeway Ave, Oshawa, ON L1J 2W3	SHEET:	1 of 1
	CITY,		DATE:	FEBRUARY 2026

ROOM FINISH SCHEDULE

ROOM NO.	ROOM NAME	FLOOR FINISH	WALL BASE	WALL MATERIAL	WALL FINISH	CEILING MATERIAL	CEILING FINISH	CEILING HEIGHT	F.R.R.	REMARK
101	CHANGE ROOM	V.C.T.	RUBBER	EXIST. /CONC.	PAINT /PAINT	A.C. TILE	-	EXIST.	-	PREPARE EXISTING SUBSTRATE. REMOVE AND DEMOLISH EXISTING ACOUSTIC TILE CEILING SYSTEM.
101B	ELEVATOR	-	-	CONC.	-	-	-	-	-	
101C	MACHINE ROOM	EXIST. CONC.	-	EXIST./ CONC.	PAINT/ PAINT	-	-	-	-	REMOVE EXISTING VCT FLOORING AND WALL BASE CLEAN AND STRIP SUBSTRATE OF RESIDUAL SEALANT GRIND EXISTING CONCRETE SLAB SMOOTH PROVIDE FLOOR REDUCER STRIP AT FLOOR TRANSITION
102A	OFFICE	EXIST. /V.C.T.	EXIST. /RUBBER	EXIST. /GYP.BD.	EXIST. /PAINT	EXIST.	-	EXIST.	-	PRIME AND PAINT FURRING WALL TYPE F1. PROVIDE RUBBER BASE TO MATCH EXISTING REMOVE EXISTING VCT FLOORING IN FULL UNITS SAWCUT AND MAKE GOOD EXISTING CONCRETE SLAB AS REQUIRED TO ACCOMMODATE SERVICE LINES - SEE MECH. PROVIDE VCT FLOORING TO MATCH EXISTING
201	ELEVATOR	-	-	CONC.	-	-	-	-	-	
202	GENERAL OFFICE	V.C.T.	RUBBER	EXIST. /GYP.BD.	PAINT /PAINT	A.C. TILE	-	2600	-	PREPARE EXISTING SUBSTRATE. PRIME AND PAINT GYPSUM BOARD BULKHEAD AT EXTERIOR WINDOW.
202A	COPY ROOM	V.C.T.	RUBBER	EXIST. /GYP.BD.	PAINT /PAINT	A.C. TILE	-	2600	-	PREPARE EXISTING SUBSTRATE.
202B	VICE PRINCIPAL	V.C.T.	RUBBER	EXIST. /GYP.BD.	PAINT /PAINT	A.C. TILE	-	2600	-	PREPARE EXISTING SUBSTRATE. PRIME AND PAINT GYPSUM BOARD BULKHEAD AT EXTERIOR WINDOW.
202C	PRINCIPAL	V.C.T.	RUBBER	EXIST. /GYP.BD.	PAINT /PAINT	A.C. TILE	-	2600	-	PREPARE EXISTING SUBSTRATE. PRIME AND PAINT GYPSUM BOARD BULKHEAD AT EXTERIOR WINDOW.
202D	HEALTH ROOM	V.C.T.	RUBBER	GYP.BD.	PAINT	A.C. TILE	-	2600	-	
202E	WASHROOM	V.C.T.	RUBBER	EXIST. /GYP.BD.	PAINT /PAINT	A.C. TILE	-	2600	-	PREPARE EXISTING SUBSTRATE.
203	WORK ROOM	V.C.T.	RUBBER	EXIST. /CONC. /GYP.BD.	PAINT /PAINT /PAINT	-	-	-	EXIST.	PREPARE EXISTING SUBSTRATE. PAINT EXISTING PRECAST CONCRETE ROOF DECK
C101	CORRIDOR	EXIST./ P.T.	P.T.	EXIST./ CONC.	EXIST./ PAINT	EXIST.	-	EXIST.	EXIST.	PROVIDE PT FLOORING AND WALL BASE TO MATCH EXISTING AT DOOR NO. 101 AND ELEVATOR DOOR OPENING. PRIME AND PAINT ENTIRE WALL PLANE OF MASONRY OPENING AND MAKE GOOD.

	PROJECT NAME	École élémentaire Antonine-Maillet New Elevator and Office Renovations	PROJECT NO:	25116
	PROJECT ADDRESS	615 Ridgeway Ave, Oshawa, ON L1J 2W3	SHEET:	2 of 1
	CITY,		DATE:	FEBRUARY 2026

ROOM FINISH SCHEDULE

ROOM NO.	ROOM NAME	FLOOR FINISH	WALL BASE	WALL MATERIAL	WALL FINISH	CEILING MATERIAL	CEILING FINISH	CEILING HEIGHT	F.R.R.	REMARK
C201	LOBBY	EXIST.	EXIST./TERRAZZO	EXIST./GYP.BD.	PAINT/PAINT	A.C. TILE	-	EXIST.	-	PROVIDE TERRAZZO WALL BASE TO MATCH EXISTING. REMOVE AND DEMOLISH EXISTING ACOUSTIC TILE CEILING SYSTEM.



PROJECT NAME École élémentaire Antonine-Maillet
New Elevator and Office Renovations
PROJECT ADDRESS 615 Ridgeway Ave,
Oshawa, ON L1J 2W3
CITY

PROJECT NO: 25116
SHEET: 1 of 1
DATE: February 2026

DOOR AND FRAME SCHEDULE

DOOR NO.	SIZE	DOOR TYPE	DOOR MATERIAL	DOOR FINISH	DOOR GRILLE	GLAZING	FRAME TYPE	FRAME MATERIAL	FRAME FINISH	LABEL	REMARK
101	950 X 2150 X 45	A	H.M.	PAINT	-	-	1	P.S.	PAINT	45 MINS.	LEVERSET, OVERHEAD STOP, KICKPLATE.
101C	950 X 2150 X 45	A	H.M.	PAINT	-	-	1	P.S.	PAINT	2 HR.	LEVERSET, DOOR CLOSER, KICKPLATE.
202	950 X 2150 X 45	B	H.M.	PAINT	-	LAM./ FIRE RATED	3	P.S.	PAINT	45 MINS.	LEVERSET, OVERHEAD STOP, KICKPLATE.
202A	950 X 2150 X 45	C	WOOD S.C.	STAIN	-	LAM.	1	P.S.	PAINT	-	LEVERSET, OVERHEAD STOP, KICKPLATE.
202B	950 X 2150 X 45	C	WOOD S.C.	STAIN	-	LAM.	1	P.S.	PAINT	-	LEVERSET, OVERHEAD STOP, KICKPLATE.
202C	950 X 2150 X 45	C	WOOD S.C.	STAIN	-	LAM.	1	P.S.	PAINT	-	LEVERSET, OVERHEAD STOP, KICKPLATE.
202D	950 X 2150 X 45	D	WOOD S.C.	STAIN	-	LAM.	1	P.S.	PAINT	-	LEVERSET, OVERHEAD STOP, KICKPLATE.
202E	950 X 2150 X 45	A	WOOD S.C.	STAIN	-	-	1	P.S.	PAINT	-	LEVERSET, OVERHEAD STOP, KICKPLATE.
202W	2 - 525 X 1300	-	-	-	-	LAM./ FIRE RATED	4	P.S.	PAINT	1 HR.	PRESSED STEEL WINDOW FRAME AND GLASS ASSEMBLY.
C102	1000 X 2150 X 45	E	H.M.	PAINT	-	LAM./ FIRE RATED	2	P.S.	PAINT	45 MINS.	LEVERSET + PANIC DEVICE, OVERHEAD STOP, MOTORIZED OPERATOR, ELEC. STRIKE, KICKPLATE

DOOR AND FRAME SCHEDULE

ÉCOLE ÉLÉMENTAIRE
ANTONINE-MAILLET NEW ELEVATOR &
OFFICE RENOVATIONS
615 RIDGEWAY AVE
OSHAWA ONTARIO

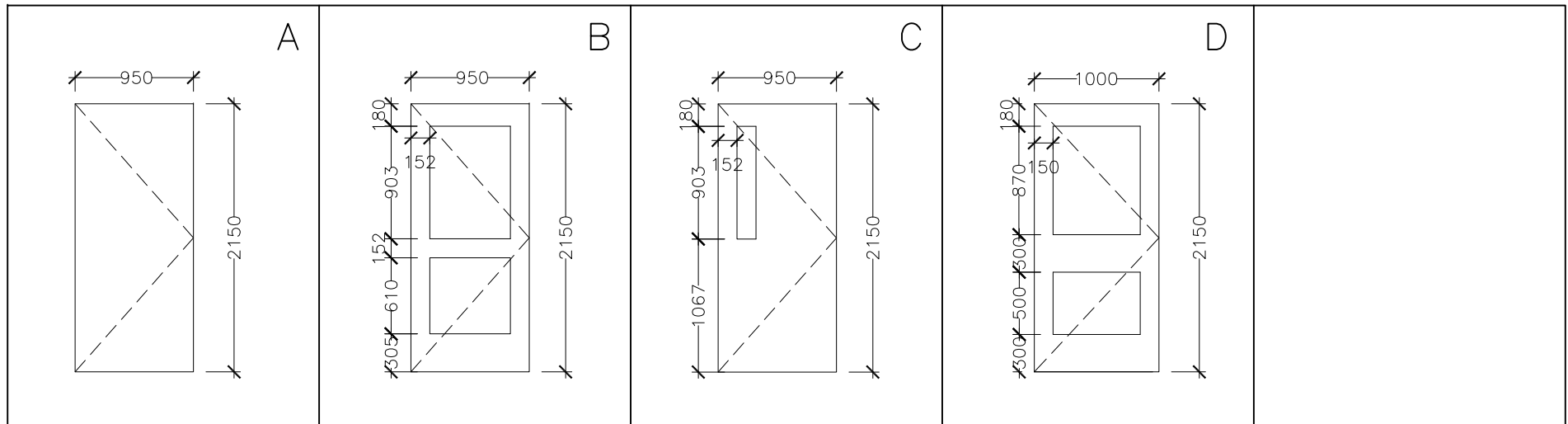
PROJECT NO.: 25116

DATE: JANUARY 2026

REVISED:

SHEET 1 OF 2

DOOR TYPES



TYPICAL NOTES:

1. AT 140 CONCRETE BLOCK WALLS PROVIDE DOOR FRAMES WITH THROAT SIZE 146 TO WRAP AROUND CONCRETE BLOCK.
2. AT 190 CONCRETE BLOCK WALLS PROVIDE DOOR FRAMES WITH THROAT SIZE 197 TO WRAP AROUND CONCRETE BLOCK.
3. AT GYPSUM BOARD PARTITIONS PROVIDE DOOR FRAMES WITH THROAT SIZE 124 TO WRAP AROUND PARTITIONS.

DOOR AND FRAME SCHEDULE

ÉCOLE ÉLÉMENTAIRE
ANTONINE-MAILLET NEW ELEVATOR &
OFFICE RENOVATIONS
615 RIDGEWAY AVE
OSHAWA ONTARIO

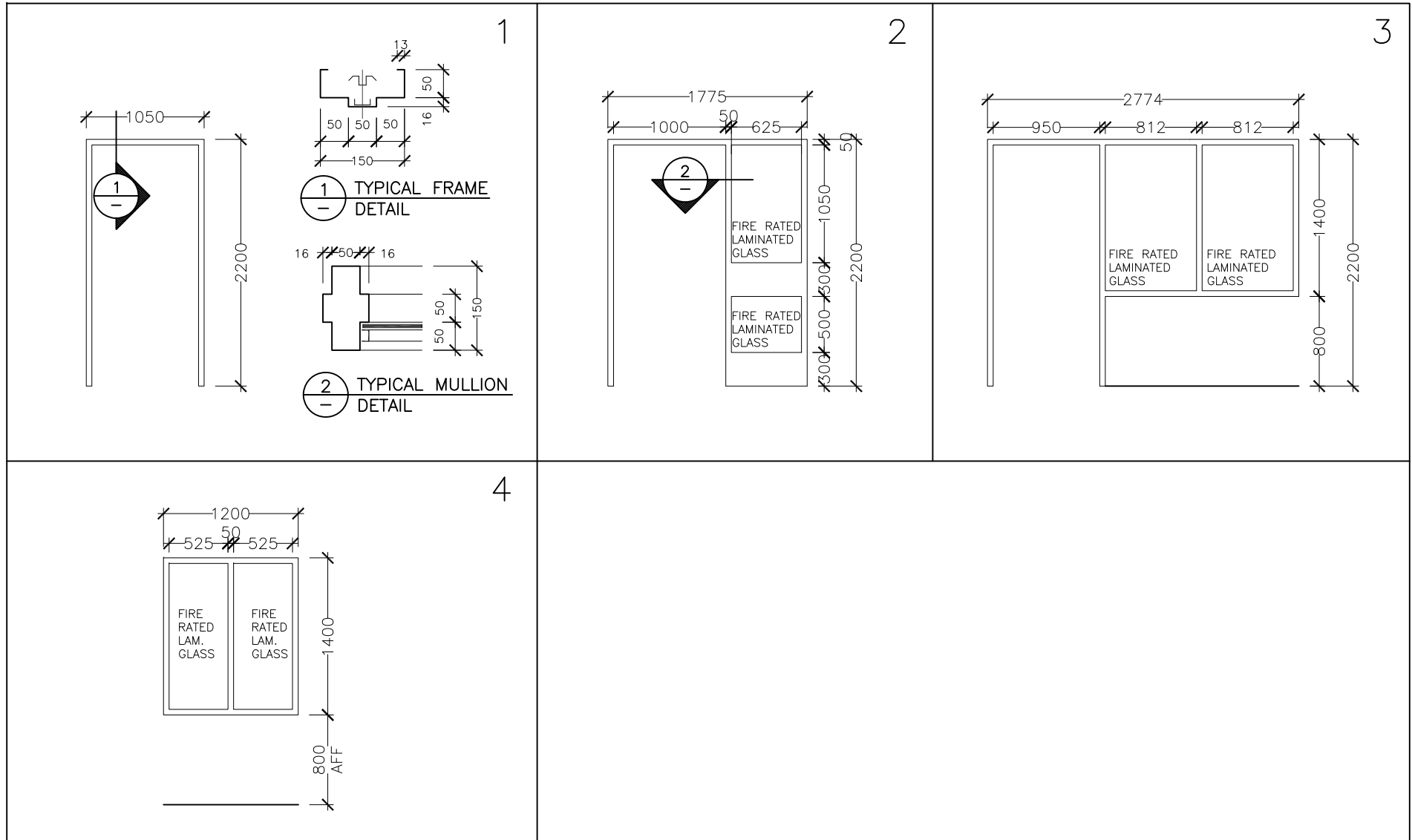
PROJECT NO.: 25116

DATE: JANUARY 2026

REVISED:

SHEET 2 OF 2

FRAME TYPES



PART 1 GENERAL

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END OF SECTION

1.1 Hazardous Material Report

- .1 A copy of a detailed Designated Substances Report is included herein, titled as: "Designated Substance and Hazardous Materials Survey - Pre-Renovation " for École élémentaire Antonine-Maillet, 615 Ridgeway Ave, Oshawa, ON dated February 26, 2026 prepared for Conseil scolaire Viamonde by Arcadis Professional Services (Canada) Inc.
- .2 This report identifies existing building components which contain designated substances and asbestos products. The recommendations given in the report shall not be construed as a requirement of this Contract unless Work under the Contract results in disturbance to identified asbestos products. The Contractor is to review the contents of the report and exercise means as required to conform to Ontario Regulation 654/85.
- .3 The report, by its nature, cannot reveal all conditions that exist or can occur on the site. Should subsurface conditions be found to vary substantially from the report, changes in the Work will be made, with resulting credits or expenditures to the contract Price accruing to the Owner.
- .4 The Contractor is to note that subsequent to the preparation of this Report, some corrective work has been undertaken.
- .5 Refer to Section 02 81 00 for remediation.

Designated Substance and Hazardous Materials Survey – Pre-Renovation

École élémentaire Antonine-Maillet
615 Ridgeway Avenue, Oshawa, Ontario

Client Project No.: 30305984

February 26, 2026

Arcadis Project No. 30305984



Designated Substance and Hazardous Materials Survey -Pre-Renovation

École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario

February 26, 2026

Arcadis Project No. 30305984

Prepared By:

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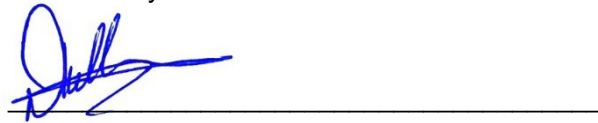
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Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
01	00	02/26/26	All	Final Report	Ada Nguyen

Contents

Acronyms and Abbreviations.....	v
Executive Summary.....	1
1 Introduction.....	1
1.1 Purpose.....	1
1.2 Scope of Work.....	1
2 Background Information.....	2
2.1 Exclusions.....	2
3 Results.....	2
3.1 Asbestos.....	3
3.1.1 Suspect Building Materials Not Found.....	3
3.1.2 Thermal Systems Insulation (TSI).....	3
3.1.3 Vermiculite	Error! Bookmark not defined.
3.1.4 Ceiling Tiles.....	3
3.1.5 Drywall Joint Taping Compound	4
3.1.6 Asbestos Cement Products.....	4
3.1.7 Vinyl Sheet Flooring	4
3.1.8 Vinyl Floor Tile and Associated Mastic.....	5
3.1.9 Caulking, Putty and Mastic.....	5
3.1.10 Roofing Products.....	5
3.1.11 Other Building Materials	6
3.1.12 Potentially Asbestos-Containing Materials.....	6
3.2 Paint	6
3.3 Lead Products.....	7
3.4 Silica.....	7
3.5 Mercury	7
3.6 Polychlorinated Biphenyls (PCBs)	7
3.7 Halocarbon-Containing Equipment (HCE)	7
3.8 Suspect Visible Mould.....	8
4 Recommendations.....	8
4.1 General.....	8
4.2 Remediation Work	8
4.3 Renovation Work Involving Hazardous Materials	8

5	References	10
6	Limitations and Service Constraints	11

Tables

Table 1: Building Description.....	2
Table 2: Results of Analyses of Bulk Samples for Asbestos in CT	4
Table 3: Results of Analyses of Bulk Samples for Asbestos in VSF	4
Table 4: Results of Analyses of Bulk Samples for Asbestos in VFT	5
Table 5: Results of Analyses of Bulk Samples for Asbestos in Caulking, Putty, and Mastic	5
Table 6: Results of Analyses of Bulk Samples for Lead in Paint	6
Table 7: Bulk Material Sample Quantities	F-1
Table 8: Paint Condition Categories.....	F-5

Appendices

Appendix A: Asbestos Summary Table
Appendix B: Asbestos Bulk Summary Table
Appendix C: Laboratory Certificates of Analysis
Appendix D: Floor Plans
Appendix E: Regulations and Guidelines
Appendix F: Survey Methodology

Acronyms and Abbreviations

ACM	Asbestos-Containing Materials
Arcadis	Arcadis Professional Services (Canada) Inc.
DSHMS	Designated Substance Survey and Hazardous Materials Survey
EACC	Environmental Abatement Council of Canada
HCE	Halocarbon-Containing Equipment
NIOSH	National Institute for Occupational Safety and Health
OHS	Occupational Health and Safety
PACM	Potentially Asbestos-Containing Materials
PCBs	Polychlorinated Biphenyls
PLM	Polarized Light Microscopy
TEM	Transmission Electron Microscopy
USEPA	United States Environmental Protection Agency

Executive Summary

Arcadis Professional Services (Canada) Inc. (Arcadis) was retained by the Conseil scolaire Viamonde (CSV) to conduct a pre-renovation designated substance and hazardous materials survey (DSHMS) of École élémentaire Antonine-Maillet located at 615 Ridgeway Avenue, Oshawa, Ontario.

The objective of the assessment was to identify specified designated substance and hazardous materials (DSHMs) in preparation for building renovation. This assessment is intended to be used for renovation purposes only and may not provide sufficient detail for long term management of hazardous materials as required by Health and Safety regulations. The results of this assessment are intended for use with a properly developed scope of work and performance specification.

The project consisted of a limited intrusive assessment of the specified project area as shown on the floor plans included in Appendix D.

The designated substance and hazardous materials (DSHMs) considered during this assessment included the following:

- Asbestos-containing materials (ACM)
- Paint (lead)
- Lead Products
- Silica
- Mercury
- Polychlorinated Biphenyls (PCBs)
- Halocarbon-Containing Equipment (HCE)
- Suspect visible mould

Arcadis performed the assessment on December 5, 2025. The assessment was conducted by Matthew Molinari of Arcadis.

Summary of Findings

Asbestos: Asbestos-containing materials (ACM) were confirmed present in the assessed area including:

- Reinforced autoclaved aerated concrete “Siporex” joint caulking
- Concrete block filler paint
- 9” x 9” beige vinyl floor tiles and associated mastic
- 9” x 9” green vinyl floor tiles and associated mastic
- 12” x 12” beige vinyl floor tiles
- Vinyl sheet flooring and associated paper backing
- Parging cement on pipe fittings
- Drywall joint taping compound

- Cement wall panels

Potentially Asbestos-Containing Materials (PACM): Materials presumed to contain asbestos in the assessed area include:

- ceramic tile grout and mortar beds

Lead: Material that was identified with levels of lead that exceeded criteria in the assessed area are as follows:

- white wall paint
- blue wall paint

Silica: Crystalline silica is a presumed component of concrete, mortar, brick, masonry, ceramic tiles, grout and mortar bed and gypsum board finishes where present in the assessed area.

Mercury: Mercury vapor is present in fluorescent lamps where present in the assessed area.

Polychlorinated Biphenyls (PCBs): Based on visual observations (evidence of T-8 fixtures) the building has been comprehensively re-lamped and will not contain PCB ballasts.

Halocarbon-Containing Equipment: Building related cooling, refrigeration or fire suppression equipment suspected to be HCE was not observed.

Suspect Visible Mould: No suspect visible mould was identified in the assessed area.

Recommendations

We recommend the following on the basis of the findings of the designated substance and hazardous materials (DSHMs) outlined in this report.

General

1. Ensure that all asbestos-containing materials identified not impacted by the proposed renovations are managed in place. The Ontario Regulation 278/05 Regulation Respecting Asbestos on Construction Projects and in Buildings and Repair Operations provides guidance in asbestos management programs including risk assessment, development of safe work procedures, worker instructions, development and implementation of Asbestos Management Plans and record keeping.
2. O. Reg. 278/05 requires the owner to give any other person who is an occupier of the building written notice of any information in the survey record that relates to the area occupied by the person; and to give any employer with whom the owner arranges or contracts for work written notice of the information in the survey record if the work may involve material mentioned in the record, or may be carried out in close proximity to such material; and advise the workers employed by the owner who work in the building of the information if the workers may do work that involves the material, or is to be carried out in close proximity to such materials.
3. Investigate any items excluded from the scope of work of this report. Ideally this investigation will be performed as part of the development of the specifications, or at a minimum immediately prior to commencing renovations when the areas are no longer occupied. Specifically the following materials/areas need to be investigated:
 - a. Ceramic tile grout and mortar beds

4. Provide this report and the detailed plans and specifications to the contractor prior to bidding or commencing work.
5. Retain a qualified consultant to specify, inspect and verify the successful removal of hazardous materials.
6. Update the asbestos inventory upon completion of the abatement and removal of asbestos-containing materials.

Remediation Work

Asbestos-containing materials and presumed asbestos-containing materials were in good condition at the time of the assessment.

Renovation Work Involving Hazardous Materials

1. Prepare plans and performance specifications for hazardous building materials handling and removal required for the planned renovation work. The specifications should include the scope of work, safe work practices, personal protective equipment, respiratory protection, and disposal of waste materials. Provide this report and the detailed plans and specifications to the contractor prior to bidding or commencing work.
2. Remove all asbestos-containing materials (ACM) in the designated work area prior to renovation, alteration, maintenance or demolition work. If the identified ACM will not be removed prior to commencement of the work, disturbance of ACM must follow the appropriate asbestos precautions for the classification of work being performed. Asbestos-containing materials must be disposed of at a landfill approved to accept asbestos waste.
3. Test PACM if impacted by the proposed renovations or demolition. If PACM is not tested, it must be treated as ACM.
4. If work activities may cause exposure to paint containing elevated levels of metal (lead) conduct a risk assessment for exposure, develop an exposure control plan, write safe work procedures, and implement controls. The Ontario Ministry of Labour, Immigration, Training and Skills Development Guideline, Lead on Construction Projects provides guidance in assessment and control of lead exposure, which can be used as a guide for other metals.
5. Items painted with paints containing elevated levels of lead may be a hazardous waste. Test lead-painted materials for leachable lead and other metals prior to disposal. Dispose of painted non-metallic materials exceeding the criteria for leachable lead as hazardous waste. Well adhered paints containing elevated levels of lead on metal substrates do not require leachable lead analysis as the materials can be recycled with the paint intact.
6. Lead-containing items [lead-acid batteries, others] should be recycled when taken out of service or prior to building demolition.
7. If silica-containing materials will be affected by sanding, drilling, chipping, grinding, cutting, sawing, sweeping, demolition or blasting, develop a silica exposure control plan to address control methods and personal protective equipment requirements in order to reduce worker exposure to a level as low as reasonably achievable below the occupational exposure limit prescribed in the Ontario Occupational Health and Safety Regulations Guidance is provided in the Ontario Ministry of Labour, Immigration, Training and Skills Development Guideline, Silica on Construction Projects Silica control methods can

include construction of barriers or enclosure systems to restrict access to and contain the work area; the use of wet methods; local exhaust ventilation when practical; and the use of personnel protective equipment.

8. Recycle and reclaim mercury from fluorescent lamps and thermostats when taken out of service. Do not break lamps or separate liquid mercury from components. Liquid mercury is classified as a hazardous waste and must be disposed of in accordance with local regulations.
9. When light fixtures are removed from service, ensure a qualified person examines the light ballasts for PCB content. If ballasts are not clearly labelled as “non-PCB” or are suspected to contain PCBs, package, and ship ballasts for destruction at a federally permitted facility. Liquid in oil transformers should be sampled for classification purposes. Capacitors suspected to contain PCBs must be disposed of as hazardous waste when removed from service. Dispose of non-liquid PCB materials as hazardous waste when they are removed from the building. Materials with PCB concentration above 50 mg/kg have an end of use date of December 31, 2025 and to comply with PCB Regulations (SOR/2008-273) must be removed and replaced by this date. Liquid containing PCBs less than 50 mg/kg may remain in place until the day on which the liquid is removed from the equipment.

Please refer to Section 4.0 of this report for detailed recommendations regarding administrative, renovation or demolition activities.

Findings of this report are subject to our standard Limitations, as outlined in Section 6.0.

This Executive Summary is subject to the same standard limitations as contained in the report and must be read in conjunction with the entire report.

1 Introduction

1.1 Purpose

Arcadis Professional Services (Canada) Inc. (Arcadis) was retained by the Conseil scolaire Viamonde (CSV) to conduct a pre-renovation designated substance and hazardous materials survey (DSHMS) of École élémentaire Antonine-Maillet located at 615 Ridgeway Avenue, Oshawa, Ontario.

The objective of the assessment was to identify specified designated substance and hazardous materials (DSHMs) in preparation for building renovation. This assessment is intended to be used for renovation purposes only and may not provide sufficient detail for long term management of hazardous materials as required by Health and Safety regulations. The results of this assessment are intended for use with a properly developed scope of work and performance specification.

The project consisted of a limited intrusive assessment of the specified project area as shown on the floor plans included in Appendix D.

Arcadis performed the assessment on December 5, 2025. The assessment was conducted by Matthew Molinari of Arcadis.

1.2 Scope of Work

The scope of work for the project, as referenced in the Arcadis proposal dated November 20, 2025, identifies the requirement to conduct a DSHMS within the study area. Specifically, the scope of work included:

- Review of previous documents related to the work, including floor plans and previous reports.
- Development of sampling strategy to address any identified gaps.
- Conduct initial walk-through inspection to visually identify potential designated substance and hazardous materials (DSHMs).
- Conduct a comprehensive, limited intrusive DSHMS on interior and exterior finishes of the site.
- Submit representative samples of suspect materials identified to accredited laboratories for analysis.
- Evaluation and interpretation of field findings and sample analytical results to develop conclusions and recommendations pertaining to hazardous building materials identified and to provide a summary of the locations of DSHMs.

For the purpose of this assessment, designated substance and hazardous materials (DSHMs) are defined as follows:

- Asbestos-containing materials (ACM)
- Paint (lead)
- Lead products
- Silica

- Mercury
- Polychlorinated Biphenyls (PCBs)
- Halocarbon-Containing Equipment (HCE)
- Suspect visible mould

The assessment was restricted to accessible locations of the buildings. Concrete block walls were investigated for vermiculite by coring small holes in select locations. Roof access and assessment was not included as part of the DSHMS.

A general description of the building included in this DSHMS is provided in Table 1 below:

Table 1: Building Description

Building Name	Address	Total Inside Gross m ²	Year Constructed/ Significant renovations or additions	Building Description
École élémentaire Antonine-Maillet	615 Ridgeway Avenue, Oshawa, Ontario	2,924	1961 (Original Construction) / 1965 (Addition)	Two storey building. Built-up roof. Concrete foundation. Brick and concrete exterior siding. Gypsum board, masonry block and brick interior walls. Gypsum board, acoustic ceiling tile and reinforced autoclaved aerated concrete panel ceilings. Vinyl sheet flooring, vinyl floor tile and terrazzo flooring. Heating, air conditioning and ventilation is supplied by roof top air handling units.

2 Background Information

Background information for the Site includes the following:

- Survey of Asbestos-Containing Materials, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario, March 31, 2020 prepared by Arcadis.

2.1 Exclusions

No areas or items were excluded during this assessment.

3 Results

The following section summarizes the findings of the assessment and provides a general description of the designated substances and hazardous materials (DSHMs) identified, approximate quantity and their locations. Site Photographs are provided in Appendix B. Laboratory certificates of analysis are provided in Appendix C. Floor plans

indicating locations of asbestos-containing materials and room numbers are provided in Appendix D. Appendix E provides information on applicable regulation and guidelines. Refer to Appendix F for the survey methodology.

3.1 Asbestos

During the course of our assessment, representative bulk samples of material were collected by Arcadis staff. The samples were forwarded to EMSL in Mississauga, Ontario for asbestos analyses. EMSL holds a current Certificate of Accreditation for Bulk Asbestos Fibre Analysis under the Voluntary Accreditation Program (NVLAP). Bulk sampling was performed in general accordance with the requirements specified in the ASTM E2356 Standard, and O. Reg. 278/05. Please refer to the Asbestos Summary Table in Appendix A for additional details.

3.1.1 Suspect Building Materials Not Found

The following types of building materials may historically contain asbestos but were not observed in the assessed area and are not discussed in the report findings:

- Spray-applied fireproofing
- Texture finishes (acoustic/decorative)
- Plaster
- Vermiculite
- Firestopping
- Levelling compound
- Roofing Materials

3.1.2 Thermal Systems Insulation (TSI)

3.1.2.1 Pipe Insulation

Parging cement is present on pipe fittings in Rooms 101, 102, 102A and 201. The material was sampled (sample S.01) and determined to be asbestos-containing. Parging cement is a friable insulation, jacketed with canvas and is in good condition. There are approximately six pipe fittings.

3.1.2.2 Duct Insulation

Ducts are insulated with non-asbestos fibreglass and jacketed with either canvas or foil.

3.1.2.3 Mechanical Equipment Insulation

Mechanical equipment is insulated with non-asbestos fiberglass or was not insulated.

3.1.3 Ceiling Tiles

Two distinct types of ceiling tiles (CT) are present in the assessed area, as follows:

Table 2: Results of Analyses of Bulk Samples for Asbestos in CT

Size, Type, Pattern,	Locations (Total Quantity in Square Meters)	Sample Number	Asbestos Type
2' x 4' Ceiling tile – pinholes and fissures	Rooms 102, 103 and 104, Corridors C101, C201 and C202	9A to 9C	None detected
12" x 12" Ceiling tile – deep directional fissures	Corridor C102 and Room 101	104-CT-1A to B2-CT-3C	None detected ⁽¹⁾

NOTE:

(1) Sample results derived from a report prepared by Arcadis for Conseil scolaire Viamonde titled "Survey of Asbestos-Containing Materials, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario" dated March 31, 2020.

3.1.4 Drywall Joint Taping Compound

Gypsum board with drywall joint taping compound (DJTC) is present as a wall finish in Rooms 103, 104, A1, A2 and 201 and as a ceiling finish in Room 101A. The DJTC was sampled and determined to be asbestos-containing (samples 106-DW-1A and 210-DW-3A). DJTC is a non-friable material which may become friable during removal. All DJTC is painted and is in good condition. There is approximately 175 total square meters of drywall present.

3.1.5 Asbestos Cement Products

Asbestos cement wall panels (2' x 2') with holes are present in Corridors C101 and C102. The material was sampled and determined to be asbestos-containing (sample C102-TH-2). Cement panels are a non-friable material and in good condition. There is approximately 20 total square meters of asbestos cement wall panels (2' x 2') with holes present in the assessed area.

Solid asbestos cement wall panels are present in Room 202. The material was sampled and determined to be asbestos-containing (sample 202-TH-2). Cement panels are a non-friable material and in good condition. There is approximately 20 total square meters of solid asbestos cement wall panels present in the assessed area.

3.1.6 Vinyl Sheet Flooring

Two types of vinyl sheet flooring (VSF) are present in the assessed area, as follows:

Table 3: Results of Analyses of Bulk Samples for Asbestos in VSF

Pattern, Colour	Paper Backing (Yes/No)	Locations (Total Quantity in Square Meters)	Sample Number	Asbestos Type
VSF – Pink	No	Rooms 102, 102A	6A to 6C	None detected ⁽¹⁾
VSF – Terrazzo look	Yes	Corridor C102	C102-SF-3A	9% Chrysotile ⁽¹⁾

NOTE:

(1) Sample results derived from a report prepared by Arcadis for Conseil scolaire Viamonde titled "Survey of Asbestos-Containing Materials, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario" dated March 31, 2020.

The vinyl sheet flooring with no paper backing is non-friable. Vinyl sheet flooring with paper backing is considered to be friable during removal. Vinyl sheet flooring is in good condition and applied over a concrete substrate.

3.1.7 Vinyl Floor Tile and Associated Mastic

Four types of vinyl floor tile (VFT) are present in the assessed area, as follows:

Table 4: Results of Analyses of Bulk Samples for Asbestos in VFT

Size, Pattern, Colour	Locations (Total Quantity in Square Meters)	Sample Number	Asbestos Type (tile)	Asbestos Type (mastic)
12" x 12" VFT – pinkish beige, camouflage pattern	Room 201	10-A to 10-C	None detected (PLM) None detected (TEM)	None detected
9" x 9" VFT – beige	Rooms 202 and 203	3A, S.03	5% Chrysotile ⁽¹⁾	2% Chrysotile ⁽¹⁾
9" x 9" VFT – green	Room 101A	4A, 101A-FT-2	13.2% Chrysotile ⁽¹⁾	2% Chrysotile ⁽¹⁾
12" x 12" VFT – beige with dark and white flecks	Room 101	101-FT-1A	7.4% Chrysotile ⁽¹⁾	None detected ⁽¹⁾

NOTE:

(1) Sample results derived from a report prepared by Arcadis for Conseil scolaire Viamonde titled "Survey of Asbestos-Containing Materials, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario" dated March 31, 2020.

The vinyl floor tiles and mastic are non-friable and are in good condition. The tiles are installed over a cement substrate. Mastic was analyzed for asbestos content where it was present on the tiles, however a comprehensive testing program for mastic was not performed.

3.1.8 Caulking, Putty and Mastic

Three types of caulking are present in the assessed area, as follows:

Table 5: Results of Analyses of Bulk Samples for Asbestos in Caulking, Putty, and Mastic

Colour/Material	Locations (Total Quantity in Linear Meters)	Sample Number	Asbestos Type
Interior white door caulking	Corridor C201 (applied to S01 entrance doors)	2A to 2C	None detected (PLM) None detected (TEM)
Interior brown door caulking	Corridor C201 (applied to Room 201 door)	4A to 4C	None detected (PLM) None detected (TEM)
Exterior brown door caulking	S01 entrance doors	S01-TH-11A to S01-TH-11C	None detected ⁽¹⁾

NOTE:

(1) Sample results derived from a report prepared by Arcadis for Conseil scolaire Viamonde titled "Survey of Asbestos-Containing Materials, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario" dated March 31, 2020.

3.1.9 Other Building Materials

Reinforced autoclaved aerated concrete joint caulking (SJC) is present on reinforced autoclaved aerated concrete ceiling panel finishes in Rooms 201, 202, 203, A1 and A2. The material was sampled and determined to contain 2% chrysotile asbestos (sample 1A). SJC is a non-friable material which may become friable during removal and is in good condition. There is approximately 75 square meters of reinforced autoclaved aerated concrete panels with SJC present.

Mortar is present on interior brick wall finishes within the surveyed area. The material was sampled and determined to be non-asbestos (samples 3A to 3C).

Block filler paint is present on concrete block finishes throughout the 1961 construction era. The material was sampled and determined to contain 1% chrysotile asbestos (sample 5A). Concrete block filler paint is a non-friable material which may become friable during removal.

Mortar is present on concrete block wall finishes throughout the 1961 construction era. The material was sampled and determined to be non-asbestos (sample 8A).

Block filler paint is present on concrete block walls throughout the 1965 construction era. The material was sampled and determined to be non-asbestos (sample 6A).

Mortar is present on concrete block wall finishes throughout the 1965 construction era. The material was sampled and determined to be non-asbestos (samples 7A and 7B).

3.1.10 Potentially Asbestos-Containing Materials

A number of materials which might contain asbestos were not sampled during the assessment due to limitations in scope and methodology. Where present, these materials are considered to be potentially asbestos-containing materials (PACM) until otherwise proven by sampling and analysis. Materials that potentially contain asbestos include:

- ceramic tile grout and mortar beds

3.2 Paint

During the course of our site investigation, representative bulk samples of predominant paint types were collected by Arcadis staff. The samples were forwarded to EMSL in Mississauga, Ontario for analyses for lead content. EMSL holds a current Certificate of Accreditation for Lead in Paint under the Canadian Association for Laboratory Accreditation (CALA). Results of bulk sample analysis in paint content are provided in the table below. Samples in bold exceed the criteria.

Table 6: Results of Analyses of Bulk Samples for Lead in Paint

Sample ID	Sample Location	Substrate Material	Sample Description	Condition	Analytical Results (ppm)
					Lead (90 ppm)
P-1	Room 101	Concrete block	White wall paint	Good	1,700

Sample ID	Sample Location	Substrate Material	Sample Description	Condition	Analytical Results (ppm)
					Lead (90 ppm)
P-2	Room 202	Concrete block	Blue wall paint	Good	920

Surfaces in “fair” condition should be repaired and/or monitored but are not considered to be lead-containing paint hazards.
Surfaces in “poor” condition are considered to be lead-containing paint hazards and should be addressed through abatement or interim controls.

Where one colour of paint is indicated in the sample descriptions in the table above, only one layer of paint was observed. Where multiple colours are indicated in the sample description, multiple layers of paint were observed. Similarly painted areas throughout the building are presumed to contain lead at the same concentrations as noted above.

3.3 Lead Products

Materials presumed to contain lead were observed in the assessed area including:

- Electrical components including wiring connectors, grounding conductors, and solder.
- Glazing on ceramic tiles, in the solder (in buildings built pre-1986) on the seals of bell joints of any cast iron drainpipe and in the solder on the sweated-on joints between copper pipe and fittings.

3.4 Silica

Crystalline silica is a presumed component of the following materials where present in the assessed area:

- poured or pre-cast concrete
- masonry and mortar
- brick and brick mortar
- ceramic tiles, grout and mortar bed
- gypsum board and taping compound

3.5 Mercury

Mercury vapor is present in fluorescent lamps where present in the assessed area.

3.6 Polychlorinated Biphenyls (PCBs)

Based on visual observations (evidence of T-8 fixtures) the building has been comprehensively re-lamped and will not contain PCB ballasts.

3.7 Halocarbon-Containing Equipment (HCE)

Building related cooling, refrigeration or fire suppression equipment suspected to be HCE was not observed.

3.8 Suspect Visible Mould

Suspect visible mould and/or water staining was not observed during the assessment.

4 Recommendations

We recommend the following on the basis of the findings of the designated substance and hazardous materials (DSHMs) outlined in this report

4.1 General

1. Ensure that all asbestos-containing materials identified are managed in place. The Ontario Regulation 278/05 Regulation Respecting Asbestos on Construction Projects and in Buildings and Repair Operations provides guidance in asbestos management programs including risk assessment, development of safe work procedures, worker instructions, development and implementation of Asbestos Management Plans and record keeping.
2. O. Reg. 278/05 requires the owner to give any other person who is an occupier of the building written notice of any information in the survey record that relates to the area occupied by the person; and to give any employer with whom the owner arranges or contracts for work written notice of the information in the survey record if the work may involve material mentioned in the record, or may be carried out in close proximity to such material; and advise the workers employed by the owner who work in the building of the information if the workers may do work that involves the material, or is to be carried out in close proximity to such materials.
3. Investigate any items excluded from the scope of work of this report. Ideally this investigation will be performed as part of the development of the specifications, or at a minimum immediately prior to commencing renovations when the areas are no longer occupied. Specifically the following materials/areas need to be investigated:
 - a. ceramic tile grout and mortar beds.
4. Provide this report and the detailed plans and specifications to the contractor prior to bidding or commencing work.
5. Retain a qualified consultant to specify, inspect and verify the successful removal of hazardous materials.
6. Update the asbestos inventory upon completion of the abatement and removal of asbestos-containing materials.

4.2 Remediation Work

No asbestos-containing materials warrant remedial action at this time.

4.3 Renovation Work Involving Hazardous Materials

1. Prepare plans and performance specifications for hazardous building materials handling and removal required for the planned renovation work. The specifications should include the scope of work, safe

work practices, personal protective equipment, respiratory protection, and disposal of waste materials. Provide this report and the detailed plans and specifications to the contractor prior to bidding or commencing work.

2. Remove all asbestos-containing materials (ACM) in the designated work area prior to renovation, alteration, maintenance or demolition work. If the identified ACM will not be removed prior to commencement of the work, disturbance of ACM must follow the appropriate asbestos precautions for the classification of work being performed. Asbestos-containing materials must be disposed of at a landfill approved to accept asbestos waste.
3. Test PACM if impacted by the proposed renovations or demolition. If PACM is not tested, it must be treated as ACM.
4. If work activities may cause exposure to paint containing elevated levels of metal (lead) conduct a risk assessment for exposure, develop an exposure control plan, write safe work procedures, and implement controls. The Ontario Ministry of Labour, Immigration, Training and Skills Development Guideline, Lead on Construction Projects provides guidance in assessment and control of lead exposure, which can be used as a guide for other metals.
5. Items painted with paints containing elevated levels of lead may be a hazardous waste. Test lead-painted materials for leachable lead and other metals prior to disposal. Dispose of painted non-metallic materials exceeding the criteria for leachable lead as hazardous waste. Well adhered paints containing elevated levels of lead on metal substrates do not require leachable lead analysis as the materials can be recycled with the paint intact.
6. Lead-containing items [lead-acid batteries, others] should be recycled when taken out of service or prior to building demolition.
7. If silica-containing materials will be affected by sanding, drilling, chipping, grinding, cutting, sawing, sweeping, demolition or blasting, develop a silica exposure control plan to address control methods and personal protective equipment requirements in order to reduce worker exposure to a level as low as reasonably achievable below the occupational exposure limit prescribed in the Ontario Occupational Health and Safety Regulations Guidance is provided in the Ontario Ministry of Labour, Immigration, Training and Skills Development Guideline, Silica on Construction Projects Silica control methods can include construction of barriers or enclosure systems to restrict access to and contain the work area; the use of wet methods; local exhaust ventilation when practical; and the use of personnel protective equipment.
8. Recycle and reclaim mercury from fluorescent lamps and thermostats when taken out of service. Do not break lamps or separate liquid mercury from components. Liquid mercury is classified as a hazardous waste and must be disposed of in accordance with local regulations.
9. When light fixtures are removed from service, ensure a qualified person examines the light ballasts for PCB content. If ballasts are not clearly labelled as “non-PCB” or are suspected to contain PCBs, package, and ship ballasts for destruction at a federally permitted facility. Liquid in oil transformers should be sampled for classification purposes. Capacitors suspected to contain PCBs must be disposed of as hazardous waste when removed from service. Dispose of non-liquid PCB materials as hazardous waste when they are removed from the building. Materials with PCB concentration above 50 mg/kg have an end of use date of December 31, 2025 and to comply with PCB Regulations

(SOR/2008-273) must be removed and replaced by this date. Liquid containing PCBs less than 50 mg/kg may remain in place until the day on which the liquid is removed from the equipment.

5 References

The following legislation and documents were referenced in completing the assessment and this report:

1. Occupational Health and Safety Act, (OSHA), R.S.O. 1990, c. O.1.
2. ASTM E2356 Standard Practice for Comprehensive Buildings Asbestos Surveys, 2018 Edition.
3. Ontario Regulation 278/05 – Designated Substance – Asbestos on Construction Projects and in Buildings and Repair Operations, O. Reg. 278/05
4. R.R.O. 1990, Reg. 347: General - Waste Management
5. Ozone Depleting Substances and Other Halocarbons, O Reg. 463/10.
6. Ontario Ministry of Labour, Immigration, Training and Skills Development (MLITSD) “*A Guide to the Regulation Respecting Asbestos on Construction Projects and in Buildings and Repair Operations*”, November 2022
7. Federal Halocarbon Regulations, 2022, SOR/2022-110, under Canadian Environmental Protection Act, 1999.
8. PCB Regulations, SOR/2008-273, as amended up to October 31, 2021, under Canadian Environmental Protection Act, 1999.
9. Identification of Lamp Ballasts Containing PCBs. Report EPS 2/CC/2 (revised), Environment Canada, August 1991.
10. Surface Coating Materials Regulations, SOR/2016-193, as amended up to December 19, 2022, under Canada Consumer Product Safety Act.
11. Guideline, Lead on Construction Projects, Ontario Ministry of Labour, Immigration, Training and Skills Development, 2011.
12. Environmental Abatement Council of Canada Lead Guidelines for Construction, Renovation, Maintenance or Repair, October 2014
13. Transportation of Dangerous Goods Regulations, SOR/2001-286, Transportation of Dangerous Goods Act, 1992.
14. Mould Guidelines for the Canadian Construction Industry, Canadian Construction Association, 2018 Edition.
15. Environmental Abatement Council of Canada Mould Abatement Guidelines, Edition 3 (2015).
16. Guideline, Silica on Construction Projects, Ontario Ministry of Labour, Immigration, Training and Skills Development, November 2022.

6 Limitations and Service Constraints

The opinions, conclusions and recommendations presented in this report are limited to the information obtained during the performance of the specific scope of service identified in the report. To the extent that Arcadis relied upon any information prepared by other parties not under direct contract to Arcadis, no representation as to the accuracy or completeness of such information is made. This report is an instrument of professional service and the services described in the report were performed in accordance with generally accepted standards and level of skill and care ordinarily exercised by members of the profession working under similar conditions including comparable budgetary and schedule constraints. No warranty, guarantee or certification express or implied, is intended or given with respect to Arcadis' services, opinions, conclusions or recommendations.

Arcadis' observations, the results of any testing and Arcadis' opinions, conclusions and recommendations apply solely to conditions existing at the specific times when and specific locations where Arcadis' investigative work was performed. Arcadis affirms that data gathered and presented in this report was collected in an appropriate manner in accordance with generally accepted methods and practices. Arcadis cannot be responsible for decisions made by our client solely on the basis of economic factors. Observation and testing activities such as those conducted by Arcadis are inherently limited and do not represent a conclusive or complete characterization. Arcadis analyzed only the substances, conditions and locations described in the report at the time indicated. Conditions in other parts of the project site, building or area may vary from conditions at the specific locations where observations were made and where testing was performed by Arcadis. Additionally, other building material hazards which were not identified by Arcadis, may also be present un-accessed areas and in walls, ceilings, cavities, and floors.

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Appendix A

Asbestos Summary Table

APPENDIX A: Asbestos Summary Table								
Level	Room	Material	Asbestos Content	Location Within Space	Estimated Quantity	Friable or Non-Friable	Condition	Comments
1	101	12" x 12" vinyl floor tiles	7.4% Chrysotile	Floor	10-50 m ²	Non-Friable	G	-
		Pipe fitting insulation	55% Chrysotile	Above ceiling	>20 fittings	Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	101A	9" x 9" vinyl floor tiles	13.2% Chrysotile	Floor	<10 m ²	Non-Friable	G	-
		Floor tile mastic	2% Chrysotile	Below floor tiles	10-50 m ²	Non-Friable	G	-
		Drywall joint compound	2.8% Chrysotile	Ceiling	<10 m ²	Non-Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	102	Pipe fitting insulation	55.0% Chrysotile	Above ceiling	< 5 fittings	Friable	G	Drywall on walls and vinyl sheet flooring reportedly installed post 1995.
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	102A	Pipe fitting insulation	55.0% Chrysotile	Above ceiling	10-20 fittings	Friable	F	Drywall on walls and vinyl sheet flooring reportedly installed post 1995.
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	103	Drywall joint compound	2.8% Chrysotile	Wall	<10 m ²	Non-Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	104	Drywall joint compound	2.8% Chrysotile	Wall	<10 m ²	Non-Friable	G	-

APPENDIX A: Asbestos Summary Table								
Level	Room	Material	Asbestos Content	Location Within Space	Estimated Quantity	Friable or Non-Friable	Condition	Comments
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	C101	2' x 2' cement panels	28.0% Chrysotile	On ceiling bulkhead west of stair A1	< 10 m ²	Non-Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	C102	Vinyl sheet flooring	9% Chrysotile	In front of door to Room 102	< 10 m ²	Non-Friable	G	-
		Vinyl sheet flooring mastic	28.6% Chrysotile	In front of door to Room 102	< 10 m ²	Friable	G	Asbestos-containing paper backing on vinyl sheet flooring is a friable material if disturbed.
		2' x 2' cement panels	28.0% Chrysotile	At ceiling bulkhead	< 10 m ²	Non-Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
1	A1	Drywall joint compound	2.8% Chrysotile	North wall	10-50 m ²	Non-Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
		Reinforced autoclaved aerated concrete "Siporex" joint caulking	2% Chrysotile	Between ceiling panels	1-5 m ²	Non-Friable	G	-
2	201	Pipe fitting insulation	55% Chrysotile	Below ceiling at south wall	< 5 fittings	Friable	G	12" vinyl floor tile reportedly installed post 1995.
		Drywall joint compound	2.8% Chrysotile	Wall	<10 m ²	Non-Friable	G	-

APPENDIX A: Asbestos Summary Table								
Level	Room	Material	Asbestos Content	Location Within Space	Estimated Quantity	Friable or Non-Friable	Condition	Comments
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
		Reinforced autoclaved aerated concrete "Siporex" joint caulking	2% Chrysotile	Between ceiling panels	1-5 m ²	Non-Friable	G	-
2	202	9" x 9" vinyl floor tiles	5% Chrysotile	Floor	10-50 m ²	Non-Friable	G	-
		Floor tile mastic	2% Chrysotile	Below floor tiles	10-50 m ²	Non-Friable	G	-
		Cement board	23% Chrysotile	On west wall	< 10 m ²	Non-Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
		Reinforced autoclaved aerated concrete "Siporex" joint caulking	2% Chrysotile	Between ceiling panels	1-5 m ²	Non-Friable	G	-
2	203	9" x 9" vinyl floor tiles	5% Chrysotile	Floor	10-50 m ²	Non-Friable	G	-
		Floor tile mastic	2% Chrysotile	Below floor tiles	10-50 m ²	Non-Friable	G	-
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
		Reinforced autoclaved aerated concrete "Siporex" joint caulking	2% Chrysotile	Between ceiling panels	1-5 m ²	Non-Friable	G	-
2	C201	Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
2	C202	Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
2	A2	Drywall joint compound	2.8% Chrysotile	North wall	10-50 m ²	Non-Friable	G	-

APPENDIX A: Asbestos Summary Table								
Level	Room	Material	Asbestos Content	Location Within Space	Estimated Quantity	Friable or Non-Friable	Condition	Comments
		Concrete block-filler paint	1% Chrysotile	Walls	10-50 m ²	Non-Friable	G	-
		Reinforced autoclaved aerated concrete "Siporex" joint caulking	2% Chrysotile	Between ceiling panels	1-5 m ²	Non-Friable	G	-

Appendix B

Asbestos Bulk Sample Table

Sample N ^o	Location	Description	Asbestos Content
1A	Room 202	Reinforced autoclaved aerated concrete "Siporex" joint caulking	2% Chrysotile
2A	C201	Interior white door caulking	None detected (PLM) None detected (TEM)
2B	C201	Interior white door caulking	None detected
2C	C201	Interior white door caulking	None detected
3A	C201	Interior brick mortar	None detected
3B	C201	Interior brick mortar	None detected
3C	C202	Interior brick mortar	None detected
4A	C201	Interior brown door caulking	None detected
4B	C201	Interior brown door caulking	None detected
4C	C201	Interior brown door caulking	None detected
5A	Room 202	Concrete block filler paint (1961 construction era)	1% Chrysotile
6A	C206	Concrete block filler paint (1965 construction era)	None detected
7A	C206	Concrete block mortar (1965 construction era)	None detected
7B	C206	Concrete block mortar (1965 construction era)	None detected
8A	Room 202	Concrete block mortar (1961 construction era)	None detected
9A	C201	2' x 4' ceiling tiles with pinholes and fissures	None detected
9B	C201	2' x 4' ceiling tiles with pinholes and fissures	None detected
9C	C202	2' x 4' ceiling tiles with pinholes and fissures	None detected
10A	Room 201	12" x 12" vinyl floor tile – pinkish-beige, camouflage pattern	None detected (PLM) None detected (TEM)
10A	Room 201	Mastic under 12" x 12" vinyl floor tile – pinkish-beige, camouflage pattern	None detected
10B	Room 201	12" x 12" vinyl floor tile – pinkish-beige, camouflage pattern	None detected
10B	Room 201	Mastic under 12" x 12" vinyl floor tile – pinkish-beige, camouflage pattern	None detected
10C	Room 201	12" x 12" vinyl floor tile – pinkish-beige, camouflage pattern	None detected
10C	Room 201	Mastic under 12" x 12" vinyl floor tile – pinkish-beige, camouflage pattern	None detected
1A	Room 206	12" vinyl floor tile – white with brown fleck	None detected (PLM) ⁽¹⁾ None detected (TEM) ⁽¹⁾
1B	Room 206	12" vinyl floor tile – white with brown fleck	None detected ⁽¹⁾
1C	Room 206	12" vinyl floor tile – white with brown fleck	None detected ⁽¹⁾
2A	Room 206	Mastic under 12" vinyl floor tile`	None detected ⁽¹⁾
2B	Room 206	Mastic under 12" vinyl floor tile	None detected ⁽¹⁾
2C	Room 206	Mastic under 12" vinyl floor tile	None detected ⁽¹⁾
3A	Room 202	Mastic under 9" beige vinyl floor tile	2% Chrysotile ⁽¹⁾
4A	Room 222	Mastic under 9" green vinyl floor tile	2% Chrysotile ⁽¹⁾
5A	Room 110B	Vinyl sheet flooring – beige	None detected (PLM) ⁽¹⁾ None detected (TEM) ⁽¹⁾
5B	Room 110D	Vinyl sheet flooring – beige	None detected ⁽¹⁾

Sample Nº	Location	Description	Asbestos Content
5C	Room 110B	Vinyl sheet flooring – beige	None detected ⁽¹⁾
6A	Room 102	Vinyl sheet flooring – pink	None detected (PLM) ⁽¹⁾ None detected (TEM) ⁽¹⁾
6B	Room 102A	Vinyl sheet flooring – pink	None detected ⁽¹⁾
6C	Room 102	Vinyl sheet flooring – pink	None detected ⁽¹⁾
7A	Room 102	Drywall joint compound	None detected ⁽¹⁾
7B	Room 102	Drywall joint compound	None detected ⁽¹⁾
7C	Room 110B	Drywall joint compound	None detected ⁽¹⁾
8A	Room 110D	Paint on concrete block	None detected ⁽¹⁾
8B	Room 207	Paint on concrete block	None detected ⁽¹⁾
8C	Room 209	Paint on concrete block	None detected ⁽¹⁾
1A	Room 222	12" ceiling tile adhesive	None detected ⁽¹⁾
1B	Room 222	12" ceiling tile adhesive	None detected ⁽¹⁾
1C	Room 222	12" ceiling tile adhesive	None detected ⁽¹⁾
106-DW-1A	Room 106	Drywall joint compound on drywall ceiling – 1961	2.8% Chrysotile ^(1,3)
210-DW-3A	Room 210	Drywall joint compound on drywall ceiling – 1965	0.5% Chrysotile ⁽¹⁾
104-CT-1A	Room 104	12" x 12" ceiling tile deep directional fissure - yellow - 1961	None detected ⁽¹⁾
C102-CT-1B	Room C102	12" x 12" ceiling tile deep directional fissure - yellow - 1961	None detected ⁽¹⁾
C209-CT-1C	Room C209	12" x 12" ceiling tile deep directional fissure - yellow - 1961	None detected ⁽¹⁾
C102-CT-3A	Room C102	12" x 12" ceiling tile deep directional fissure - white – 1961	None detected ⁽¹⁾
B2-CT-3B	Room B2	12" x 12" ceiling tile deep directional fissure - white – 1961	None detected ⁽¹⁾
B2-CT-3C	Room B2	12" x 12" ceiling tile deep directional fissure - white – 1961	None detected ⁽¹⁾
B1-CT-5A	Room B1	2' x 4' ceiling tile fissure on 2 ft. natural back – "Fireguard" blue letters	None detected ⁽¹⁾
B1-CT-5B	Room B1	2' x 4' ceiling tile fissure on 2 ft. natural back – "Fireguard" blue letters	None detected ⁽¹⁾
B1-CT-5C	Room B1	2' x 4' ceiling tile fissure on 2 ft. natural back – "Fireguard" blue letters	None detected ⁽¹⁾
B1-CT-6A	Room B1	2' x 4' ceiling tile fissure and dot. Embossed letters on back	None detected ⁽¹⁾
B1-CT-6B	Room B1	2' x 4' ceiling tile fissure and dot. Embossed letters on back	None detected ⁽¹⁾
B1-CT-6C	Room B1	2' x 4' ceiling tile fissure and dot. Embossed letters on back	None detected ⁽¹⁾
101-FT-1A	Room 101	12" x 12" floor tile – beige with dark brown and white directional flecks	7.4% Chrysotile ⁽¹⁾
101A-FT-2	Room 101A	9" x 9" floor tile – green	13.2% Chrysotile ⁽¹⁾
C102-SF-3A	Room C102	Vinyl sheet flooring with a paper back. Terrazzo look – small pattern	9.0% Chrysotile ⁽¹⁾

Sample Nº	Location	Description	Asbestos Content
108-FT-4A	Room 108	12" x 12" floor tile – brown with brown fleck (new look)	None detected ⁽¹⁾
108-FT-4B	Room 108	12" x 12" floor tile – brown with brown fleck (new look)	None detected ⁽¹⁾
108-FT-4C	Room 108	12" x 12" floor tile – brown with brown fleck (new look)	None detected ⁽¹⁾
B2-SF-6A	Room B2	Vinyl sheet flooring with a paper back. Terrazzo look – large pattern	None detected ⁽¹⁾
B2-SF-6B	Room B2	Vinyl sheet flooring with a paper back. Terrazzo look – large pattern	None detected ⁽¹⁾
B2-SF-6C	Room B2	Vinyl sheet flooring with a paper back. Terrazzo look – large pattern	None detected ⁽¹⁾
220-FT-7	Room 220	9" x 9" floor tile – white with black streaks – 1961	8.9% Chrysotile ⁽¹⁾
218-FT-8A	Room 218	12" x 12" floor tile – beige with mauve fleck (new look)	1.0% Chrysotile ^(1,3)
213-FT-11	Room 213	9" x 9" floor tile – white with black streaks - 1965	25.1% Chrysotile ⁽¹⁾
C102-TH-2	Room C102	2' x 2' cement wall panels with holes – 1961	28.0% Chrysotile ⁽¹⁾
107B-TH-2	Room 107B	Heat shield on light fixture	68.0% Chrysotile ⁽¹⁾
202-TH-4	Room 202	Solid cement wall panels - 1961	23.0% Chrysotile ⁽¹⁾
C203-TH-5A	Room C203	Insulation on pipe straight "antisweat" with black paper - 1961	<0.25% Chrysotile ^(1,2)
C203-TH-5B	Room C203	Insulation on pipe straight "antisweat" with black paper - 1961	None detected ⁽¹⁾
C203-TH-5C	Room C203	Insulation on pipe straight "antisweat" with black paper - 1961	None detected ⁽¹⁾
S02-TH-7A	Room S02	Cementitious soffit panels	19% Chrysotile ⁽¹⁾
208-TH-8A	Room 208	Insulation on pipe straight "antisweat" with black paper - 1965	<0.25% Chrysotile ^(1,2)
208-TH-8B	Room 208	Insulation on pipe straight "antisweat" with black paper - 1965	None detected ⁽¹⁾
208-TH-8C	Room 208	Insulation on pipe straight "antisweat" with black paper - 1965	None detected ⁽¹⁾
S04-TH-9A	Room S04	Exterior caulking on door – grey - 1965	<0.25% Chrysotile ^(1,2)
S04-TH-9B	Room S04	Exterior caulking on door – grey - 1965	None detected ⁽¹⁾
S04-TH-9C	Room S04	Exterior caulking on door – grey - 1965	None detected ⁽¹⁾
S04-TH-10A	Room S04	Caulking around soffit – 1965	0.6% Chrysotile ⁽¹⁾
S01-TH-11A	Room S01	Exterior caulking on door – brown - 1961	<0.25% Chrysotile ^(1,2)
S01-TH-11B	Room S01	Exterior caulking on door – brown - 1961	None detected ⁽¹⁾
S01-TH-11C	Room S01	Exterior caulking on door – brown - 1961	None detected ⁽¹⁾
S.01	-	Mud joint compound elbow insulation	55% Chrysotile ⁽¹⁾
S.03	-	9" x 9" floor tile beige/light grey	5% Chrysotile ⁽¹⁾
1-A	Room 218	Mastic under asbestos vinyl floor tile – black coloured	0.75% Chrysotile ⁽¹⁾
2-A	Room 218	Vinyl baseboard – black coloured	None detected (TEM) ⁽¹⁾
2-B	Room 218	Vinyl baseboard – black coloured	None detected ⁽¹⁾
2-C	Room C208	Vinyl baseboard – black coloured	None detected ⁽¹⁾

Sample N ^o	Location	Description	Asbestos Content
3-A	Room 218	Baseboard mastic – dark brown coloured	None detected (TEM) ⁽¹⁾
3-B	Room 218	Baseboard mastic – dark brown coloured	None detected ⁽¹⁾
3-C	Room 211	Baseboard mastic – dark brown coloured	None detected ⁽¹⁾
4-A	Room B2	Mastic under non-asbestos sheet flooring – cream coloured	28.6% Chrysotile ^(1,3)
5-A	Room B2	Caulking on stair stringer – grey coloured	3.2% Chrysotile ^(1,3)
6-A	Room 211	Mastic under non-asbestos vinyl floor tile – black coloured	None detected (TEM) ⁽¹⁾
6-B	Room 211	Mastic under non-asbestos vinyl floor tile – black coloured	None detected ⁽¹⁾
6-C	Room 210	Mastic under non-asbestos vinyl floor tile – black coloured	None detected ⁽¹⁾
7-A	Room 211	Vinyl floor tile (new) – grey coloured	None detected (TEM) ⁽¹⁾
7-B	Room 211	Vinyl floor tile (new) – grey coloured	None detected ⁽¹⁾
7-C	Room 210	Vinyl floor tile (new) – grey coloured	None detected ⁽¹⁾
8-A	Room 211	Vinyl baseboard – grey coloured	None detected (TEM) ⁽¹⁾
8-B	Room 211	Vinyl baseboard – grey coloured	None detected ⁽¹⁾
8-C	Room 211	Vinyl baseboard – grey coloured	None detected ⁽¹⁾
9-A	Room 212	Caulking on window frame in partition wall– white coloured	None detected (TEM) ⁽¹⁾
9-B	Room 224A	Caulking on window frame in partition wall– white coloured	None detected ⁽¹⁾
9-C	Room 224A	Caulking on window frame in partition wall– white coloured	None detected ⁽¹⁾
10A	Room 211	Mortar in concrete block wall	None detected (TEM) ⁽¹⁾
10B	Room 224A	Mortar in concrete block wall	None detected ⁽¹⁾
10C	Room 224A	Mortar in concrete block wall	None detected ⁽¹⁾
8-A	Exterior C203	Cementitious aggregate finish – white in colour from exterior window base	None detected ⁽¹⁾
8-B	Exterior 102	Cementitious aggregate finish – white in colour from exterior window base	None detected ⁽¹⁾
8-C	Exterior 216	Cementitious aggregate finish – white in colour from exterior window base	None detected ⁽¹⁾
9-A	Exterior C203	Mortar – grey in colour from exterior brick wall (1965)	None detected ⁽¹⁾
9-B	Exterior 108	Mortar – grey in colour from exterior brick wall (1965)	None detected ⁽¹⁾
9-C	Exterior 102A	Mortar – grey in colour from exterior brick wall (1965)	None detected ⁽¹⁾
10-A	Exterior 210	Mortar – grey in colour from exterior brick wall (1961)	None detected ⁽¹⁾
10-B	Exterior 212	Mortar – grey in colour from exterior brick wall (1961)	None detected ⁽¹⁾
10-C	Exterior 214	Mortar – grey in colour from exterior brick wall (1961)	None detected ⁽¹⁾

NOTES:

- (1) Sample results taken from a report prepared by Arcadis for the Conseil scolaire Viamonde titled *Survey of Asbestos-Containing Materials, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario* dated March 31, 2020.
- (2) Asbestos-containing material" is defined as material that contains 0.5% or more asbestos by dry weight.
- (3) Materials collected in the area have since been removed and are provided here for reference purposes only.

Bulk samples were analyzed by Polarized Light Microscopy (PLM) analysis, except where "TEM" is noted, in which case Transmission Electron Microscopy analysis was also performed.

< = Less than.

Chrysotile = Chrysotile asbestos.

Appendix C

Laboratory Certificates of Analysis



EMSL Canada Inc.

2756 Slough Street Mississauga, ON L4T 1G3
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<http://www.EMSL.com> / torontolab@emsl.com

EMSL Canada Order 552521761
Customer ID: 55CLEG25
Customer PO: 30305671
Project ID:

Attn: Matthew Molinari
Arcadis Professional Svcs (Canada) Inc.
8133 Warden Ave, Unit 300
Markham, ON L6G 1B3

Phone: (905) 940-6161
Fax:
Collected:
Received: 12/08/2025
Analyzed: 12/15/2025

Proj: Antonne - Maillet / 30305671

Summary Test Report for Asbestos Analysis of Bulk Materials for Ontario Regulation 278/05

Client Sample ID: 1A **Lab Sample ID:** 552521761-0001

Sample Description: Rm 202/Siporex Joint Compound

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray/Beige	0.0%	98.0%	2% Chrysotile	

Client Sample ID: 1B **Lab Sample ID:** 552521761-0002

Sample Description: Rm 202/Siporex Joint Compound

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025					Positive Stop (Not Analyzed)

Client Sample ID: 1C **Lab Sample ID:** 552521761-0003

Sample Description: Rm 201/Siporex Joint Compound

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025					Positive Stop (Not Analyzed)

Client Sample ID: 2A **Lab Sample ID:** 552521761-0004

Sample Description: C201/Interior White Door Caulking

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM Grav. Reduction	12/15/2025	Gray	0.0%	100%	None Detected	
TEM Grav. Reduction	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 2B **Lab Sample ID:** 552521761-0005

Sample Description: C201/Interior White Door Caulking

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 2C **Lab Sample ID:** 552521761-0006

Sample Description: C201/Interior White Door Caulking

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 3A-Block Fill **Lab Sample ID:** 552521761-0007

Sample Description: C201/Interior Block Mortar

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	White	0.0%	100.0%	None Detected	



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EMSL Canada Order 552521761
Customer ID: 55CLEG25
Customer PO: 30305671
Project ID:

Summary Test Report for Asbestos Analysis of Bulk Materials for Ontario Regulation 278/05

Client Sample ID: 3A-Mortar **Lab Sample ID:** 552521761-0007A

Sample Description: C201/Interior Block Mortar

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 3B-Block Fill **Lab Sample ID:** 552521761-0008

Sample Description: C201/Interior Block Mortar

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	White	0.0%	100.0%	None Detected	

Client Sample ID: 3B-Mortar **Lab Sample ID:** 552521761-0008A

Sample Description: C201/Interior Block Mortar

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 3C-Block Fill **Lab Sample ID:** 552521761-0009

Sample Description: C202/Interior Block Mortar

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Brown/White	0.0%	100.0%	None Detected	

Client Sample ID: 3C-Mortar **Lab Sample ID:** 552521761-0009A

Sample Description: C202/Interior Block Mortar

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 4A **Lab Sample ID:** 552521761-0010

Sample Description: C201/Interior Brown Door Caulking

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM Grav. Reduction	12/15/2025	White/Beige	0.0%	100%	None Detected	
TEM Grav. Reduction	12/15/2025	White/Beige	0.0%	100.0%	None Detected	

Client Sample ID: 4B **Lab Sample ID:** 552521761-0011

Sample Description: C201/Interior Brown Door Caulking

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Brown	0.0%	100.0%	None Detected	

Client Sample ID: 4C **Lab Sample ID:** 552521761-0012

Sample Description: C201/Interior Brown Door Caulking

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Brown	0.0%	100.0%	None Detected	



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EMSL Canada Order 552521761
Customer ID: 55CLEG25
Customer PO: 30305671
Project ID:

Summary Test Report for Asbestos Analysis of Bulk Materials for Ontario Regulation 278/05

Client Sample ID: 5A **Lab Sample ID:** 552521761-0013

Sample Description: Rm202/Block Filler Paint (BFP) (1961 Era)

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Beige	0.0%	99.0%	1% Chrysotile	

Client Sample ID: 5B **Lab Sample ID:** 552521761-0014

Sample Description: Rm202/Block Filler Paint (BFP) (1961 Era)

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025					Positive Stop (Not Analyzed)

Client Sample ID: 6A **Lab Sample ID:** 552521761-0015

Sample Description: C206/Block Filler Paint (BFP) (1965 Era)

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	White/Beige	0.0%	100.0%	None Detected	

Client Sample ID: 7A **Lab Sample ID:** 552521761-0016

Sample Description: C206/Masonry Mortar (1965 Era)

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 7B **Lab Sample ID:** 552521761-0017

Sample Description: C206/Masonry Mortar (1965 Era)

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray/Beige	0.0%	100.0%	None Detected	

Client Sample ID: 8A **Lab Sample ID:** 552521761-0018

Sample Description: Rm202/Masonry Mortar (1961 Era)

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	0.0%	100.0%	None Detected	

Client Sample ID: 9A **Lab Sample ID:** 552521761-0019

Sample Description: C201/2x4 CT, Pinhole & Fissure

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Brown	80.0%	20.0%	None Detected	

Client Sample ID: 9B **Lab Sample ID:** 552521761-0020

Sample Description: C201/2x4 CT, Pinhole & Fissure

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	80.0%	20.0%	None Detected	



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Project ID:

Summary Test Report for Asbestos Analysis of Bulk Materials for Ontario Regulation 278/05

Client Sample ID: 9C

Lab Sample ID: 552521761-0021

Sample Description: C202/2x4 CT, Pinhole & Fissure

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Gray	80.0%	20.0%	None Detected	

Client Sample ID: 10A-Vinyl Floor Tile

Lab Sample ID: 552521761-0022

Sample Description: Rm 201/12x12 VFT (Pinkish - Beige, Camouflage Pattern) + Mastic

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM Grav. Reduction	12/15/2025	Pink	0.0%	100%	None Detected	
TEM Grav. Reduction	12/15/2025	Pink	0.0%	100.0%	None Detected	

Client Sample ID: 10A-Mastic

Lab Sample ID: 552521761-0022A

Sample Description: Rm 201/12x12 VFT (Pinkish - Beige, Camouflage Pattern) + Mastic

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Black	0.0%	100.0%	None Detected	

Client Sample ID: 10B-Vinyl Floor Tile

Lab Sample ID: 552521761-0023

Sample Description: Rm 201/12x12 VFT (Pinkish - Beige, Camouflage Pattern) + Mastic

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Beige	0.0%	100.0%	None Detected	

Client Sample ID: 10B-Mastic

Lab Sample ID: 552521761-0023A

Sample Description: Rm 201/12x12 VFT (Pinkish - Beige, Camouflage Pattern) + Mastic

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Black	0.0%	100.0%	None Detected	

Client Sample ID: 10C-Vinyl Floor Tile

Lab Sample ID: 552521761-0024

Sample Description: Rm 201/12x12 VFT (Pinkish - Beige, Camouflage Pattern) + Mastic

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Beige	0.0%	100.0%	None Detected	

Client Sample ID: 10C-Mastic

Lab Sample ID: 552521761-0024A

Sample Description: Rm 201/12x12 VFT (Pinkish - Beige, Camouflage Pattern) + Mastic

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	12/15/2025	Black	0.0%	100.0%	None Detected	



EMSL Canada Inc.

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Customer ID: 55CLEG25
Customer PO: 30305671
Project ID:

Summary Test Report for Asbestos Analysis of Bulk Materials for Ontario Regulation 278/05

Analyst(s):

Antonio Peluso	PLM (17)
Diana Costantino	PLM (1)
Nickesh Mistry	PLM (6)
	PLM Grav. Reduction (3)
Stephanie Achaiya	TEM Grav. Reduction (3)

Reviewed and approved by:

Matthew Davis or other approved signatory
or Other Approved Signatory

None Detected = <0.1%. EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This is a summary report; official reports are available on LabConnect or upon request and relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted. The above analyses were performed in general compliance with Appendix E to Subpart E of 40 CFR (previously EPA 600/M4-82-020 "Interim Method") but augmented with procedures outlined in the 1993 ("final") version of the method. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-friable organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Unless requested by the client, building materials manufactured with multiple layers (i.e. linoleum, wallboard, etc.) are reported as a single sample. Estimation of uncertainty is available on request.

Samples analyzed by EMSL Canada Inc. Mississauga, ON NVLAP Lab Code 200877-0

Initial report from: 12/15/2025 19:51:38

**EMSL Canada Inc.**

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EMSL Canada Or 552521715

CustomerID: 55CLEG25

CustomerPO: 30305671

ProjectID:

Attn: **Matthew Molinari**
Arcadis Professional Svcs (Canada) Inc.
8133 Warden Ave, Unit 300
Markham, ON L6G 1B3

Phone: (905) 940-6161
Fax:
Received: 12/8/2025 09:00 AM
Collected:

Project: **Antoine - Meillet / 30305671****Test Report: Lead in Paint Chips by Flame AAS (SW 846 3050B/7000B)***

<i>Client Sample</i>	<i>Description</i>	<i>Collected</i>	<i>Analyzed</i>	<i>Weight</i>	<i>RDL</i>	<i>Lead Concentration</i>
P-1			12/10/2025	0.2548 g	64 ppm	1700 ppm
552521715-0001	Site: Room 101 / White Wall Paint					
P-2			12/10/2025	0.2561 g	64 ppm	920 ppm
552521715-0002	Site: Room 202 / Blue Wall Paint					

Rowena Fanto, Lead Supervisor
or other approved signatory

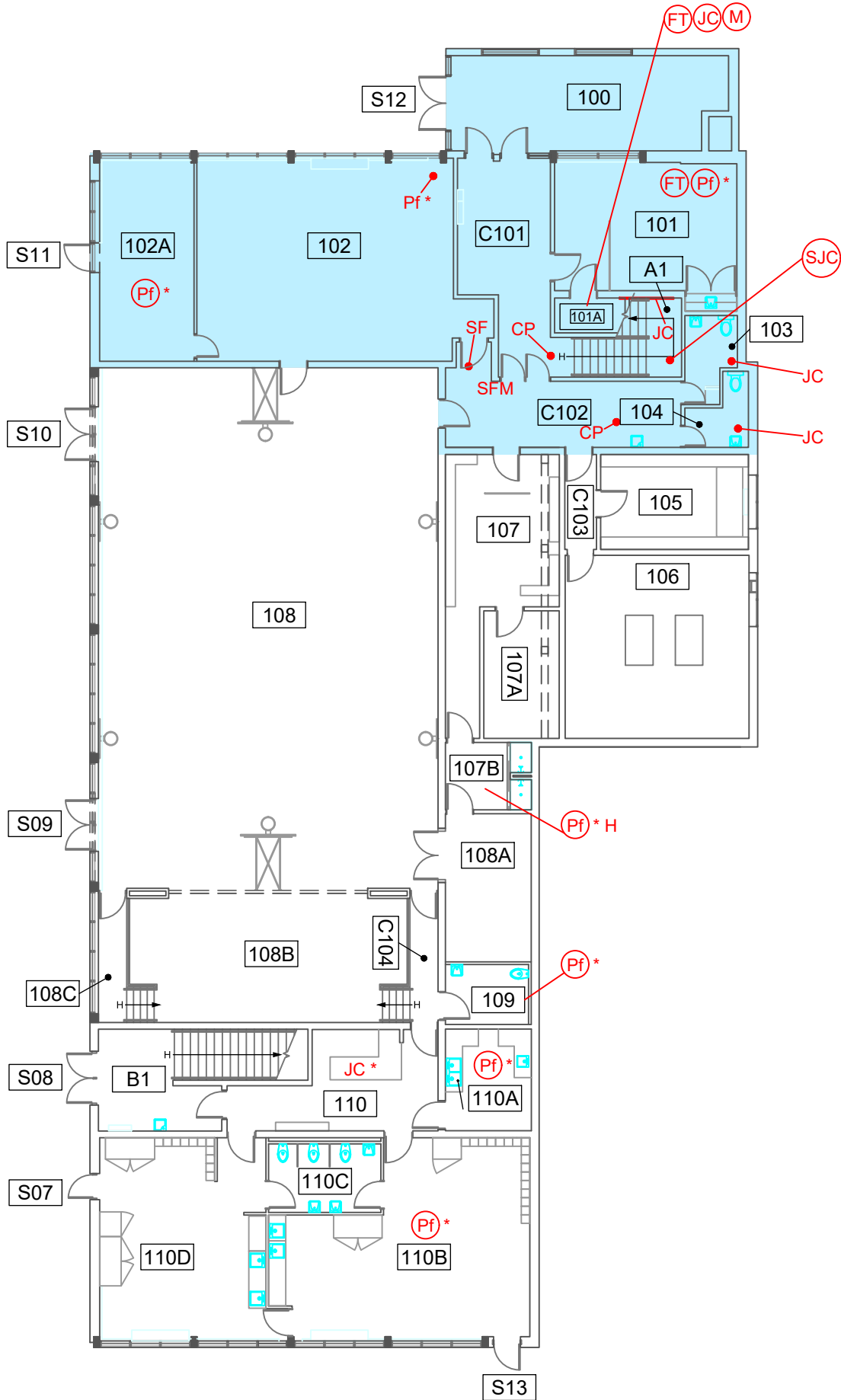
EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted. * Analysis following Lead in Paint by EMSL SOP/Determination of Environmental Lead by FLAA. Reporting limit is 0.0064% wt based on the minimum sample weight per our SOP. "<" (less than) result signifies the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. Definitions of modifications are available upon request.

Samples analyzed by EMSL Canada Inc. Mississauga, ON AIHA LAP, LLC-ELLAP Accredited #196142

Initial report from 12/15/2025 08:13:58

Appendix D

Floor Plans



ASBESTOS PAINT IS PRESENT ON
CONCRETE BLOCK WALLS THROUGHOUT
THE 1961 CONSTRUCTION ERA

LEGEND:

- 25 FUNCTIONAL SPACE
- THROUGHOUT FUNCTIONAL SPACE
- * ABOVE CEILING ASSEMBLY
- Pf ASBESTOS ON PIPE FITTINGS
- FT ASBESTOS FLOOR TILE
- SFM ASBESTOS SHEET FLOOR MASTIC
- SF ASBESTOS SHEET FLOORING
- JC ASBESTOS DRYWALL JOINT COMPOUND
- H ASBESTOS HEAT SHIELD ON LIGHT FIXTURES
- CP ASBESTOS CEMENT PRODUCT
- SJC SIPOREX JOINT CAULKING
- M ASBESTOS FLOOR TILE MASTIC
- STUDY AREA

NOTE:

REVISIONS:

No.	Date:	By:	Revisions

REFERENCE:

1.



CONSEIL SCOLAIRE VIAMONDE

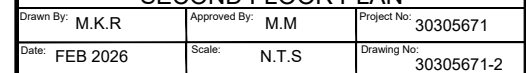
**PRE-RENOVATION DESIGNATED
SUBSTANCES AND HAZARDOUS
MATERIALS SURVEY**

**LOCATIONS OF ASBESTOS-CONTAINING
MATERIALS**

ÉCOLE ÉLÉMENTAIRE ANTONINE MAILLET
615 Ridgeway Avenue, Oshawa, Ontario

GROUND FLOOR PLAN

Drawn By: M.K.R	Approved By: M.M	Project No: 30305671
Date: FEB 2026	Scale: N.T.S	Drawing No: 30305671-1



Appendix E

Regulations and Guidelines

Canada Labour Code

Requirements related to disclosing the presence of hazardous substances (including designated substances) in federal government buildings are specified in Part II of the Canada Labour Code, sections 125(1)y and 125(1)(z.14), which state that employers shall:

- “ensure that the activities of every person granted access to the workplace do not endanger the health and safety of employees [Section y]; and
- take all reasonable care to ensure that all of the persons granted access to the workplace, other than the employer’s employees, are informed of every known or foreseeable health or safety hazard to which they are likely to be exposed in the workplace [Section z.14]”.

Canada Occupational Health and Safety Regulations

The requirement for employees to keep and maintain a record of all hazardous substances that are used, produced, handled or stored for use in the work place and the criteria to employ in carrying out an investigation into potential exposure to a hazardous substance are specified in Part X – Hazardous Substances – of the Canada Occupational Health and Safety Regulations.

Asbestos

Occupational Health and Safety (OHS) for federal employees is regulated by the Canada Labour Code (CLC) Part II. The *Canada Occupational Health and Safety Regulations (COHSR), Part X, Hazardous Substances* covers specific requirements related to the management and control of asbestos-containing materials (ACM). The COHSR, Part X, Hazardous Substances, states an employer shall ensure that an employee’s exposure to a concentration of airborne asbestos fibres is as close to zero as possible, but in any event the employer shall ensure that the concentration does not exceed the value for airborne asbestos fibres adopted by the American Conference of Governmental Industrial Hygienists in its publication entitled *Threshold Limit Values (TLV) and Biological Exposure Indices (BEI)*, as amended from time to time (currently 0.1 fibre/cm³ or f/cc). There are also specific requirements for hazard prevention detailed in the Hazard Prevention Program (HPP) in the CLC.

For the purposes of this report, the following federal requirements will be followed, unless provincial requirements are more stringent. Federal legislation and policy referenced in this report includes:

- Canada Labour Code, R.S.C., 1985, c. L-2.
- Canada Occupational Health and Safety Regulations Part X, Hazardous Substances; SOR/86-304
- Public Services and Procurement Canada Standard on Asbestos Management, 2024
- Public Services and Procurement Canada Directive on Asbestos Management, 2024
- Department of National Defence Standard on the Management of Asbestos-Containing Material in DND Immovables, October 1, 2024
- Government of Canada Technical Guideline to Asbestos Exposure Management Program, January 2018
- Transportation of Dangerous Goods Regulations, SOR/2001-286

The management and requirements for the potential disturbance of asbestos in buildings is also regulated at the provincial level under the Ontario Occupational Health and Safety Act (OHSA), and Regulation 278/05 – Designated Substance – Asbestos on Construction Projects and in Buildings and Repair Operations. Asbestos-containing material is defined as a material that contains 0.5 per cent or more asbestos by dry weight.

Disposal of asbestos waste (friable and non-friable materials) is governed by Ontario Regulation 278/05 and by R.R.O. 1990, Reg. 347: General - Waste Management. O.Reg. 278/05 classifies asbestos work operations into three types (Type 1, 2 and 3) and specifies procedures to be followed in conducting asbestos abatement work. The Federal Transportation of Dangerous Goods Regulation set out the requirements for the proper transport of asbestos waste in Ontario.

Paint

In Canada, the Surface Coating Materials Regulations (SOR/2016-193) under the federal Hazardous Products Act provides a concentration of metals that must not be exceeded in surface coatings that are presently sold in this country. Where no criteria is listed, the laboratory detection limit is used.

The *National Plumbing Code* allowed lead as an acceptable material for pipes until 1975 and in solder until 1986.

The Ontario Ministry of Labour, Immigration, Training and Skills Development *Guideline, Lead on Construction Projects*, dated April 2011, provides guidance in the measures and procedures that should be followed when handling lead containing materials during construction projects. In the guideline, lead-containing construction operations are classified into three groups – Type 1 (low risk), Type 2 (medium risk) and Type 3 (high risk) based on presumed airborne concentrations of lead. Any operation that may expose a worker to lead that is not a Type 1, Type 2, or Type 3b operation, is classified as a Type 3a operation.

The *Environmental Abatement Council of Canada (EACC) Lead Guideline* for Construction, Renovation, Maintenance or Repair, October 2014, states the following:

- Paints or coatings containing less than or equal to 0.1% lead by weight (1,000 ppm) are considered low-level lead paints. If these materials are disturbed in a non-aggressive manner, performed using normal dust control procedures, then worker protection from the inhalation of lead is not required.
- Paints or coatings containing between 0.1% and 0.5% (5,000 ppm) lead by weight are considered lead-containing paints. Tasks performed that disturb these materials must be completed using precautionary measures and procedures specified in the guideline.
- Construction operations involving lead-based paints with concentrations greater than 0.5% lead must always be completed in accordance with precautionary measures and procedures specified in the guideline.

For building materials that are to be disposed of at a landfill, all lead-based paints and associated substrate (concrete, plaster, wood, etc.) must undergo Toxicity Characteristic Leachate Properties (TCLP) testing to determine disposal procedures. The disposal of lead-containing paint is regulated under the Federal Transportation of Dangerous Goods Regulations and by the Ontario Ministry of the Environment, Conservation and Parks.

PCB

The management of equipment classified as waste and containing Polychlorinated Biphenyls (PCBs) at concentrations of 50 parts per million (mg/kg) or greater is regulated by Ontario Regulation 362, *Waste Management – PCBs*. Under this regulation, PCB waste is defined as any waste material containing PCBs in concentrations of 50 mg/kg or greater. Any equipment containing PCBs at or greater than this level, such as transformers, switchgear, light ballasts and capacitors, which is removed from service due to age, failure or as a result of decommissioning, is considered to constitute a PCB waste. Although current federal legislation (effective 1 July 1980) has prohibited the manufacture and sale of new equipment containing PCBs since that time, continued operation of equipment supplied prior to this date and containing PCBs is still permitted. Handling, storage and disposition of such

equipment is, however, tightly regulated and must be managed in accordance with provincial and federal government requirements as soon as it is taken out of service or becomes unserviceable

Removal of in-service equipment containing PCBs, such as fluorescent light ballasts, capacitors and transformers, is subject to the requirements of the federal *PCB Regulations* (discussed below).

The *PCB Regulations*, which came into force on 5 September 2008, were made under the *Canadian Environmental Protection Act*, 1999 (CEPA 1999) with the objective of addressing the risks posed by the use, storage and release to the environment of PCBs, and to accelerate their destruction. The *PCB Regulations* set different end-of-use deadlines for equipment containing PCBs at various concentration levels.

The Regulations Amending the PCB Regulations and Repealing the Federal Mobile PCB Treatment and Destruction Regulations were published on 23 April 2014, in the Canada Gazette, Part II, and came into force on 1 January 2015. The most notable part of the amendments is the addition of an end-of-use deadline date of 31 December 2025 for specific electrical equipment located at electrical generation, transmission and distribution facilities.

When the PCB materials are classified as waste, jurisdiction falls under the Ontario Ministry of the Environment, Conservation and Parks (MECP) and O.Reg. 362. All remedial and PCB management work must be carried out under the terms of the Director's Instruction issued by an MECP District Office (for quantities of PCB fluid greater than 50 litres). The PCB waste stream, regardless of quantity, must be registered with the MECP, in accordance with O.Reg. 347, *General - Waste Management*. O.Reg. 362 applies to any equipment containing greater than 1 kg of PCBs.

The Federal Transportation of Dangerous Goods Regulation sets out the requirements for the proper transport of PCB waste across provincial boundaries.

Suspect Visible Mould

At present, there are no specific laws or regulations governing acceptable levels of mould in buildings. The lack of specific regulatory standards is due in part to an inability to establish exposure-response relationships. Variation in individual susceptibility, limitations in sampling and analytical techniques, and the vast number of fungal agents and their products make it difficult to establish safe levels of exposure for all individuals. With a lack of defined exposure criteria, current Health Canada and other agency guidelines on the assessment and control of mould contamination in public buildings are largely based on prudent avoidance (i.e., remove any indoor growth or amplification site of mould, regardless of the concentration of moulds or their products in the indoor environment).

Although there are currently no regulations in Canada pertaining specifically to mould in buildings, occupational health and safety regulations typically require employers to take every precaution reasonable in the circumstances for the protection of workers.

Control of exposure to mould is required under Section 25(2)(h) of the Ontario *Occupational Health and Safety Act*, which states that employers shall take every precaution reasonable in the circumstances for the protection of workers. Recommended work practices are outlined in the following documents:

- Canadian Construction Association. Mould Guidelines for the Canadian Construction Industry. Standard Construction Document CCA 82 2004.
- Environmental Abatement Council of Canada (EACC) Mould Abatement Guideline Edition 3, 2015.

Mercury

In Canada, the Surface Coating Materials Regulations (SOR/2005-109) under the federal *Hazardous Products Act* provides a concentration of mercury that must not be exceeded in surface coatings that are presently sold in this country. This value was set at 10 ppm in 2005. However, it is important to note that there is not a direct correlation between the concentration of mercury in a material to the potential occupational exposure if the material is disturbed.

Waste light tubes generated during renovations or building demolition and waste mercury from equipment must either be recycled or disposed of in accordance with the requirements of Ont. Reg. 347 - *Waste Management, General*. Waste mercury in amounts less than 5 kg (per month) are exempt from the generator registration requirements prescribed by O.Reg. 347 – *Waste Management – General*. Waste mercury from mercury switches or gauges should, however, be properly collected and shipped to a recycling facility or disposed of as a hazardous waste. Removal of mercury-containing equipment (e.g., switches, gauges, controls, etc.) should be carried out in a manner which prevents spillage and exposure to workers.

Silica

The Ontario Ministry of Labour, Immigration, Training and Skills Development *Guideline, Silica on Construction Projects*, dated November 2022, provides guidance in controlling exposure to silica dust during construction activities. In the guideline, silica-containing construction operations are classified into three groups - Type 1 (low risk), Type 2 (medium risk) and Type 3 (high risk) based on presumed airborne concentrations of respirable crystalline silica in the form of cristobalite, tridymite, quartz and tripoli.

Additional precautionary measures should also be implemented for certain types of materials (e.g., plaster and texture coat materials, including non-asbestos applications, concrete block, etc.). For minor disturbances such as drilling, a HEPA-filtered attachment should be used. For removal of more than a minor amount of material, enclosures should be constructed for dust control and separation of the work area from adjacent areas.

Halocarbon Containing Equipment (HCE)

Ontario Regulation 463/10 – *Ozone Depleting Substances and Other Halocarbons*, applies to the use, handling and disposal of Class 1 ozone-depleting substances, including various chlorofluorocarbons (CFCs), halons and other halocarbons, Class 2 ozone-depleting substances, including various hydrochlorofluorocarbons (HCFCs) and halocarbons, and other halocarbons, including fluorocarbons (FCs) and hydrofluorocarbons (CFCs). The most significant requirements for handling of ozone-depleting substances (ODS') and other Halocarbons, which include, for example, refrigerants used in refrigeration equipment and chillers, include the following:

- certification is required for all persons testing, repairing, filling, or emptying equipment containing ODS' and other halocarbons;
- the discharge of a Class 1 ODS or anything that contains a Class 1 ODS to the natural environment or within a building is prohibited;
- the making, use of, selling of or transferring of a Class 1 ODS is restricted to certain conditions;
- the discharge of a solvent or sterilant that contains a Class 2 ODS is prohibited;
- the making, use of, selling of or transferring of a solvent or sterilant that contains a Class 2 ODS is restricted to certain conditions;
- fire extinguishing equipment that contains a halon may be discharged to fight fires, except fires for firefighting training purposes;

- portable fire extinguishing equipment that contains a halon may be used or stored if the extinguisher was sold for use for the first time before 1 January 1996;
- records of the servicing and repair of equipment containing ODS' and other halocarbons must be prepared and maintained by the owner of the equipment; and
- equipment no longer containing ODS' and other halocarbons must be posted with a notice completed by a certified person.

Ontario Regulation 347, *General – Waste Management*, has also been amended to provide for more strict control of CFCs. The requirements under the amended regulation apply primarily to the keeping of records for the receipt or recycling of CFC waste.

On federal land, aboriginal land and federal works, buildings and undertakings, the Federal Halocarbon Regulations, 2022 (SOR/2022-110) applies. The regulations prohibit the release of halocarbons contained in refrigeration systems, air conditioning systems, fire extinguishers (except to fight a fire that is not a fire caused for training purposes) or containers or equipment used in the re-use, recycling, reclamation or storage of a halocarbon.

The regulations also impose restrictions on the servicing and dismantling, disposing of or decommissioning of any system containing halocarbons and requires the recovery of halocarbons into an appropriate container by a certified person. The regulation also details an owner's record-keeping obligations.

The Federal Transportation of Dangerous Goods Regulation set out the requirements for the proper transport of halocarbon waste in Ontario.

Other Biological Hazards

Hantaviruses are found in the droppings, urine and saliva of infected rodents and humans can contract the virus from breathing in airborne particles or from being bitten. In Canada, a hantavirus capable of causing disease in humans – named Sin Nombre virus – has been identified in deer mice. Although the risk in Canada is low, when it happens, the disease can be very severe.

Exposure to hantaviruses can cause a rare, but often fatal, disease called Hantavirus pulmonary syndrome (HPS). The earliest documented case of HPS in Canada was contracted in Alberta in 1989. Since then, there have been over 70 confirmed cases. Most of the cases occurred in western Canada (Manitoba, Saskatchewan, Alberta, and British Columbia), except for one case in Quebec.¹

Hantavirus is typically transmitted by breathing particles in air from the droppings, urine and saliva of infected rodents. However, there have been a small number of reported cases of HPS believed to have been contracted through rodent bites.

Workers removing accumulations of bird or bat droppings are at risk of exposure to airborne fungal spores (and other microbial hazards) likely to be released when this material is disturbed. Bird and bat droppings should be presumed to be contaminated with the fungi *Histoplasma capsulatum*, *Cryptococcus neoformans*, and other infectious hazards. The spores of some of these organisms can remain infectious for decades after their growth in the guano has ceased. Many of these microorganisms are known to cause respiratory infections in workers exposed during construction or maintenance disturbance.

¹ Health Canada – “It’s Your Health – Hantaviruses” – August 2009.

Toxic and Flammable Chemical

Toxic and Flammable chemicals are regulated in Ontario under Part IV of OSHA. If a worker is or may be exposed to a chemical agent, or biological agent designated as a toxic substance, the employer must ensure that the identity of the chemical agent or toxic agent, its possible effects on worker health and safety and any precautions required to protect the health and safety of the worker are clearly indicated by labels, SDSs, or other similar means and the information required is clearly communicated to the worker. Written procedures must be prepared and implemented to eliminate or minimize a risk of exposure to a chemical agent or toxic agent by any route that could cause an adverse health effect, and to address emergency and cleanup procedures in the event of a spill or release of a chemical agent or toxic agent.

Radioactive Materials

Radioactive Materials are regulated in Ontario under Radiation Protection Regulations SOR/2003-203 and Nuclear Substances and Radiation Devices Regulations, SOR/2000-207, s. 6, as amended up to March 13, 2015, under Nuclear Safety and Control Act. An exposure control plan is required if a worker's radiation exposure exceeds or may exceed the applicable action level.

Urea Formaldehyde Foam Insulation

Urea-formaldehyde foam insulation was a type of expanding foam insulation mixed on-site and injected into wall cavities in homes and buildings, particularly during the 1970s. Developed in Europe in the 1950s and used widely in North America from the mid-1970s, UFFI was banned in Canada due to health concerns about the release of formaldehyde, a potential carcinogen.

Other Designated Substances

Vinyl Chloride

Vinyl chloride vapours may be released from polyvinyl chloride (PVC) products in the event of heating or as a result of decomposition during fire. PVC is used in numerous materials that may be found in building construction, including, for example, piping, conduits, siding, window and door frames, plastics, garden hoses, flooring and wire and cable protection.

Ontario has two main regulations for vinyl chloride: a workplace regulation ([R.R.O. 1990, Reg. 846](#)) that sets an occupational exposure limit and requires employers to manage risk, and an air quality regulation ([O. Reg. 419/05](#)) that establishes stringent standards for ambient air concentrations near facilities, which supersedes previous federal regulations

Arsenic

Arsenic is a heavy metal used historically in pesticides and herbicides. The primary use in building construction materials was its use in the wood preservative chromated copper arsenate (CCA). CCA was used to pressure treat lumber since the 1940s. Pressure-treated wood containing CCA is no longer being produced for use in most settings.

In Canada, the federal regulation of arsenic involves multiple aspects, including the Canadian Environmental Protection Act, 1999 (CEPA) for environmental releases, Health Canada's Guidelines for Canadian Drinking Water Quality for water safety, the Food and Drugs Act for contaminants in food and drugs, and the Canada Consumer Product Safety Act for consumer products.

Isocyanates

Isocyanates are a class of chemicals used in the manufacture of certain types of plastics, foams, coatings and other products. Isocyanate-based building construction materials may include rigid foam products such as foam-core panels and spray-on insulation and paints, coatings, sealants and adhesives. Isocyanates may be inhaled if they are present in the air in the form of a vapour, a mist or a dust. In Ontario, isocyanate regulations are governed by O. Reg. 490/09 (Designated Substances), which requires employers to implement a control program if workers are likely to be exposed to isocyanates.

Benzene

Benzene is a clear, highly flammable liquid used mainly in the manufacture of other chemicals. The commercial use of benzene as a solvent has practically been eliminated, however it continues to be used as a solvent and reactant in laboratories.

Ethylene Oxide

Ethylene oxide is a colourless gas at room temperature. It has been used primarily for the manufacture of other chemicals, as a fumigant and fungicide and for sterilization of hospital equipment.

Coke Oven Emissions

Coke oven emissions are airborne contaminants emitted from coke ovens and are not a potential hazard associated with building construction materials.

Appendix F

Survey Methodology

Sampling activities were conducted in accordance with Arcadis' Standard Operation Procedures which take into account current federal and provincial regulations pertaining to such work (i.e., sampling procedures, required number of samples and laboratory analytical procedures).

Representative bulk samples were collected of accessible suspect paint, and asbestos-containing materials in sufficient quantities for laboratory analysis. Samples were sealed in polyethylene zip-lock bags labeled with the sample number, suspect material description, and sample location. As part of sampling procedures, sampling tools were cleaned between sample collection events to avoid the potential for cross-contamination of samples.

All sample bags were compiled in order and placed into a single container accompanied with a chain of custody form outlining the project information, date, building location, number of samples, and sample description. Samples were submitted to the analytical laboratory in a sealed container via courier.

Asbestos

Asbestos has been widely used in buildings, both in friable applications (materials which can be crumbled, pulverized or powdered by hand pressure, when dry) such as pipe and tank insulation, sprayed-on fireproofing and acoustic texture material and in non-friable manufactured products such as floor tile, gaskets, cement board and so on. The use of asbestos in friable applications was curtailed around the mid-1970s and, as such, most buildings constructed prior to the mid to-late 1970s contain some form of friable construction material with an asbestos content. Asbestos vermiculite has been reported to be used up until about 1990. The use of asbestos in certain non-friable materials continued beyond the mid-1970s and are commonly found in buildings constructed up to and including the mid-1980s, with some materials still in production through 2018. Manufacturing, importation, and use of asbestos was banned in Canada in 2018.

A separate set of samples was collected of each type of homogenous material suspected to contain asbestos. A homogenous material is defined by the US EPA as material that is uniform in texture and appearance, was installed at one time, and is unlikely to consist of more than one type or formulation of material. The homogeneous materials are determined by visual examination, available information on the phases of the construction and prior renovations.

Bulk sampling protocols followed the ASTM E2356 Standard, which indicates requirements for the number of samples to collect for each homogeneous material. The table below provides an outline of the minimum number of samples to be collected from the ASTM E2356 Standard.

Table 7: Bulk Material Sample Quantities

Type of Material	Size of Area of Homogeneous Material	Minimum Number of Samples Collected
Any homogeneous material, including but not limited to fireproofing, drywall joint compound, ceiling tile stucco, acoustical and stipple finishes, and visually similar floor tiles.	Less than 90 m ² (<1,000 ft ²)	3
	90 m ² or more, but less than 450 m ² (1,000-5,000 ft ²)	5
	450 m ² or more (>5,000 ft ²)	7

In some cases, manufactured products such as asbestos cement pipe were visually identified without sample confirmation.

Flooring mastic/adhesive were only sampled and analyzed if present on the underside of flooring samples (vinyl floor tile and vinyl sheet flooring) in sufficient quantity for laboratory analysis.

Attempts to distinguish and delineate asbestos-containing drywall compound from new non-asbestos drywall compound is often unachievable. Arcadis collected drywall joint compound samples from exterior walls, columns or

other locations which are unlikely to have been renovated in an attempt to determine the presence of asbestos in the original drywall compound.

Arcadis samples roofing felts only at the Clients request. A temporary repair will be made with asphalt-based mastic and fibreglass mesh. A more permanent repair is required if the roofing or the building is to remain in use for any extended period of time. Arcadis will not be responsible or liable for leaks or water damage caused by sampling and or repair.

Arcadis conducts limited demolition of masonry block walls (core holes) to investigate for loose fill insulation. The core holes are temporarily patched with expanding foam.

Arcadis will submit the bulk samples to an NVLAP accredited laboratory for analysis. The analysis is performed in accordance with Test Method EPA/600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials, July 1993.

EPA Method 600 states that materials characterized by interfering binder/matrix or low asbestos content may require additional gravimetric reduction sample treatment beyond routine polarized light microscopy (PLM) analysis (e.g., dissolution with hydrochloric acid, treatment with organic solvents or ashing in a muffle furnace or low temperature plasma asher to remove unwanted components). Arcadis will submit one sample of each sample set (3) of vinyl floor tiles to be analyzed by transmission electron microscopy (TEM) if the first two samples are reported negative by PLM.

The asbestos analysis was completed using a stop positive approach. Only one result of greater than the regulated criteria is required to determine that a material is asbestos-containing, but all samples must be analyzed to conclusively determine that a material is non-asbestos. The laboratory will stop analyzing samples from a homogeneous material once greater than the criteria was detected in any of the samples of that material. All samples of a homogeneous material will be analyzed if no asbestos is detected.

Bulk samples of materials which could contain asbestos were collected and submitted to EMSL Canada Inc. (EMSL) for analysis of asbestos content. Asbestos-containing materials are defined as 0.5% or greater, or any amount if vermiculite.

Classification, Condition and Accessibility

Spray Applied Fireproofing, Insulation and Texture Finishes

To evaluate the condition of ACM spray applied as fireproofing, thermal insulation, or texture, decorative or acoustic finishes, the following criteria are applied:

GOOD

Surface of material shows no significant signs of damage, deterioration, or delamination. Up to 1 percent visible damage to surface is allowed within range of **GOOD**. Evaluation of sprayed fireproofing requires the surveyor to be familiar with the irregular surface texture typical of sprayed asbestos products. **GOOD** condition includes un-encapsulated or unpainted fireproofing or texture finishes, where no delamination or damage is observed, and encapsulated fireproofing or texture finishes where the encapsulation has been applied after the damage or fallout occurred.

POOR

Sprayed materials show signs of damage, delamination, or deterioration. More than 1 percent damage to surface of ACM spray.

In observation areas where damage exists in isolated locations, both **GOOD** and **POOR** condition may be reported. The extent or percentage of each condition will be recorded on the survey or re-assessment form.

NOTE: FAIR condition is not utilized in the evaluation of the sprayed fireproofing, sprayed insulation, or texture coat finishes.

The evaluation of ACM spray applied as fireproofing, non-mechanical thermal insulation, or texture, decorative or acoustic finishes which are present above ceilings, may be limited by the number of observations made, and by building components such as ducts or full height walls that obstruct the above ceiling observations. Persons entering the ceiling are advised to be watchful for ACM **DEBRIS** prior to accessing or working above ceilings in areas of buildings with ACM regardless of the reported condition.

Mechanical Insulation

The evaluation of the condition of mechanical insulation (on boilers, breaching, ductwork, piping, tanks, equipment etc.) utilizes the following criteria:

GOOD

Insulation is completely covered in jacketing and exhibits no evidence of damage or deterioration. No insulation is exposed. Includes conditions where the jacketing has minor surface damage (i.e., scuffs or stains), but the jacketing is not penetrated.

FAIR

Minor penetrating damage to jacketed insulation (cuts, tears, nicks, deterioration, or delamination) or undamaged insulation that has never been jacketed. Insulation is exposed but not showing surface disintegration. The extent of missing insulation ranges should be minor to none.

POOR

Original insulation jacket is missing, damaged, deteriorated, or delaminated. Insulation is exposed and significant areas have been dislodged. Damage cannot be readily repaired.

The evaluation of mechanical insulation may be limited by the number of observations made and building components such as ducts or full height walls that obstruct observations. It is not possible to observe the full length of mechanical insulation from all angles.

Non-friable and Potentially Friable Materials

Non-friable materials generally have little potential to release airborne fibres, even when damaged by mechanical breakage. However, some non-friable materials, i.e., exterior asbestos cement products, may have deteriorated so that the binder no longer effectively contains the asbestos fibres. In such cases of significantly deteriorated non-friable material, the material should be treated as a friable product.

Evaluation of Accessibility

The accessibility of building materials known or suspected of being ACM is rated according to the following criteria:

ACCESS (A)

Areas of the building within reach (from floor level) of all building users. Includes areas such as gymnasiums, workshops, and storage areas where activities of the building users may result in disturbance of ACM not normally within reach from floor level.

ACCESS (B)

Frequently entered maintenance areas within reach of maintenance staff, without the need for a ladder. Includes: frequently entered pipe chases, tunnels and service areas or areas within reach from a fixed ladder or catwalk, e.g. tops of equipment, mezzanines.

ACCESS (C) EXPOSED

Areas of the building above 2.4 metres where use of a ladder is required to reach the ACM. Only refers to ACM that is exposed to view, from the floor or ladder, without the removal or opening of other building components such as ceiling tiles, or service access door or hatch. Does not include infrequently accessed service areas of the building.

ACCESS (C) CONCEALED

Areas of the building which require the removal of a building component, including lay-in ceilings and access panels into solid ceiling systems. Includes rarely entered crawl spaces, attic spaces, etc. Observations will be limited to the extent visible from the access points.

ACCESS (D)

Areas of the building behind inaccessible solid ceiling systems, walls, or mechanical equipment, etc. where demolition of the ceiling, wall, or equipment, etc. is required to reach the ACM. Evaluation of condition and extent of ACM is limited or impossible, depending on the surveyor's ability to visually examine materials in ACCESS D.

ACM DEBRIS

DEBRIS from Friable ACM

The presence of fallen ACM is noted separately from the presumed friable ACM source (sprayed fireproofing, thermal insulation, texture, decorative or acoustic finishes or mechanical insulation) and is referred to as **DEBRIS**.

DEBRIS from Damaged Non-Friable ACM

The presence of fallen ACM from damaged non-friable ACM is also reported separately from the non-friable ACM source. Only fallen non-friable ACM that has become friable is reported as **DEBRIS**.

The identification of the exact location or presence of **DEBRIS** on the top of ceiling tiles is limited by the number of observations made and the presence of building components such as ducts or full height walls that obstruct observations. Workers are advised to be watchful for the presence of **DEBRIS** prior to accessing or working in proximity to mechanical insulation or above ceilings in areas of buildings with ACM regardless of the reported presence or absence of **DEBRIS**.

Paint

Arcadis collects samples of distinctive paint finishes and surface coatings present in more than a limited application, where removal of the paint is possible. Arcadis collects samples by scraping the painted finish to include base and covering applications. Paint and surface coatings are evaluated for condition. All paints will be analyzed for lead.

When evaluating the condition of paints, an attempt is made to determine whether the deterioration is due to a moisture problem or some other existing building deficiency. **“Poor”** surfaces are considered to be a hazard and should be corrected. **“Fair”** surfaces should be repaired but are not yet considered to be a hazard; if not repaired, they should be monitored frequently. **“Good/intact”** surfaces should be monitored to ensure that they remain in a nonhazardous condition.

In addition, the presence of paint debris is considered in evaluating conditions. Given the variety of paint uses, there are many applications that can have a tendency for the paint to “wear” from the surface slowly, over an extended

period of time. Conditions where paint has worn from a surface are worth noting for maintenance discussions (i.e., related to re-coating the surface should, for example, the coating provide weather protection), however, in the absence of loose paint chip debris/dust, such conditions would not represent a potential exposure situation related to lead.

The condition evaluation criteria for paints is summarized in the table below.

Table 8: Paint Condition Categories

Type of Building Component ¹	Total Area of Deteriorated Paint on Each Component		
	Good/Intact	Fair ²	Poor ³
Exterior components with large surface areas.	Entire surface is intact.	Less than or equal to 10 square feet	More than 10 square feet
Interior components with large surface areas (walls, ceilings, floors, doors).	Entire surface is intact.	Less than or equal to 2 square feet	More than 2 square feet
Interior and exterior components with small surface areas (windowsills, baseboards, soffits, trim).	Entire surface is intact.	Less than or equal to 10% of the total surface area of the component.	More than 10% of the total surface area of the component
NOTES: 1 Building component in this table refers to each individual component or side of building, not the combined surface area of all similar components in a room (e.g., a wall with 1 square foot of deteriorated paint is in "fair" condition, even if the other three walls in a room are intact). 2 Surfaces in "fair" condition should be repaired and/or monitored but are not considered to be "lead-containing paint hazards". 3 Surfaces in "poor" condition are considered to be "lead-containing paint hazards" and should be addressed through abatement or interim controls.			

Analysis for lead in paints or surface coatings is performed in accordance with US EPA SW-846 Method No. 3050B/Method No. 7000B; Flame Atomic Absorption (FAA) at an accredited laboratory by the American Industrial Hygiene Association (AIHA). For the purpose of this report a criteria of 90 ppm will be used to define lead-based paint.

Analysis for mercury in paint is performed in accordance with EPA Cold Vapor Atomic Absorption (CVAA) via 7471B. For the purpose of this project, a criteria of 10 ppm is used as stipulated in the Surface Coating Materials Regs (SOR/2016-93).

Analysis for arsenic in paint is performed in accordance with Individual Elements by EPA Inductively Coupled Plasma (ICP) via 6010D. There is no current regulated criteria; therefore, the laboratory detection limit of 10 ppm is used for this project.

Analysis for PCB is performed via EPA SW 846 3540C/8082A. For the purpose of this project a criteria of 50ppm or greater is used based on the threshold given in Canadian Environmental Protection Act (1999) SOR/2008-273.

Lead Products

Lead is a heavy metal that can be found in construction materials such as paints, coatings, mortar, concrete, pipes, solder, packings, sheet metal, caulking, glazed ceramic products and cable splices. Lead building products were identified by visual observation only.

Leachate Testing

Representative samples are collected of each material (e.g. wood, gypsum, concrete) coated with metal-containing paint. Samples are submitted for analysis to EMSL Canada Inc. OR Bureau Veritas labs, Burnaby, BC, NVLAP accredited Laboratory in accordance with the Toxicity Characteristic Leaching Procedure (TCLP) outlined in US EPA SW-846 Method 1311 and Method 6010D.

Results are compared to Ontario Ministry of Environment, Conservation and Parks Leachable toxic waste means waste when subject to the TCLP leaks or spills which may lead to the escape of hazardous waste from the facility or may pose a threat to human health.

Silica

Silica exists in several forms of which crystalline silica is of most concern with respect to potential worker exposures. Quartz is the most abundant type of crystalline silica. Some commonly used construction materials containing silica include brick, refractory brick, concrete, concrete block, cement, mortar, rock and stone, sand, fill dirt, top soil and asphalt containing rock or stone.

Arcadis identified building materials suspected of containing crystalline silica (e.g., concrete, cement, tile, brick, masonry, mortar) by knowledge of current and historic applications and visual inspection only. Arcadis did not perform sampling of these materials for laboratory analysis of crystalline silica content.

Mercury

Mercury has been used in electrical equipment such as alkaline batteries, fluorescent light bulbs (lamps), high intensity discharge (HID) lights (mercury vapour, high pressure sodium and metal halide), "silent switches" and in instruments such as thermometers, manometers and barometers, pressure gauges, float and level switches and flow meters. Mercury-containing lamps, the bulk of which are 1.22 m (four feet) fluorescent lamps contain between 7 and 40 mg of mercury each. Mercury compounds have also been used historically as additives in latex paint to protect the paint from mildew and bacteria during production and storage.

Building materials/products/equipment suspected to contain mercury were identified by visual inspection only. Dismantling of equipment suspected of containing mercury was not performed. Mercury spills or damaged mercury-containing equipment were recorded where observed.

Polychlorinated Biphenyls (PCBs)

In most institutional, commercial facilities and in smaller industrial facilities, the primary source of equipment potentially containing PCBs is fluorescent and H.I.D. light ballasts. Small transformers may also be present. In larger industrial facilities, larger transformers and switch gear containing or potentially containing, PCBs may also be present.

PCBs were also commonly added to industrial paints from the 1940s to the late 1970s. PCBs were added directly to the paint mixture to act as a fungicide, to increase durability and flexibility, to improve resistance to fires and to increase moisture resistance. The use of PCBs in new products was banned in Canada in the 1970s. PCB amended paints were used in specialty industrial/institutional applications prior to the 1970s including government buildings and equipment such as industrial plants, radar sites, ships as well as non-government rail cars, ships, grain bins, automobiles and appliances.

Arcadis determined the potential for light ballast and wet transformers to contain PCBs based on the age of the building, a review of maintenance records and examination of labels or nameplates on equipment, where present and accessible. The information was compared to known ban dates of PCBs and Environment Canada publications. Dry type transformers were presumed to be free of dielectric fluids and hence non-PCB. Arcadis recorded spills or leakage of suspect PCB-containing fluids where observed or identified in historical documents. Fluids (mineral oil, hydraulic or Askaral) in transformers, capacitors or other equipment are not sampled for PCB content. Capacitors which were installed in 1980 or earlier are assumed to contain PCBs.

Window, door, penetration, and expansion caulking were sampled for PCB content in buildings older than 1985. The material was considered a PCB solid if PCB content is 50ppm or greater based on the threshold given in PCB Regulations, SOR/2008-273.

Halocarbon-Containing Equipment (HCE)

Arcadis determines the potential presence of halocarbons (chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, halons, etc.) in air conditioning units, chillers, commercial coolers, and fire suppression systems by visual inspection of manufactures' labels or plates, maintenance records, or logbooks, etc.

Suspect Visible Mould

Moulds are forms of fungi that are found everywhere both indoors and outdoors all year round. Outdoors, moulds live in the soil, on plants and on dead and decaying matter. More than 1000 different kinds of indoor moulds have been found in buildings. Moulds spread and reproduce by making spores, which are all small and light-weight, able to travel through air, capable of resisting dry, adverse environmental conditions, and hence capable of surviving a long time. Moulds need moisture and nutrients to grow and their growth is stimulated by warm, damp and humid conditions.

Arcadis identified the presence of any suspect visible mould or water damage observed during the course of our site investigation. Suspect visible mould is typically a coloured, textured substance or discolouration or staining on a building material surface which, based on our experience, may be mould growth. The adjective suspect is used where the presence of mould has not been confirmed by laboratory analysis.

Other Biological Hazards (Rodent Droppings)

Arcadis identifies other biological hazards by visual observation only. Areas where rodent or bird droppings are noticed will be noted and photographed. Arcadis does not perform sampling of these materials for laboratory analysis, unless specifically requested by the Client.

Toxic or Flammable Chemicals

Arcadis identifies toxic or flammable chemical by visual observation only. Areas used to store toxic and flammable chemicals will be noted and photographed.

Radioactive Materials

Arcadis identifies radioactive materials, such as smoke detectors, by visual observation only. Suspect areas where radioactive materials are present will be noted and photographed. Testing for radiation is not conducted.

Urea Formaldehyde Foam Insulation

Potential for Urea Formaldehyde Foam Insulation (UFFI) was assessed in building older than 1980. Arcadis inspected accessible areas where UFFI may have been applied such as attics, crawlspaces and wall spaces by

looking for oozing out foam, color and texture, wall plugs covering injection ports etc. UFFI was identified by visual observation only.

Other Designated Substances

Any products or materials observed during the course of the site inspections, which could contain any of the other designated substances) and which are present in a form that could present an exposure hazard, were documented.

- Isocyanates are a class of chemicals used in the manufacture of certain types of plastics, foams, coatings and other products. Isocyanate-based building construction materials may include rigid foam products such as foam-core panels and spray-on insulation and paints, coatings, sealants and adhesives. Isocyanates may be inhaled if they are present in the air in the form of a vapour, a mist or a dust. Products that may contain Isocyanates are visually assessed only.
- Vinyl chloride vapours may be released from polyvinyl chloride (PVC) products in the event of heating or as a result of decomposition during fire. PVC is used in numerous materials that may be found in building construction, including, for example, piping, conduits, siding, window and door frames, plastics, garden hoses, flooring and wire and cable protection. Materials suspected to contain vinyl chloride were identified by visual observation only.
- Arsenic is a heavy metal used historically in pesticides and herbicides. The primary use in building construction materials was its use in the wood preservative chromated copper arsenate (CCA). CCA was used to pressure treat lumber since the 1940s. Pressure-treated wood containing CCA is no longer being produced for use in most settings. Material suspected to contain arsenic were identified by visual observation only.
- Ethylene oxide is a colourless gas at room temperature. It has been used primarily for the manufacture of other chemicals, as a fumigant and fungicide and for sterilization of hospital equipment.
- Coke oven emissions are airborne contaminants emitted from coke ovens and are not a potential hazard associated with building construction materials.
- Acrylonitrile is used to produce nitrile-butadiene rubber, acrylonitrile-butadiene-styrene (ABS) polymers and styrene-acrylonitrile (SAN) polymers. Products made with ABS resins which may be found in buildings include telephones, bottles, packaging, refrigerator door liners, plastic pipe, building panels and shower stalls. Acrylonitrile can be released into the air by combustion of products containing ABS.
- Benzene is a clear, highly flammable liquid used mainly in the manufacture of other chemicals. The commercial use of benzene as a solvent has practically been eliminated, however it continues to be used as a solvent and reactant in laboratories.

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1.1 GENERAL CONDITIONS

CCDC 2 - 2020 The General Conditions of the Stipulated Price Contract is the General Conditions between the Owner and Contractor.

1.2 SUPPLEMENTARY CONDITIONS

Refer to Schedule F for amendments to these General Conditions.

END OF DOCUMENT

PART 1 - GENERAL

1.1 Summary of Work

- .1 Section Includes
 - .1 Title and description of work: École élémentaire Antonine-Maillet Renovations, 615 Ridgeway Ave, Oshawa, Ontario.
 - .2 Contract method: Stipulated Price.
 - .3 Owner's occupancy: **August 21, 2026**.

1.2 Project Coordination

- .1 Coordinate progress of the Work, progress schedules, submittals, use of site, temporary utilities, construction facilities and controls.

1.3 Cutting and Patching

- .1 Approvals
 - .1 Submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of any element of Project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of any operational element.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate contractor.
- .2 Inspection
 - .1 Inspect existing conditions, including elements subject to damage

- or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .3 Execution
 - .1 Perform cutting, fitting, and patching including excavation and fill, to complete the Work.
 - .2 Remove and replace defective and non- conforming work.
 - .3 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical work.
 - .4 Perform work to avoid damage to other work.
 - .5 Prepare proper surfaces to receive patching and finishing.
 - .6 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
 - .7 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.
 - .8 Restore work with new products in accordance with Contract Documents.
 - .9 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
 - .10 At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with approved fire-rated fire-resistant material, full thickness of construction element.
 - .11 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

1.4 Field Engineering

- .1 Qualifications of Surveyor
 - .1 Qualified registered land surveyor, acceptable to Owner.
 - .2 Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
- .2 Survey Requirements
 - .1 Establish two permanent bench marks on site, referenced to established bench marks by survey control points. Record locations, with horizontal and vertical data in Project Record Documents.
 - .2 Establish lines and levels, locate and lay out, by instrumentation.

- .3 Records
 - .1 Maintain a complete, accurate log of control and survey work as it progresses.
 - .2 On completion of foundations and major site improvements, prepare certified survey showing dimensions, locations, angles and elevations of Work.
- .4 Subsurface Conditions
 - .1 Refer to GC 6.4.
 - .2 Promptly notify consultant in writing if subsurface conditions at Place of the Work differ materially from those indicated in Contract Documents, or reasonable assumption of probable conditions based thereon.
 - .3 After prompt investigation, should Consultant determine that conditions do differ materially, instructions will be issued for changes in the Work as provided in Part 6 - Changes in the Work.

1.5 Project Meetings

- .1 Administrative
 - .1 Schedule and administer project progress meetings throughout progress of work and at call of Consultant.
 - .2 Distribute written notice of each meeting four days in advance of meeting date to Consultant and Owner.
 - .3 Provide physical space and make arrangements for meetings.
 - .4 Record minutes. Include significant proceedings and decisions. Identify 'action by' parties.
 - .5 Reproduce and distribute copies of minutes within three days after each meeting and transmit to meeting participants, affected parties not in attendance, Consultant and Owner.

1.6 Schedule

- .1 Schedules Required.
 - .1 Construction Progress Schedule.
 - .2 Submittal Schedule for Shop Drawings, Product Data and Samples.

- .3 Cash Allowance Schedule for purchasing products.
- .2 Format
 - .1 Prepare schedule in form of horizontal bar chart.
 - .2 Provide separate bar for each trade or operation.
 - .3 Provide horizontal time scale identifying first work day of each week.
 - .4 Format for listings: List of Contents of this specification or Chronological order of start of each item of work.
- .3 Submission
 - .1 Submit initial schedules within 15 days after award of Contract.
 - .2 Submit one opaque reproduction, plus 2 copies to be retained by Consultant.
 - .3 Consultant will review schedule and return reviewed copy within 10 days after receipt.
 - .4 Resubmit finalized schedule within 7 days after return of reviewed copy.

1.7 Quality Control

- .1 Inspection
 - .1 Refer to GC 2.3.
 - .2 Owner and Consultant shall have access to the Work.
 - .3 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Consultant instructions, or law of Place of the Work.
 - .4 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .2 Independent Inspection Agencies
 - .1 Independent Inspection/Testing Agencies will be engaged by Owner for purpose of inspecting and/or testing portions of Work. Cost of such services will be performed under allowance as set out in this Section.
 - .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Reports
 - .1 Submit 4 copies of inspection and test reports promptly to Consultant.

- .2 Provide copies to Subcontractor of work being inspected/tested and manufacturer/fabricator of material being inspected/tested.

1.8 Construction Facilities and Temporary Controls

- .1 Installation/Removal
 - .1 Provide construction facilities and temporary controls in order to execute work expeditiously.
 - .2 Remove from site all such work after use.
- .2 Hoarding
 - .1 Erect hoarding around entire perimeter of site and where indicated on drawings to protect public, workers, public and private property from injury or damage.
 - .2 Provide hoarding with solid plywood on 2"x4" wood framing, braced as required to a height of 8', protecting public and private property from injury or damage. Provide lockable gates within hoarding for access to site by workers and vehicles.
 - .3 Provide temporary enclosures and hoarding specific to work being performed as required. Maintain protected exits through the Work Area throughout the construction period, or co-ordinate with the Owner required notifications and signed alternate exit routes as required.
- .3 Weather Enclosures
 - .1 Provide weathertight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
 - .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work area for temporary heat.
- .4 Dust Tight Screens
 - .1 Provide dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.
 - .2 Maintain and relocate protection until such Work is complete.
- .5 Dewatering
 - .1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.
- .6 Site Storage/Loading

- .1 Refer to GC 3.12
- .2 Confine the Work and operations of employees to limits indicated by Contract Documents. Do not unreasonably encumber premises with Products.
- .3 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the Work.
- .7 Sanitary Facilities
 - .1 Provide sufficient sanitary facilities for workers in accordance with local health authorities.
 - .2 Maintain in clean condition.
 - .3 Existing facilities as designated may be used during construction period.
- .8 Water Supply
 - .1 Owner will provide a continuous supply of potable water for construction use.
 - .2 Contractor shall not cause or allow water to be used in a wasteful manner.
- .9 Temporary Heating
 - .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
 - .2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders not permitted.
 - .3 Maintain temperatures of minimum 10 °C in areas where construction is in progress, unless indicated otherwise in specifications.
 - .4 Ventilate heated areas and keep building free of exhaust or combustion gases.
 - .5 Permanent heating system of building, or portions thereof, may be used when available. Be responsible for damage thereto, and cleaning of coils and replacement of filters prior to handover to Owner.
- .10 Temporary Power
 - .1 Owner will pay for temporary power required during construction for temporary lighting and operating of power tools, to maximum supply of 110 volts 15 amps.
 - .2 Arrange for connection with appropriate utility company. Pay costs for installation, maintenance and removal.
- .11 Temporary Telephone
 - .1 Provide and pay for temporary telephones necessary for own use.
- .12 Equipment/Tool/Materials Storage

- .1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.
- .13 Project Cleanliness
 - .1 Maintain the Work in tidy condition, free from accumulation of waste products and debris.
 - .2 Remove waste material and debris from site and deposit in waste container at end of each working day. Co-ordinate location with Owner. Minimize dust due to movement of waste material and debris.
 - .3 Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.

1.9 Material and Equipment

- .1 Product and Material Quality
 - .1 Refer to GC 3.8
 - .2 Products, materials, equipment and articles (referred to as Products throughout specifications) incorporated in Work shall be new, not damaged or defective, and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
 - .3 Defective Products, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.
 - .4 Should any dispute arise as to quality or fitness of Products, decision rests strictly with Consultant based upon requirements of Contract Documents.
 - .5 Products, materials, equipment and articles listed by or bearing labels of Underwriters' Laboratories of Canada will be the only acceptable products, materials, equipment and articles where certification is required by local authorities and whenever available for use or application intended.
- .2 Storage, Handling and Protection
 - .1 Handle and store Products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
 - .2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact.

- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Coordinate delivery and receive products supplied by the Owner. Receive packing slips and delivery confirmations, verify completeness and acceptable condition of owner supplied products delivery. Off-load products and store on site in accordance with this article.
- .3 Manufacturer's Instructions
 - .1 Unless otherwise indicated in specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
 - .2 Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant may establish course of action.
 - .3 Improper installation of erection of Products, due to failure in complying with these requirements, authorizes Consultant to require removal and reinstallation at no increase in Contract Price.
- .4 Workmanship
 - .1 Workmanship shall be best quality, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
 - .2 Do not employ any unfit person or anyone unskilled in their required duties.
 - .3 Decisions as to quality or fitness of workmanship in cases of dispute rest solely with Consultant, whose decision is final.
- .5 Concealment
 - .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
 - .2 Before installation, inform Consultant if there is a contradictory situation. Install as directed by Consultant.
- .6 Pre-ordered Products
 - .1 To expedite schedule, Owner has pre-ordered products and will be responsible for payment for such products. Contractor to assume responsibility for obligations of Owner for agreements with manufacturers and distributors for pre-ordered products. Quotations and purchase orders will be made available to Contractor for co-ordination purposes.
 - .1 Products installed by Contractor:
 - .1 See paragraph 1.11.2.4.
 - .2 Install products in accordance with respective sections of this specification or in accordance with Article 1.11.3.

- .1 RESERVED
RESERVED

1.10 Health and Safety

- .1 The Contractor shall be responsible for ensuring that all subtrades and construction personnel conform to the Owner's published Health and Safety requirements. Such requirements will be provided to the Contractor prior to the commencement of the Contract.

1.11 Project Closeout

- .1 Final Cleaning
 - .1 Refer to GC 3.13
 - .2 When the Work is Substantially Performed, remove surplus products, tools construction machinery and equipment not required for performance of remaining Work.
 - .3 Remove waste materials and debris from site at regularly scheduled times or dispose of as directed by Consultant. Do not burn waste materials on site, unless approved by Consultant.
 - .4 Leave work broom clean before inspection process commences.
 - .5 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
 - .6 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments and walls.
 - .7 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
 - .8 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
 - .9 Broom clean and wash exterior walks, steps and surfaces.
 - .10 Remove dirt and other disfigurements from exterior surfaces.
- .2 Systems Demonstration
 - .1 Prior to final inspection, demonstrate operation of each system to Owner and Consultant.
 - .2 Instruct personnel in operation, adjustment, and maintenance of equipment and systems, using provided operation and maintenance data as basis for instruction.

- .3 Documents
 - .1 Collect reviewed submittals and assemble documents executed by Subcontractors, suppliers, and manufacturers.
 - .2 Submit material prior to final Application for Payment.
 - .3 Submit operation and maintenance data, record (as-built) drawings.
 - .4 Provide warranties and bonds fully executed and notarized.
 - .5 Execute transition of Performance and Labour and Materials Payment Bond to warranty period requirements.
 - .6 Submit a final statement of accounting giving total adjusted Contract Price, previous payments, and monies remaining due.
 - .7 Consultant will issue a final change order reflecting approved adjustments to Contract Price not previously made.
- .4 Inspection/Takeover Procedures
 - .1 Prior to application for certificate of Substantial Performance, carefully inspect the Work and ensure it is complete, that major and minor construction deficiencies are complete, defects are corrected and building is clean and in condition for occupancy. Notify Consultant in writing, of satisfactory completion of the Work and request an inspection.
 - .2 During Consultant inspection, a list of deficiencies and defects will be tabulated. Correct same.
 - .3 When Consultant considers deficiencies and defects have been corrected and it appears requirements of Contract have been performed, make application for certificate of Substantial Performance. Refer to General Conditions Article GC 14 for specifics to application.
 - .4 Conform to OAA/OGCA Take-Over Procedures Document No. 100 latest edition and the board supplemental conditions.

PART 2- PRODUCTS Not Used.

PART 3- EXECUTION Not Used.

PART 1 - GENERAL

1.1 Section Includes

- .1 Title and description of Work
- .2 Contract Method
- .3 Work by others
- .4 Future work
- .5 Work sequence
- .6 Contractor use of premises
- .7 Owner occupancy
- .8 Partial Owner occupancy
- .9 Preordered products Pretendered work
- .10 Owner furnished items

1.2 Related Sections

- .1 Section 00100: Invitation to Tenderers

1.3 Work Covered by Contract Documents

- .1 Work of this Contract comprises general construction and renovations to the École élémentaire Antonine-Maillet for the Conseil Scolaire Viamonde, located at 615 Ridgeway Ave, Oshawa, Ontario and further identified as Project No.25116.

CSV École élémentaire Antonine-Maillet Renovations 615 Ridgeway Ave, Oshawa, Ontario	Summary of Work Single Contract	Section 01011 Page 2 January 2026

1.4 Contract Method

- .1 Construct the Work under a single fixed price contract.

1.5 Work Sequence

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction and as follows:
 - .1 Commence the work July 2, 2026, or instructed by the Owner.
 - .2 Complete Work for occupancy on or before August 21, 2026.
- .2 Coordinate Progress Schedule and coordinate with Owner Occupancy during construction.
- .3 Required stages:
 - .1 Mobilization including preparation of Shop Drawings and ordering of materials and equipment are to commence immediately upon the award of Contract.
 - .2 Contractor to co-ordinate parts of the Work to expedite the required stages.

1.6 Progress Draw Breakdown

- .1 Submit proposed breakdown to Consultant for review following award of Contract. Itemized in detail indicating proportions of work of each subtrade in accordance with Sections of this specification, and in further detail as required by the Consultant to accurately assess the progress of Work.

1.7 Contractor Use of Premises

- .1 Contractor has unrestricted use of Work Area until Substantial

Performance.

- .2 Contractor shall limit use of premises for Work, for storage, and for access, to allow;
 - .1 Owner occupancy.
 - .2 Work by other contractors.
 - .3 Public usage.
- .3 Coordinate use of premises under direction of Owner and Consultant.
- .4 Assume full responsibility for protection and safekeeping of products under this Contract.
- .5 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

1.8 Owner Occupancy

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Cooperate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.9 No Smoking Policy

- .1 No person is allowed to smoke at any time on the property. It is the Contractor's responsibility to ensure that his employees and Sub-Contractors, if any, comply with this policy.

1.10 Vehicle and Operation

- .1 Conform to regulation of Municipality regarding cleanup of tracking on streets and protection of sidewalks and curbs and other applicable Laws, By-laws and Regulations.
- .2 Make arrangements with Owner for suitable access for the site. Pay all charges in connection therewith.
- .3 Drivers of motor vehicles shall not operate their vehicles beyond the

CSV École élémentaire Antonine-Maillet Renovations 615 Ridgeway Ave, Oshawa, Ontario	Summary of Work Single Contract	Section 01011 Page 4 January 2026

parking area. Such vehicles shall be operated with due caution at all times while on school property. Speed limits shall not exceed 8 kilometers (5 miles) per hour at any time.

1.11 Digital Photographs

- .1 Provide digital photographs as requested by the Consultant to verify progress of the Work.

PART 2 - PRODUCTS Not Used.

PART 3 - EXECUTION Not Used.

1 Requirements Included

- .1 Cash allowances
 - .1 Contingency allowance

2 Cash Allowances

- .1 Refer to GC 4.1.
- .2 Include in the Contract Price, cash allowances stated herein.
- .3 Cash allowances, unless otherwise specified, cover the net cost to the Contractor of services, products, construction machinery and equipment, freight, handling, unloading, storage and other authorized expenses incurred in performing the Work.
- .4 The Contract Price, and not the cash allowance, includes the Contractor's overhead and profit in connection with such cash allowance.
- .5 The Contract Price will be adjusted by written order to provide for an excess or deficit to each cash allowance.
- .6 Where costs under a cash allowance exceed the amount of the allowance, the Contractor will be compensated for any excess incurred and substantiated plus an allowance for overhead and profit as set out in the Contract Documents.
- .7 Progress payments on accounts of work authorized under cash allowances shall be included in the Consultant's monthly certificate for payment.
- .8 A schedule shall be prepared jointly by the Consultant and Contractor to show when items called for under cash allowances must be authorized by the Consultant for ordering purposes so that the progress of the Work will not be delayed.
- .9 The Cash Allowance is for items not included in the Contract including:
 - .1 Data cabling
 - .2 Security
 - Security does not include Fire Watch to be provided by electrical contractor.
 - .3 PA termination

CSV École élémentaire Antonine-Maillet Renovations 615 Ridgeway Ave, Oshawa, Ontario	Allowances	Section 01021 Page 2 January 2026

- .4 Intercom relocation and testing
- .5 Work as designated by consultants at later date.
- .6 Refer to the Board's Front-End Documents for the total amount of the Cash Allowance.

3 Contingency Allowances

- .1 Refer to GC 4.2.
- .2 Include in the Contract Price a stipulated sum for the Contingency Allowance, as indicated in the Board's Front-End Documents.
- .3 Do not include in the Contract Price, additional sums for products, installation, overhead or profit.
- .4 Expenditures under the contingency allowance will be authorized in accordance with the procedures provided in Part 6 - Changes in the Work, and evaluated under GC 6.3.

PART 1 - GENERAL

1.1 Section Includes

- .1 Project meetings.
- .2 Project coordination.
- .3 Cutting and patching.
- .4 Field engineering.
- .5 Identification systems.

1.2 Related Sections

- .1 Section 01601 - Material and Equipment: Coordination.
- .2 Individual Product Sections: Cutting and patching incidental to work of the section. Advance notification to other sections required.

1.3 Meetings

- .1 Schedule and administer project meetings throughout the progress of the work at the call of the Consultant.
- .2 Provide physical space and make arrangements for meetings.
- .3 Record the minutes. Reproduce and distribute copies of minutes within three days after each meeting and transmit to meeting participants.
- .4 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .5 Incorporate mutually agreed variations to Contract Documents into

Agreement, prior to signing.

- .6 During the course of Work schedule progress meetings monthly.
- .7 Contractor, major Subcontractors involved in Work and Consultants and Owner are to be in attendance.

1.4 Coordination

- .1 Allocate of mobilization areas of site; for field offices and sheds, access, traffic, and parking facilities.
- .2 During construction coordinate use of site and facilities through procedures for submittals, reports and records, schedules, coordination of drawings, recommendations, and resolution of ambiguities and conflicts.
- .3 Provide information required for preparation of coordination drawings. Review and approve revised drawings for submission to Consultant.
- .4 Mechanical and Electrical Coordinator: Employ and pay for services of a person or firm technically qualified and experienced in field coordination for the type of mechanical and electrical work required for this Project, for duration of construction work.

1.5 Cutting and Patching

- .1 Execute cutting, fitting, and patching including excavation and fill, to complete the Work.
- .2 Remove and replace defective and non-conforming work.
- .3 Restore work with new products in accordance with requirements of Contract Documents.
- .4 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical work.
- .5 Execute work by methods to avoid damage to other work, and which will provide proper surfaces to receive patching and finishing.
- .6 Employ original installer to perform cutting and patching for exposed to view materials.

- .7 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed with masonry materials without prior approval.
- .8 Refinish surfaces to match adjacent finishes: For continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

1.6 Field Engineering

- .1 Qualified registered land surveyor, acceptable to Owner.
- .2 Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
- .3 Report to Consultant when a reference point is lost or destroyed, or requires relocation because of necessary changes in grades or location.
- .4 Establish two permanent bench marks on site, referenced to established bench marks by survey control points. Record locations, with horizontal and vertical data in Project Record Documents.
- .5 Establish lines and levels, locate and lay out, by instrumentation.
- .6 On completion of foundation, prepare a certified survey showing dimensions, locations, angles and elevations of Work.

1.7 Identification Systems

- .1 Submit 2 typed copies of schedules for nameplates and valve tags 15 days prior to inspection for Substantial Performance or 5 days prior to date scheduled for instruction of Owner's personnel.
- .2 Nameplate schedules shall list: Pump, control, valves and electrical equipment nameplates.
- .3 Include nameplate designation, manufacturer's nameplate data, equipment and component parts; numbers, location of equipment, and switch location and normal operating position of switch.
- .4 Valve tag schedules shall list each tag by system. Include reference number, valve location and usage, system identification, colour code, and function, size and valve manufacturer with model number, and normal operating position of valve.

CSV École élémentaire Antonine-Maillet Renovations 615 Ridgeway Ave, Oshawa, Ontario	Coordination	Section 01040 Page 4 January 2026

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

1 Section Includes

- .1 Shop drawings and product data
- .2 Samples
- .3 Certificates and transcripts

2 Related Sections

- .1 Section 01310 - Construction Schedule: Submissions of schedules
- .2 Section 01400 - Quality Control: Submission of test and mix design mill tests.
- .3 Section 01601 - Material and Equipment: Submission of manufacturer's instructions.
- .4 Section 01655 - Systems Demonstration: Submission of system and equipment documents.
- .5 Section 01721 - Project Record Documents: Operating and maintenance manuals, and record drawings.

3 Administrative

- .1 Submit to Consultant submittals listed for review. Submit with reasonable promptness and in orderly sequence so as to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Work affected by the submittal shall not proceed until review is complete.
- .3 Review submittals prior to submission to the Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with the requirements of the Work and the Contract

Documents. Submittals not stamped, signed, dated and identified as to the specific project will be returned without being examined and shall be considered rejected.

- .4 Verify field measurements and affected adjacent Work are coordinated.
- .5 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.
- .6 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant review.
- .7 Keep one reviewed copy of each submission on site.

4 Shop Drawings and Product Data

- .1 Refer to GC 40.
- .2 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .4 Adjustments made on shop drawings by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the Work.
- .5 Make changes in shop drawings as the Consultant may require, consistent with Contract Documents. When resubmitting, notify the Consultant in writing of any revisions other than those requested.
- .6 Submit one transparency and six (6) prints of shop drawings for each requirement requested in specification Sections and as the consultant may reasonably request.
- .7 Submit six (6) copies of product data sheets or brochures for requirements requested in specification Sections and as the Consultant

may reasonably request where shop drawings will not be prepared due to standardized manufacture of product.

- .8 If upon review by the Consultant, no errors or omissions are discovered or if only minor corrections are made, the transparency will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through the same procedure indicated above, shall be performed before fabrication and installation of Work may proceed.

5 Samples

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples as to origin and intended use in the Work.
- .2 Deliver samples prepaid to Consultant's business address.
- .3 Notify the Consultant in writing, at the time of submission of deviations in samples from requirements of Contract Documents.
- .4 Adjustments made on samples by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the Work.
- .5 Make changes in samples which the Consultant may require, consistent with Contract Documents.

6 Certificates and Transcripts

- .1 Immediately after award of Contract, submit Workers' Compensation Board status transcription of insurances.

1 Section Includes

- .1 Schedule, form, content
- .2 Scheduled revisions
- .3 Critical path scheduling

2 Related Sections

- .1 Section 01770 - Take-Over Procedures: Project closeout requirements.

3 Schedules Required

- .1 Submit the following schedules:
 - .1 Construction Progress Schedule
 - .2 Submittal Schedule for Shop Drawings and Product Data
 - .3 Submittal Schedule for Samples
 - .4 Submittal Schedule for timeliness of Owner furnished Products
 - .5 Product Delivery Schedule
 - .6 Cash Allowance Schedule for purchasing Products

4 Format

- .1 Prepare schedule in the form of a horizontal bar chart.
- .2 Provide a separate bar for each trade or operation.
- .3 Provide horizontal time scale identifying the first work day of each week.
- .4 Format for listings: The chronological order of trades for the Work.
- .5 Identification of listings: By specification Section numbers and

Specification subjects.

5 Submission

- .1 Submit initial schedules within 15 days after award of Contract.
- .2 Submit one opaque reproduction, plus 2 copies to be retained by the Consultant.
- .3 Consultant will review schedule and return review copy within 10 days after receipt.
- .4 Resubmit finalized schedule within 7 days after return of review copy.
- .5 Submit revised progress schedule with each application for payment.
- .6 Distribute copies of the revised schedule to:
 - .1 Job site office.
 - .2 Subcontractors.
 - .3 Other concerned parties.
- .7 Instruct recipients to report to the Contractor within 10 days, any problems anticipated by the timetable shown in the schedule.

6 Construction Progress Schedule

- .1 Include the complete sequence of construction activities.
- .2 Include the dates for the commencement and completion of each major elements of construction including the following.
 - .1 Site clearing.
 - .2 Site utilities.
 - .3 Foundation Work.
 - .4 Structural framing.
 - .5 Special Subcontractor work.
 - .6 Equipment Installations.
 - .7 Finishes.
- .3 Show projected percentage of completion of each item as of the first day of the month.
- .4 Indicate progress of each activity to date of submission schedule.

- .5 Show changes occurring since previous submission of schedule:
 - .1 Major changes in scope.
 - .2 Activities modified since previous submission.
 - .3 Revised projections of progress and completion.
 - .4 Other identifiable changes.
- .6 Provide a narrative report to define:
 - .1 Problem areas, anticipated delays, and the impact on the schedule.
 - .2 Corrective action recommended and its effect.
 - .3 The effect of changes on schedules of other prime contractors.

7 Submittals Schedule

- .1 Include schedule for submitting shop drawings, product data, samples .
- .2 Indicate dates for submitting, review time, resubmission time, float time, last date for meeting fabrication schedule.
- .3 Include dates when reviewed submittals will be required from the Consultant.

1 Section Includes

- .1 Inspection and testing, administrative and enforcement requirements.
- .2 Tests and mix designs.
- .3 Mock-ups.
- .4 Mill tests.
- .5 Equipment and system adjust and balance.

2 Related Sections

- .1 Section 01300 - Submittals: Submission of samples to confirm product quality.
- .2 Section 01601 - Material and Equipment: Material and workmanship quality, reference standards.

3 Inspection

- .1 Refer to GC 38.
- .2 The Owner and the Consultant shall have access to the Work. If part of the Work is in preparation at locations other than the Place of the Work, access shall be given to such work whenever it is in progress.
- .3 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Consultant instructions, or the law of the Place of the Work.
- .4 If the Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have the inspections or tests satisfactorily completed and make good such Work.
- .5 The Consultant may order any part of the Work to be examined if the Work is suspected to be not in accordance with the Contract Documents.

If, upon examination such work is found not in accordance with the Contract Documents, correct such work and pay the cost of examination and correction. If such Work is found in accordance with the Contract Documents, the Owner shall pay the cost of examination and replacement.

4 Independent Inspection Agencies

- .1 Independent Inspection/Testing Agencies will be engaged by the Owner for the purpose of inspecting and/or testing portions of Work.
- .2 Costs shall be allocated as set out in Section 01021 - Allowances.
- .3 Provide equipment required for executing inspection and testing by the appointed agencies.
- .4 Employment of inspection/testing agencies does not relax the responsibility to perform Work in accordance with the Contract Documents.
- .5 If defects are revealed during inspection and/or testing, the appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Consultant at no cost to the Owner. Pay costs for retesting and reinspection.

5 Access to Work

- .1 Allow inspection/testing agencies access to the Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

6 Procedures

- .1 Notify the appropriate agency and Consultant in advance of the requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in

an orderly sequence so as not to cause delay in the Work.

- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

7 Rejected Work

- .1 Refer to GC 39.
- .2 Remove defective Work, whether the result of poor workmanship, use of defective products or damage and whether incorporated in the Work or not, which has been rejected by the Consultant as failing to conform to the Contract Documents. Replace or re-execute in accordance with the Contracts Documents.
- .3 Make good other Contractor's work damaged by such removals or replacements promptly.
- .4 If in the opinion of the Consultant it is not expedient to correct defective Work or Work not performed in accordance with the Contract Documents, the Owner may deduct from the Contract Price the difference in value between the Work performed and that called for by the Contract Documents, the amount of which shall be determined by the Consultant.

8 Reports

- .1 Submit 4 copies of inspection and test reports to the Consultant.
- .2 Provide copies to Subcontractor of work being inspected or tested and manufacturer or fabricator of material being inspected or tested .

9 Tests and Mix Designs

- .1 Furnish test results and mix designs as may be requested.
- .2 The cost of tests and mix designs beyond those called for in the Contract Documents or beyond those required by the law of the Place of Work shall be appraised by the Consultant and may be authorized as recoverable.

10 Mockup

- .1 Prepare mock-up for Work specifically requested in the specifications. Include for Work of all Sections required to provide mock-ups.
- .2 Construct in all locations acceptable to the Consultant.
- .3 Prepare mock-up for Consultant review with reasonable promptness and in an orderly sequence, so as not to cause any delay in the Work.
- .4 Failure to prepare mock-up in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 If requested, the Consultant will assist in preparing a schedule fixing the dates for preparation.
- .6 Mock-up may remain as part of the Work.

11 Mill Tests

- .1 Submit mill test certificates as may be requested.

12 Equipment and Systems

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

PART 1 - GENERAL

1.1 Section Includes

- .1 Temporary utilities.

1.2 Related Sections

- .1 Construction Section 01535 facilities: Construction Facilities
- .2 Temporary Section 01560 controls: Temporary Controls

1.3 Installation and Removal

- .1 Provide temporary utilities controls in order to execute work expeditiously.
- .2 Remove from site all such work after use.

1.4 Dewatering

- .1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.

1.5 Sanitary Facilities

- .1 Provide sufficient sanitary facilities for workers in accordance with local health authorities.

- .2 Maintain in clean condition.

1.6 Water Supply

- .1 The Owner will provide a continuous supply of potable water for construction use.
- .2 Arrange for connection with appropriate utility company and pay all costs for installation, maintenance and removal.
- .3 Pay for utility charges at prevailing rates.

1.7 Temporary Heating

- .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
- .2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders not permitted.
- .3 Maintain temperatures of minimum 10 degrees C in areas where construction is in progress, unless indicated otherwise in specifications.
- .4 Ventilate heated areas and keep building free of exhaust or combustion gases.
- .5 The use of the permanent heating system of building, or portions thereof, may not be used.
- .6 Date of Substantial Performance and Warranties for heating system do not commence until entire system is in as near original condition as possible and is so certified by Consultant.
- .7 Be responsible for damage to work due to failure in providing adequate heat and protection during construction.

1.8 Temporary Power and Light

- .1 Provide and pay for temporary power during construction for temporary

- lighting and operating of power tools, to a maximum supply of 230 volts 30 amps.
- .2 Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance and removal.
 - .3 Temporary power for electric cranes and other equipment requiring in access of above is responsibility of Contractor.
 - .4 Provide and maintain temporary lighting throughout project. Level of illumination on all floors and stairs shall not be less than 15 foot candles 162 Lx.

1.9 Temporary Telephone

- .1 Provide and pay for temporary telephones necessary for own use and use of Consultant and Owner.

1.10 Fire Protection

- .1 Provide and maintain temporary fire protection equipment during performance of work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.
- .2 Open and burning rubbish are not permitted on site.

PART 2 - PRODUCTS Not used.

PART 3 - EXECUTION Not used.

PART 1 - GENERAL

1.1 Section Includes

- .1 Construction aids.
- .2 Traffic controls.
- .3 Office and sheds.
- .4 Project identification.

1.2 Related Sections

- .1 Temporary Section 01510 utilities: Temporary Utilities
- .2 Temporary Section 01560 controls: Temporary Controls

1.3 Installation and Removal

- .1 Provide construction facilities in order to execute work expeditiously.
- .2 Remove from site all such work after use.

1.4 Scaffolding

- .1 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms and temporary stairs.

1.5 Hoisting

- .1 Provide, operate and maintain hoists required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof.
- .2 Hoists shall be operated by qualified operator.

1.6 Site Storage/ Loading

- .1 Refer to GC 36.
- .2 Confine work and operations of employees by Contract documents. Do not unreasonably encumber premises with products.
- .3 Do not load or permit to load any part of work with a weight or force that will endanger the work.

1.7 Security

- .1 Provide and pay for responsible security personnel to guard site and contents of site after working hours and during holidays.

1.8 Offices

- .1 Provide and maintain in clean condition during progress of work, adequately lighted, heated and ventilated Consultant's temporary office and Contractor's office with space for filing and layout of Contract Documents and Contractor's normal site office staff.
- .2 Provide adequate required first aid facilities.
- .3 Subcontractors may provide their own offices as necessary. Direct location of these offices.

1.9 Equipment, Tool and Materials Storage

- .1 Provide and maintain, in a clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in a manner to cause least interference with work activities.

PART 2 - PRODUCTS Not used.

PART 3 - EXECUTION Not used.

PART 1 - GENERAL

1.1 Section Includes

- .1 Reference standards.
- .2 Product quality, availability, storage, handling, protection, transportation.
- .3 Manufacturer's instructions.
- .4 Workmanship, coordination and fastenings.
- .5 Existing facilities.

1.2 Related Sections

- .1 Section 01400 - Quality Control: Quality control and inspection of Work.

1.3 Reference Standards

- .1 Within the text of the specifications, reference may be made to the following standards:

ACI	- American Concrete Institute
AISC	- American Institute of Steel Construction
ANSI	- American National Standards Institute
ASTM	- American Society of Testing and Materials
CEC	- Canadian Electrical Code (published by CSA)
CEMA	- Canadian Electrical Manufacturer's Association
CGSB	- Canadian General Standards

	Board
CISC	- Canadian Institute of Steel Construction
CLA	- Canadian Lumberman's Association
CPCA	- Canadian Painting Contractors' Association
CPCI	- Canadian Prestressed Concrete Institute
CRCA	- Canadian Roofing Construction Association
CSA	- Canadian Standards Association
FM	- Factory Mutual Engineering Corporation
IEEE	- Institute of Electrical and Electronic Engineers
IPCEA	- Insulated Power Cable Engineers Association
NAAMM	- National Association of Architectural Metal Manufacturers
NBC	- National Building Code
NEMA	- National Electrical Manufacturers' Association
TTMAC	- Terrazzo, Tile and Marble Association of Canada
ULC	- Underwriters' Laboratories of Canada

- .2 Conform to these standards, in whole or in part as specifically requested in the specifications.
- .3 If there is question as to whether any product or system is in conformance with applicable standards, the Consultant reserves the right to have such products or systems tested to prove or disprove conformance.
- .4 The cost for such testing will be born by the Owner in the event of conformance with Contract Documents or by the Contractor in the event of non-conformance.
- .5 Conform to latest date of issue of referenced standards in effect on date of submission of bids, except where a specific date or issue is specifically noted.
- .6 Conform to Ontario Building Code (OBC 2012) Ontario Regulation 332/12 for all standards.

1.4 Associations

- .1 AA - Aluminum Association, 900 19th Street N.W., Washington, D.C., U.S.A. 20006 <http://www.aluminum.org>
- .2 AASHTO - American Association of State Highway and Transportation Officials, 444 N Capitol Street N.W., Suite 249, Washington, D.C., U.S.A. 20001 <http://www.aashto.org>
- .3 ACI - American Concrete Institute, P.O. Box 9094, Farmington Hills, Michigan U.S.A. 48333 <http://www.aci-int.org>
- .4 AHA - American Hardboard Association, 887-B Wilmette Road, Palatine, Illinois, U.S.A. 60067
- .5 AITC - American Institute of Timber Construction, 7012 S. Revere Parkway, Suite 140, Englewood, Colorado, U.S.A. 80112 <http://www.aitc-glulam.org>
- .6 AMCA - Air Movement and Control Association Inc., 30 West University Drive, Arlington Heights, Illinois, U.S.A. 60004-1893 <http://www.amca.org>
- .7 ANSI - American National Standards Institute, 11 West 42nd Street, New York, New York, U.S.A. 10036 <http://www.ansi.org>
- .8 API - American Petroleum Institute, 1220 L St. Northwest, Washington, D.C., U.S.A. 20005-4070 <http://www.api.org>
- .9 ARI - Air Conditioning and Refrigeration Institute, 1815 North Fort Myer Drive, Arlington, Virginia, U.S.A. 22209 <http://www.ari.org>
- .10 ASHRAE - American Society of Heating, Refrigeration and Air-Conditioning Engineers, 1791 Tullie Circle NE, Atlanta, Georgia, U.S.A. 30329 <http://www.ashrae.org>
- .11 ASME - American Society of Mechanical Engineers, United Engineering Centre, 345 East 47th Street, New York, New York, U.S.A. 10017-2392 <http://www.asme.org>
- .12 ASTM - American Society for Testing and Materials, 100 Barr Harbor Drive West, Conshohocken, Pennsylvania 19428-2959 <http://www.astm.org>
- .13 AWCI - Association of the Wall and Ceiling Industries, 1711 Connecticut Avenue N.W., Washington, D.C. U.S.A. 20009 <http://www.awci.org>
- .14 AWMAC - Architectural Woodwork Manufacturers Association of Canada, 516 4 Street West, High River, Alberta T1V 1B6 <http://www.awmac.com>

- .15 AWS - American Welding Society, 550 N.W. LeJeune Road, Miami, Florida U.S.A. 33126 <http://www.amweld.org>
- .16 AWWA - American Water Works Association, 6666 W. Quincy Avenue, Denver, Colorado, U.S.A. 80235 <http://www.awwa.org>
- .17 CFFM - Canadian Forces Fire Marshal, 101 Colonel By Drive, 8NT MGen George R. Pearkes Bldg., Ottawa, Ontario K1A 0K2
- .18 CGA - Canadian Gas Association, 243 Consumers Road, Suite 1200, North York, Ontario M2J 5E3 <http://www.cga.ca>
- .19 CGSB - Canadian General Standards Board, Place du Portage, Phase III, 6B1, 11 Laurier Street, Hull, Quebec K1A 1G6 <http://w3.pwgsc.gc.ca/cgsb>
- .20 CISC - Canadian Institute of Steel Construction, 201 Consumers Road, Suite 300, Willowdale, Ontario M2J 4G8
- .21 CITC - Canadian Institute of Timber Construction, 200 Cooper Street, Ottawa, Ontario K2P 0G1
- .22 CMB - Construction Materials Board, 101 Colonel By Drive, 8NT MGen George R. Pearkes Bldg., Ottawa, Ontario K1A 0K2
- .23 COFI - Council of Forest Industries, 555 Burrard, Suite 1200, Vancouver, B.C. V7X 1S7 <http://www.cofi.org>
- .24 CRCA - Canadian Roofing Contractors Association, 151 Slater Street, Suite 606, Ottawa, Ontario K1P 5H3
- .25 CSA - Canadian Standards Association, 178 Rexdale Blvd., Etobicoke, Ontario M9W 1R3 <http://www.csa.ca>
- .26 CSC - Construction Specifications Canada, 100 Lombard Street, Suite 200, Toronto, Ontario M5C 1M3 <http://www.csc-dcc.ca>
- .27 CSDFMA - Canadian Steel Door and Frame Manufacturing Association One Yonge Street, Suite 1400, Toronto, Ontario M5E 1J9
- .28 CSPI - Corrugated Steel Pipe Institute, 201 Consumers Road, Suite 306, Willowdale, Ontario M2J 4G8
- .29 CSSBI - Canadian Sheet Steel Building Institute, 201 Consumers Road, Suite 305, Willowdale, Ontario M2J 4G8 <http://www.cssbi.ca>
- .30 CWC - Canadian Wood Council, 1400 Blair Place, Suite 210, Ottawa, Ontario K1J 9B8 <http://www.cwc.ca>
- .31 EEMAC - Electrical and Electronic Manufacturers' Association of Canada,

1 Yonge Street, Suite 1608, Toronto, Ontario M5E 1R1
<http://www.electro.ca>

- .32 FCC - Fire Commissioner of Canada, Place du Portage, Phase II, 165 rue Hotel de Ville, Hull Quebec K1A 0J2
- .33 ICPI - Interlocking Concrete Pavement Institute, P.O. Box 23053, Milton, Ontario L9T 2M0 <http://www.icpi.org/icpi>
- .34 IEEE - Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, New York U.S.A. 10017 <http://www.ieee.org>
- .35 MSS - Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street, N.E., Vienna, Virginia U.S.A.22180
- .36 NAAMM - National Association of Architectural Metal Manufacturers, 8 South Michigan Avenue, Suite 1000, Chicago, Illinois U.S.A. 60603 <http://www.naamm.org>
- .37 NEMA - National Electrical Manufacturers Association, 1300 N. 17th Street, Suite 1847, Rosslyn, Virginia 22209 <http://www.nema.org>
- .38 NFPA - National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts, U.S.A. 02269-9101 <http://www.nfpa.org>
- .39 NFSA - National Fire Sprinkler Association, P.O. Box 1000, Patterson, New York, U.S.A. 12563 <http://www.nfsa.org>
- .40 NHLA - National Hardwood Lumber Association, P.O. Box 34518, Memphis, Tennessee, U.S.A 38184-0518 <http://www.natlhardwood.org>
- .41 NLGA - National Lumber Grades Authority, 260-1055 West Hastings, Vancouver, B.C. V6E 2E9
- .42 NRC - National Research Council, Montreal Road, Ottawa, Ontario K1A 0S2
- .43 PCI - Prestressed Concrete Institute, 175 W. Jackson Blvd., Suite 1859, Chicago, Illinois, U.S.A. 60604 <http://www.pci.org>
- .44 QPL - Qualification Program List, c/o Canadian General Standards Board, Place du Portage, Phase III, 6B1, 11 Laurier Street, Hull, Quebec K1A 1G6 <http://w3.pwgsc.gc.ca/cgsb>
- .45 SAE - Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096-0001 <http://www.sae.org>
- .46 SCC - Standards Council of Canada, 1200-45 O'Connor Street, Ottawa, Ontario K1P 6N7 <http://www.scc.ca>

- .47 SMACNA - Sheet Metal and Air Conditioning Contractors' National Association, 4201 Lafayette Center Drive, Chantilly, Virginia 20151-1209 <http://www.smacna.org>
- .48 SSPC - Steel Structures Painting Council, 40 24th Street, Pittsburgh, Pennsylvania 15222-4656 <http://www.sspc.org>
- .49 TTMAC - Terrazzo, Tile and Marble Association of Canada, 30 Capston Gate, Unit 5 Concord, Ontario L4K 3E8 <http://www.ttmac.com>
- .50 UL - Underwriters' Laboratories, 333 Pfingsten Road, Northbrook, Illinois, U.S.A. 60062 <http://www.ul.com>
- .51 ULC - Underwriters' Laboratories of Canada, 7 Crouse Road, Scarborough, Ontario M1R 3A9 <http://www.ulc.ca>
- .52 USACE - United States Army Corps Engineers, Huntsville, Alabama <http://www.hnd.usace.army.mil>

1.5 Quality

- .1 Refer to GC 32.
- .2 Products, materials, equipment and articles (referred to as Products throughout the specifications) incorporated in the Work shall be new, not damaged or defective, and of the best quality (compatible with specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- .3 Defective Products, whenever identified prior to the completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.
- .4 Should any dispute arise as to the quality or fitness of Products, the decision rests strictly with the Consultant based upon the requirements of the Contract Documents.
- .5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the building.
- .6 Permanent labels, trademarks and nameplates on Products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.6 Availability

- .1 Immediately upon signing Contract, review Product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of Products are foreseeable, notify the Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In the event of failure to notify the Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Consultant reserves the right to substitute more readily available products of similar character, at no increase in Contract Price.

1.7 Storage, Handling and Protection

- .1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in the Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in a heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged Products at own expense and to the satisfaction of the Consultant.

1.8 Transportation

- .1 Pay costs of transportation of Products required in the performance of Work.
- .2 Transportation cost of Products supplied by the Owner will be paid for by the Owner. Unload, handle and store such Products.

1.9 Manufacturer's Instructions

- .1 Unless otherwise indicated in the specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
- .2 Notify the Consultant in writing, of conflicts between the specifications and manufacturer's instructions, so that the Consultant may establish the course of action.
- .3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes the Consultant to require removal and re-installation at no increase in Contract Price.

1.10 Workmanship

- .1 Workmanship shall be the best quality, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required Work is such as to make it impractical to produce required results.
- .2 Do not employ any unfit person or anyone unskilled in their required duties. The Consultant reserves the right to require the dismissal from the site, workers deemed incompetent, careless, insubordinate or otherwise objectionable.
- .3 Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with the Consultant, whose decision is final.

1.11 Co-Ordination

- .1 Insure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.12 Concealment

- .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation, inform the Consultant if there is a contradictory situation. Install as directed by Consultant.

1.13 Remedial Work

- .1 Refer to GC 37 and Section 01040.
- .2 Perform remedial work required to repair or replace the parts or portions of the Work identified as defective or unacceptable. Coordinate adjacent affected Work as required.
- .3 Perform remedial work by specialists familiar with the materials affected. Perform in a manner to neither damage nor endanger any portion of Work.

1.14 Location of Fixtures

- .1 Consider the location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform the Consultant of a conflicting installation. Install as directed.

1.15 Fastenings

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use noncorrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected specification Section.
- .4 Space anchors within their load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.16 Protection of Work in Progress

- .1 Adequately protect Work completed or in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Consultant, at no increase in Contract Price.
- .2 Prevent overloading of any part of the building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of Consultant.

1.17 Existing Utilities

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with a minimum of disturbance to Work, and/or building occupants and pedestrian and vehicular traffic.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in a manner approved by authority having jurisdiction, stake and record location of capped service.

CSV École élémentaire
Antonine-Maillet Renovations
615 Ridgeway Ave,
Oshawa, Ontario

Material and Equipment

Section 01601

Page 11

January 2026

PART 2 - PRODUCTS Not Used

PART 3 - EXECUTION Not Used

PART 1 - GENERAL

1.1 Section Includes

- .1 Testing, adjusting and balancing of building equipment and systems.
- .2 Procedures for demonstration and instruction of equipment and systems to Owner's personnel.

1.2 Related Section

- .1 Document 00710 - General Conditions: Inspections, tests, and approvals required by public authorities.
- .2 Section 01400 - Quality Control: Employment of testing agency and payment for services.
- .3 Individual Sections: Demonstrating systems and equipment.

1.3 References

- .1 Associated Air Balance Council (AABC): National Standards For Field Measurements and Instrumentation, Total Systems Balance, Air Distribution Hydronics Systems.

1.4 Quality Assurance

- .1 Testing organization: Current member in good standing of AABC certified to perform specified services.
- .2 Comply with applicable procedures and standards of the certification sponsoring association.

- .3 Perform services under direction of supervisor qualified under certification requirements of sponsoring association.

1.5 Submittals

- .1 Prior to start of Work, submit name of organization proposed to perform services and names of specialty personnel proposed to perform services. Designate who has managerial responsibilities for coordination of entire testing, adjusting and balancing.
- .2 Submit documentation to confirm organization compliance with quality assurance provision.
- .3 Submit 3 preliminary specimen copies of each of report forms proposed for use.
- .4 Fifteen days prior to Substantial Performance, submit 3 copies of final reports on applicable forms.
- .5 Submit reports of testing, adjusting, and balancing postponed due to seasonal, climatic, occupancy, or other reasons beyond Contractor's control, promptly after execution of those services.

1.6 Procedures

- .1 Comply with procedural standards of certifying association under whose standard services will be performed.
- .2 Report to Consultant any deficiencies or defects noted during performance of services.
- .3 Prepare each system for testing and balancing.
- .4 Cooperate with testing organization, provide access to equipment and systems.
- .5 Notify testing organization 7 days prior to time project will be ready for testing, adjusting, and balancing.

1.7 Final Reports

- .1 Organization having managerial responsibility shall make reports.
- .2 Ensure each form bears signature of recorder, and that of supervisor of reporting organization.
- .3 Identify each instrument used, and latest date of calibration of each.
- .4 Submit 3 copies of final reports on applicable forms.

1.8 Contractor Responsibilities

- .1 Prepare each system for testing and balancing.
- .2 Cooperate with testing organization and provide access to equipment and systems.
- .3 Provide personnel and operate systems at designated times, and under conditions required for proper testing, adjusting, and balancing.
- .4 Notify testing organization 7 days prior to time project will be ready for testing, adjusting, and balancing.

1.9 Preparation

- .1 Provide instruments required for test, adjust, and balance operations.
- .2 Verify systems installation is complete and in continuous operation.
- .3 Verify lighting is turned on when lighting is included in cooling load.
- .4 Verify equipment such as computers, laboratory and electronic equipment are in full operation.
- .5 Test equipment, balance distribution systems, and adjust devices for HVAC systems.

1.10 Systems Demonstration

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment

at agreed upon times, at the equipment designated location.

- .2 Owner will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.
- .3 Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
- .4 Review contents of manual in detail to explain all aspects of operation and maintenance.
- .5 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.

PART 2 - PRODUCTS Not Used.

PART 3 - EXECUTION Not Used.

PART 1 - GENERAL

1.1 Section Includes

- .1 Progressive cleaning.
- .2 Final cleaning.

1.2 Related Section

- .1 Section 01770 - Take-Over Procedures.

1.3 Project Cleanliness

- .1 Maintain the Work in tidy condition, free from accumulation of waste products and debris, other than that caused by the Owner or other Contractors.
- .2 Remove waste material and debris from the site and deposit in waste container at the end of each working day. Do not burn waste materials on site.
- .3 Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Dispose of waste materials and debris off site .
- .7 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .8 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for

this purpose.

- .9 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .10 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.4 Final Cleaning

- .1 Refer to GC 36.
- .2 When the Work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for the performance of the remaining Work.
- .3 Remove waste products and debris other than that caused by the Owner, other contractors or their employees, and leave the Work clean and suitable for the occupancy by Owner.
- .4 Prior to final review, remove surplus products, tools, construction machinery and equipment. Remove waste products and debris other than that caused by the Owner or other Contractors.
- .5 Remove waste materials and the site at regularly scheduled times or dispose of as directed by the consultant. Do not burn waste materials on site, unless approved by the Consultant.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Leave the work broom clean before the inspection process commences.
- .8 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .9 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by the manufacturer.

- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep roofs, gutters, areaways, sunken wells.
- .16 Sweep and wash clean paved areas.
- .17 Clean equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment.
- .18 Clean roofs, downspouts, and drainage systems.
- .19 Clean lighting reflectors, lenses and other lighting surfaces.
- .20 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .21 Remove snow and ice from access to building.

PART 2 - PRODUCTS Not Used.

PART 3 - EXECUTION Not Used.

PART 1 - GENERAL

1.1 Section Includes

- .1 Record documents, samples, specifications.
- .2 Equipment and systems.
- .3 Product data, materials and finishes, and related information.
- .4 Operation and maintenance data.
- .5 Warranties and bonds.

1.2 Related Sections

- .1 Section 01040 - Field Engineering: Site survey after construction.
- .2 Section 01300 - Submittals: Shop drawings, samples, manufacturers instructions, photographs.
- .3 Section 01310 - Construction Schedule: Total project Schedule.
- .4 Section 01400 - Quality Control: Test and inspect reports.
- .5 Section 01655 - Testing, Adjusting and Balancing of Systems: Test and balance, system performance verification and takeover procedures.
- .6 Individual Specifications Sections: Specific requirements for operation and maintenance data.

1.3 Submission

- .1 Prepare instructions and data by personnel experienced in maintenance and operation of described products.

- .2 Submit one copy of completed volumes in final form 15 days prior to substantial performance.
- .3 Copy will be returned after final inspection, with Consultant comments.
- .4 Revise content of documents as required prior to final submittal.
- .5 Two weeks prior to Substantial Performance of the work, submit to the Consultant, two final copies of operating and maintenance manuals.

1.4 Format

- .1 Organize data in the form of an instructional manual.
- .2 Binders: commercial quality, 8 1/2 x 11 inch maximum ring size.
- .3 When multiple binders are used, correlate data into related consistent groupings.
- .4 Cover: Identify each binder with type or printed title "Project Record Documents"; list title of Project, identify subject matter of contents.
- .5 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Test: Manufacturer's printed data, or typewritten data on 20 pound paper.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.5 Contents, Each Volume

- .1 Table of Contents: provide title of project; names, addresses, and telephone numbers of Consultant and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
- .2 For Each Product or System: list names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies

and replacement parts.

- .3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01400.

1.6 Record Documents and Samples

- .1 In addition to requirements in General Conditions, Maintain at the site for Owner one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to the Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
- .2 Store Record Documents and Samples in Field Office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain Record Documents in a clean, dry and legible condition. Do not use Record Documents for construction purposes.
- .5 Keep Record Documents and samples available for inspection by Consultant.
- .6 Consolidate, index, bind and submit record documents in accordance with Section 1780 Closeout Submittals.

1.7 Recording Actual Site Conditions

- .1 Record information on a full set of black line opaque As-Built drawings provided by Owner, and in a copy of a Project Manual.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal work until required information is recorded.
- .4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
 - .1 Measure depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
- .5 Specifications: legibly mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalog number of each project actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.8 Record Drawings

- .1 Construction drawings for this project have been prepared on a CAD system. The software used is AutoCAD 2000.
- .2 Submit As-Built drawings to Consultant for preparation of Record Drawings.
- .3 Submit As-Built drawings to the Consultant for review prior to

Application for Certificate for Substantial Performance of the work.

- .4 The Consultant will update computer drawings and submit computer disk copies and print copies directly to the Owner. Cost for preparation of Record Drawings is included in Section 01005. Consultant will submit invoices directly to Contractor for direct payment.

1.9 Equipment and Systems

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panelboard Circuit Directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break- in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01400 and 01655.
- .15 Additional Requirements: As specified in individual specification sections.

1.10 Materials and Finishes

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalog number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommend schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual specifications sections.

1.11 Warranties and Bonds

- .1 Separate each warranty or bond with index tab sheets keyed to the List of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.
- .4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.

- .5 Verify that documents are in proper form, contain full information,
and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties and bonds until time specified for submittal.

1 Manual

- .1 An organized compilation of operating and maintenance data including detailed technical information, documents and records describing operation and maintenance of individual products or systems as specified in individual sections of Divisions 02 - 16.

2 General

- .1 Assemble, coordinate, bind and index required data into Operation and Maintenance Manual.
- .2 Submit complete operation and maintenance manual to Consultant 2 weeks prior to application for Substantial Performance.
- .3 Submit 1 hardcopy, and 1 electronic copy in pdf format on USB key.
- .4 Organize data into same numerical order as contract specifications.
- .5 Material: label each section with tabs protected with celluloid covers fastened to hard paper dividing sheets.
- .6 Type lists and notes.
- .7 Drawings, diagrams and manufacturers literature must be legible.

3 Binders

- .1 Binders: vinyl, hard covered, 3 "D" ring, loose leaf, sized for 215 x 280 mm paper, with spine pocket.
- .2 Identify contents of each binder on spline.

4 Contents

- .1 Binder 1:
 - .1 Cover sheet containing:
 - .1 Date submitted.
 - .2 Project title, location and project number.
 - .3 Names and addresses of Contractor, and all Sub-contractors.
 - .2 Table of Contents of all binders.
 - .3 List of maintenance materials as specified in Section 01750 - Maintenance Materials, Special Tools and Spare Parts.
 - .4 List of special tools as specified in Section 01750 - Maintenance Materials, Special Tools and Spare Parts.
 - .5 List of spare parts as specified in Section 01750 - Maintenance Materials, Special Tools and Spare Parts.
 - .6 Warranties, guarantees.
 - .7 Copies of approvals, and certificates.
- .2 Remaining binders:
 - .1 Cover sheet containing:
 - .1 Date submitted.
 - .2 Project title, location and project number.
 - .2 Table of Contents of individual binder.
 - .3 Provide data as specified in individual sections of Divisions 02 to 16.
 - .1 List of equipment including service depot.
 - .2 Nameplate information including equipment number, make, size, capacity, model number and serial number.
 - .3 Parts list.
 - .4 Installation details.
 - .5 Operating instructions.
 - .6 Maintenance instructions for equipment.
 - .7 Maintenance instructions for finishes.
- .3 Shop drawings:
 - .1 Bind separately one complete set of reviewed final shop drawings and product data.

PART 1 - GENERAL

1.1 Section includes

- .1 Section includes:
 - .1 Spare parts.
 - .2 Maintenance materials.
 - .3 Special tools.

1.2 Related Sections

- .1 Delivery Section 01655 and receipt of Testing, Adjusting spare parts and Balancing of associated with Systems testing, adjusting and balancing:
- .2 Systems Section 01655 demonstration: Systems Demonstration
- .3 Contract closeout Section 01770 procedures Project Contract Closeout record documents:
- .4 Project record Section 01721 documents Project Record Documents
- .5 Take-over procedures: Section 01770 Take-Over Procedures
- .6 Individual Specifications Sections: Specific requirements for operation and maintenance data.

1.3 Quality

- .1 Spare parts, maintenance materials and special tools provided shall be new, not damaged or defective, and of the same quality and manufacture as Products provided in the Work.
- .2 If requested, furnish evidence as to type, source and quality of Products provided.

- .3 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

1.4 Transportation

- .1 Pay costs of transportation.

1.5 Storage, handling and protection

- .1 Store spare parts, maintenance materials and special tools in a manner to prevent damage, or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Consultant.

1.6 Spare Parts

- .1 Provide spare parts in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in the Work.
- .3 Deliver to Project site or location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual specified in Section 01300.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.7 Maintenance Materials

- .1 Provide maintenance and extra materials in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in the Work.
- .3 Deliver to Project site or location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual specified in Section 01300.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.8 Special Tools

- .1 Provide special tools in quantities specified in individual specification Sections.
- .2 Provide items with tags identifying their function and equipment to which they are associated.
- .3 Deliver to Project site or location as directed; place and store.
- .4 Receive and catalogue all items. Include listings in Maintenance Manual specified in Section 01300.

PART 2 - PRODUCTS Not used

PART 3 - EXECUTION Not used

PART 1 - GENERAL

1.1 Section Includes

- .1 Administrative procedures preceding preliminary and final inspections of the Work.

1.2 Related Sections

- .1 Testing, adjusting Section 01655 and balancing: Testing, Adjusting and Balancing of Systems
- .2 Conform to OAA/OGCA Take-Over Procedures Document No. 100 latest edition.

1.3 Inspection and Declaration Procedures

- .1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of the Work, identify deficiencies and defects; repair as required to conform to Contract Documents. Notify Consultant in writing of satisfactory completion of Contractor's Inspection and that corrections have been made. Request a Consultant's Inspection.
- .2 Consultant's Inspection: Consultants and Contractor will perform an inspection of the Work to identify obvious defects or deficiencies. Contractor shall correct Work accordingly.
- .3 Completion: submit a written certificate that following have been performed:
 - .1 Work has been completed and inspected for compliance with Contract Documents,
 - .2 Defects have been corrected and deficiencies have been completed,
 - .3 Equipment and systems have been tested, adjusted and balanced and are fully operational,
 - .4 Certificates required by authorities having jurisdiction have been submitted,

- .5 Operation of systems have been demonstrated to Owner's personnel, and
- .6 Work is complete and ready for Final Inspection.
- .4 Final Inspection: when items noted above are completed, request a final inspection of the Work by Owner, Consultants, and Contractor. If Work is deemed incomplete by Owner and Consultant, complete outstanding items and request a reinspection.
- .5 Declaration of Substantial Performance: when Owner and Consultants consider deficiencies and defects have been corrected and it appears requirements of Contract have been substantially performed, make application for certificate of Substantial Performance. Refer to General Conditions Article GC 5.4 Substantial Performance of the Work. Submission of Project Record Documents in accordance with Section 01721 and Operation and Maintenance Manual in accordance with Section 01730 is a requirement for Substantial Performance.
- .6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance shall be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of the Place of the Work.
- .7 Final Payment: When Owner and Consultant consider final deficiencies and defects have been corrected and it appears requirements of Contract have been totally performed, make application for final payment. Refer to CCDC 2, General Conditions Article GC 5.7 for specifics to application. If Work is deemed incomplete by Owner and Consultant , complete outstanding items and request reinspection.
- .8 Payment of Holdback: After issuance of certificate of Substantial Performance of Work, submit an application for payment of holdback amount in accordance with CCDC 2, General Conditions Article 5.5.

1.4 Reinspection

- .1 Should status of the Work require reinspection by Consultant due to failure of Work to comply with Contractor's claims for inspection, Owner will deduct amount of Consultant's compensation for reinspection services from payment to Contractor.

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Take-Over Procedures

Section 01770
Page 3

January 2026

PART 3 - EXECUTION Not Used.

PART 1 - GENERAL

1.1 Section Includes

- .1 As-built, samples, and specifications.
- .2 Equipment and systems.
- .3 Product data, materials and finishes, and related information.
- .4 Operation and maintenance data.
- .5 Spare parts, special tools and maintenance materials.
- .6 Warranties and bonds.
- .7 Final site survey.

1.2 Related Sections

- .1 Section 01300 - Submittals.
- .2 Section 01400 - Quality Control.
- .3 Section 01770 - Closeout Procedures.

1.3 Submission

- .1 Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- .2 Copy will be returned after final inspection, with Consultant's comments.
- .3 Revise content of documents as required prior to final submittal.

- .4 Two weeks prior to Substantial Performance of the Work, submit to the Consultant, four final copies of operating and maintenance manuals in English.
- .5 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
- .6 If requested, furnish evidence as to type, source and quality of products provided.
- .7 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .8 Pay costs of transportation.

1.4 Format

- .1 Organize data in the form of an instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: Manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.5 Contents - Each Volume

- .1 Table of Contents: provide title of project;
 - .1 date of submission; names,
 - .2 addresses, and telephone numbers of Consultant and Contractor with name of responsible parties;
 - .3 schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
 - .1 list names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01450 - Quality Control .
- .6 Training: Co-ordinate with Owner and submit schedule for demonstrations and training.

1.6 As-builts and Samples

- .1 In addition to requirements in General Conditions, maintain at the site for Consultant/Owner one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to the Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.

- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Consultant .

1.7 Recording Actual Site Conditions

- .1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Consultant .
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
- .5 Specifications: legibly mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.8 Final Survey

- .1 Submit final site survey certificate certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.9 Equipment and Systems

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01450 - Quality Control and 01810 - Commissioning .
- .15 Additional requirements: As specified in individual specification sections.

1.10 Materials and Finishes

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual specifications sections.

1.11 Spare Parts

- .1 Provide spare parts, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Engineer Consultant . Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.12 Maintenance Materials

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to location as directed ; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Consultant.

Include approved listings in Maintenance Manual.

- .5 Obtain receipt for delivered products and submit prior to final payment.

1.13 Special Tools

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.

1.14 Storage, Handling and Protection

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.

- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Consultant.

1.15 Warranties and Bonds

- .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.
- .4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.
- .5 Verify that documents are in proper form, contain full information, and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties and bonds until time specified for submittal.

PART 2 - PRODUCTS

PART 3 - EXECUTION

PART 1 - GENERAL

1.1 Protection

- .1 Protect existing items designated to remain and materials designated for salvage. In event of damage to such items, immediately replace or make repairs to approval of Consultant and at no cost to Owner.

PART 2 - PRODUCTS Not Used.

PART 3 - EXECUTION

3.1 Preparation

- .1 Inspect site and verify with Consultant items designated for removal and items to remain.
- .2 Locate and protect utility lines. Preserve in operating condition active utilities traversing site.
- .3 Notify utility companies before starting demolition.

3.2 Removal

- .1 Remove items as indicated.
- .2 Do not disturb adjacent items designated to remain in place.

3.3 Salvage

- .1 Carefully dismantle items containing materials for salvage and stockpile salvaged materials at locations as indicated or as directed by Consultant.

3.4 Disposal of Material

- .1 Dispose of materials not designated for salvage or re-use in work, off-site.

3.5 Restoration

- .1 Upon completion of work, remove debris, trim surfaces and leave work site clean.
- .2 Reinstate areas and existing works outside areas of demolition to match condition of adjacent, undisturbed areas.

PART 1 - GENERAL

1.1 References

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C 117-95 95 , Test Method for Material Finer Than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 136-01 95a , Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D 422-63(2002) 63(1990) , Test Method for Particle-Size Analysis of Soils.
 - .4 ASTM D 698-00a 91 , Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³).
 - .5 ASTM D 1557-02 91 , Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³).
 - .6 ASTM D 4318-00 95 , Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A23.1-00, Concrete Materials and Methods of Concrete Construction.

1.2 Definitions

- .1 Rock excavation: excavation of material from solid masses of igneous, sedimentary or metamorphic rock which, prior to its removal, was integral with its parent mass, and boulders or rock fragments having individual volume in excess of 1 m³.
- .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation including dense

tills, hardpan and frozen materials.

- .3 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

1.3 Protection of Existing Features

- .1 Existing buried utilities and structures:
 - .1 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
 - .2 Prior to commencing any excavation work, notify applicable owner or authorities, establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during work.
 - .3 Confirm locations of buried utilities by careful test excavations.
 - .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain direction of Consultant before moving or otherwise disturbing utilities or structures.
 - .5 Advise utility company to remove or re-route existing lines in area of excavation. Pay costs for such work.
 - .6 Record location of maintained, re-routed and abandoned underground lines.
- .2 Existing buildings and surface features:
 - .1 Conduct, with Consultant, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by work.
 - .2 Protect existing buildings and surface features which may be affected by work from damage while work is in progress and repair damage resulting from work.

1.4 Shoring, Bracing and Underpinning

- .1 Comply with applicable local regulations to protect existing features.
- .2 Engage services of qualified professional engineer who is registered in Ontario to design and inspect shoring, bracing and underpinning required for work.

- .3 At least 2 weeks prior to commencing work, submit design and supporting data.
- .4 Design and supporting data submitted to bear the stamp and signature of qualified professional engineer registered in in the Province of Ontario.
- .5 Professional engineer responsible for design of temporary structures to submit proof of insurance coverage for professional liability except where engineer is employee of contractor, in which case contractor shall submit proof that work by professional engineer is included in contractor's insurance coverage.

1.5 Samples

- .1 Submit samples in accordance with Section 01300 - Submittals.
- .2 At least 4 weeks prior to commencing work, inform Consultant of proposed source of fill materials and provide access for sampling.

PART 2 - PRODUCTS

2.1 Materials

- .1 Type 1 and Type 2 fill:
 - .1 Crushed, pit run or screened stone, gravel or sand consisting of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
 - .2 Gradations to be within limits specified when tested to ASTM C 136-01 and ASTM C 117-95. Sieve sizes to CAN/CGSB-8.1-88.

<u>Sieve Designation</u>		<u>% Passing</u>
<u>Type 1</u>		<u>Type 2</u>
75 mm	-	-
		100

50 mm	-	-	-	-
37.5 mm	-	-	-	-
25 mm	100	-	-	-
19 mm	75-100	-	-	-
12.5 mm	-	-	-	-
9.5 mm	50-100	-	-	-
4.75 mm	30-70	-	-	22-85
2.00 mm	20-45	-	-	-
0.425mm	10-25	-	-	5-30
0.180mm	-	-	-	-
0.075mm	3-8	-	-	0-10

- .2 Type 3 fill: Selected material from excavation or other sources, approved by Consultant for use intended, unfrozen and free from rocks larger than 75mm, cinders, ashes, sods, refuse or other deleterious materials.
- .3 Crushed stone: 19mm clean washed crushed limestone.

PART 3 - EXECUTION

3.1 Site Preparation

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly in accordance with Section 02070 - Sitework Demolition and Removal.

3.2 Stripping of Topsoil

- .1 Commence topsoil stripping of areas as directed by Consultant after area has been cleared of brush weeds and grasses and removed from site.
- .2 Strip topsoil to depths as directed by Consultant. Avoid mixing topsoil

with subsoil.

- .3 Stockpile in locations as directed by Consultant. Stockpile height not to exceed 2 m.
- .4 Dispose of unused topsoil off site.

3.3 Stockpiling

- .1 Stockpile fill materials in areas designated by Consultant. Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.

3.4 Shoring, Bracing and Underpinning

- .1 Construct temporary works to depths, heights and locations as approved by Consultant.
- .2 During backfill operation:
 - .1 Unless otherwise as indicated or as directed by Consultant, remove shoring from excavations.
 - .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
- .3 Upon completion of substructure construction:
 - .1 Remove shoring and bracing.
 - .2 Remove excess materials from site and restore water courses as indicated and as directed by Consultant.

3.5 Dewatering and Heave Prevention

- .1 Keep excavations free of water while work is in progress.
- .2 Avoid excavation below groundwater table if quick condition or heave is likely to occur. Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.

- .3 Protect open excavations against flooding and damage due to surface run-off.
- .4 Dispose of water in a manner not detrimental to public and private property, or any portion of work completed or under construction.
- .5 Submit for Consultant's review details of proposed dewatering or heave prevention methods, such as dikes, well points, and sheet pile cut-offs.
- .6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, water courses or drainage areas.

3.6 Excavation

- .1 Advise Consultant sufficiently in advance of excavation operations to enable original cross sections to be taken.
- .2 Excavate to lines, grades, elevations and dimensions as indicated.
- .3 Remove concrete masonry paving walks demolished foundations and rubble and other obstructions encountered during excavation in accordance with Section 02070 - Sitework Demolition and Removal.
- .4 Excavation must not interfere with normal 45° splay of bearing from bottom of any footing.
- .5 For trench excavation, unless otherwise authorized by Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
- .6 Dispose of surplus and unsuitable excavated material off site.
- .7 Establish a control system of soil leaving the site to ensure that compliance with M.O.E.'s guidelines and regulations are met on the removal, disposal, and destination of on-site excavated soil. Obtain all approvals for disposal of existing fill, topsoil and original sub-soils and contaminated soils, if encountered. Claims for additional costs to the Contract with respect to approvals not prior obtained will not be accepted.
- .8 Do not obstruct flow of surface drainage or natural watercourses.
- .9 Earth bottoms of excavations to be undisturbed soil, level, free from

loose, soft or organic matter.

- .10 Notify Consultant when bottom of excavation is reached.
- .11 Obtain Consultant approval of completed excavation.
- .12 Remove unsuitable material from trench bottom to extent and depth as directed by Consultant.
- .13 Where required due to unauthorized over- excavation, correct as follows:
 - .1 Fill under bearing surfaces and footings with concrete specified for footings .
 - .2 Fill under other areas with Type 2 fill compacted to minimum of 95% Corrected Maximum Dry Density.
- .14 Hand trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to approval of Consultant.

3.7 Fill Types and Compaction

- .1 Use fill of types as indicated or specified below. Compaction densities are percentages of maximum densities obtained from ASTM D 698-00a ASTM D 1557-02 corrected maximum dry density.
 - .1 Exterior side of perimeter walls: Use Type 2 fill to subgrade level. Compact to 95%.
 - .2 Within building area: use Type 2 to underside of base course for floor slabs. Compact to 98%. Base course 19mm clean washed crushed stone. Compact to 100%.
 - .3 Under concrete slabs: provide 200 mm, 19 mm clean washed crushed stone compact to 100% SPD on 150 mm compact.
 - .4 Retaining walls: use Type 2 fill to subgrade level on high side for minimum 500 mm from wall and compact to 95%. For remaining portion, use Type 3 fill compacted to 95%.

3.8 Bedding and Surround of Underground Services 3.9 Backfilling

- .1 Place and compact granular material for bedding and surround of underground services as indicated.

- .2 Vibratory compaction equipment: appropriate for specified result.
- .3 Do not proceed with backfilling operations until Consultant has inspected and approved installations.
- .4 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .5 Do not use backfill material which is frozen or contains ice, snow or debris.
- .6 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .7 Backfilling around installations.
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in- place concrete within 24 h after placing of concrete.
 - .3 Place layers simultaneously on both sides of installed work to equalize loading. Difference not to exceed
 - .4 m.
 - .5 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
 - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Consultant or:
 - .2 If approved by Consultant, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant.

3.9 Restoration

- .1 Upon completion of work, remove surplus materials and debris, trim slopes, and correct defects as directed by Consultant.
- .2 Replace topsoil.
- .3 Reinstall pavement and sidewalks and lawns to elevation which existed before excavation and blend to ensure smooth transition.
- .4 Clean and reinstall areas affected by work as directed by Consultant.

CSV École élémentaire
Antonine-Maillet Renovations
615 Ridgeway Ave
Oshawa, Ontario

Excavating, Trenching and
Backfilling

Section 02223
Page 9

January 2026

Designated Substance and Hazardous Materials Specifications– Pre-Renovation

**École élémentaire Antonine-Maillet,
615 Ridgeway Avenue, Oshawa, Ontario**

February 26, 2026

Arcadis Project No. 30305984



Part 1 General

1.1 Scope of Work

- .1 Arcadis Professional Services (Canada) Inc. (Arcadis) was retained by the Conseil scolaire Viamonde (CSV) to conduct a pre-renovation designated substance and hazardous materials survey (DSHMS) of École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario.
- .2 The objective of the assessment was to identify designated substance and hazardous materials (DSHMs) in preparation for building renovation. This assessment is intended to be used for renovation purposes only and may not provide sufficient detail for long term management of hazardous materials as required by Health and Safety regulations. The results of this assessment are intended for use with a properly developed scope of work and performance specification.
- .3 The project consisted of a limited intrusive assessment of select areas of the building.
- .4 The DSHMS was conducted using a visual assessment with intrusive methods and was comprehensive in scope. However, additional hazardous materials may be uncovered during renovation activities. Any suspect materials encountered should be managed as designated substances and hazardous materials unless sampling and laboratory analysis confirm otherwise.
- .5 The following table summarizes the location of asbestos-containing materials and the suggested abatement method for the removal and handling of these materials. The bidding parties are responsible for the determination of the estimated quantities during the bidding process.

Designated Substance	Area	Material Description	Recommended Removal Measures
Asbestos	On pipe fittings above ceilings in Rooms 101, 102 and 102A.	Thermal insulation	Type 2 glovebag asbestos procedures
	Room 101	(12"x12") Vinyl Floor Tile – beige with dark brown and white directional flecks	Type 1 asbestos procedures without power tools.
	Rooms 101A, 202 and 203	(9"x9") Vinyl floor tiles and associated mastic	Type 1 asbestos procedures without power tools, Type 2 enclosure asbestos procedures with power tools attached to dust collecting devices equipped with HEPA filters.
	Corridor C102	Vinyl Sheet flooring and associated paper backing	Type 2 enclosure asbestos procedures without power tools, or power tools attached to dust collecting devices equipped with HEPA filters for areas <1m ² or Type 3 asbestos procedures for areas >1m ² .
	Rooms 101, 103, 104, 201, A1 and A2	Gypsum board with asbestos-containing drywall joint taping compound	Type 2 enclosure asbestos procedures with power tools attached to dust collecting devices equipped with HEPA filters.

Designated Substance	Area	Material Description	Recommended Removal Measures
	Corridors C101 and C102	(2'x2') Cement board wall panels	Type 1 asbestos procedures without power tools, Type 2 enclosure asbestos procedures.
	Room 202	Solid cement board panels	Type 1 asbestos procedures without power tools, Type 2 enclosure asbestos procedures.
	Rooms A1, A2, 201, 202 and 203	Reinforced autoclaved aerated concrete "Siporex" joint caulking	Type 1 asbestos procedures without power tools.
	Throughout the 1961 Era of construction	Concrete block-filler paint	Type 1 asbestos procedures without power tools, Type 2 enclosure asbestos procedures with power tools attached to dust collecting devices equipped with HEPA filters.

- .6 The following table summarizes the material description of designated substances and other hazardous materials and the suggested abatement method for the removal and handling of these materials. The bidding parties are responsible for the determination of the estimated quantities during the bidding process.

Designated Substance / Hazardous Material	Material Description	Recommended Action/Removal Measures
Lead	High-level lead paint (lead concentration greater than 0.1% (1000 ppm) by weight) is present within the Project Area. - White wall paint on Concrete block walls throughout the study area. Low-level lead paint (lead concentration less than or equal to 0.1% (1000 mg/Kg) by weight) is present within the Project Area. - Blue wall paint on concrete block walls throughout the study area. Lead in the solder on the sweated-on joints between copper pipe fittings. Lead may also be present in the solder on the seals of bell joints of cast iron drainpipe and glazing on ceramic tiles.	The Ministry of Labour, Immigration, Training and Skills Development <i>Guideline – Lead on Construction Projects</i>, dated April 2011, provides guidance in the measures and procedures that should be followed when handling lead-containing materials during construction projects. In addition, the Environmental Abatement Council of Canada - <i>EACC Lead Abatement Guidelines, October 2014</i>, also provides guidance and recommended work practices. If lead-containing paint applications and surface coatings are not removed prior to the handling, disturbance, or removal of the substrate materials, then the contractor must: - Remove/scrap flaking paint to the best extent possible - Encapsulate other surfaces in good condition For building materials that are to be disposed at a landfill, all lead-based paints and associated substrate (concrete, plaster, wood, etc.) must undergo Toxicity Characteristic Leachate Properties (TCLP) testing to determine disposal procedures. The disposal of lead-containing paint is regulated under the Federal Transportation of Dangerous

Designated Substance / Hazardous Material	Material Description	Recommended Action/Removal Measures
		Goods Act and by the Ministry of the Environment, Conservation and Parks (MECP).
Mercury	Mercury may be present in fluorescent bulbs.	The presence of mercury within assembled units (e.g., fluorescent light tubes and bulbs) should not be considered a hazard provided that the assembled units remain sealed and intact. However, direct skin contact with mercury and inhalation of mercury vapour should be avoided. The fluorescent light tubes and bulbs should be sent for recovery and recycling of mercury. Prior to any demolition activities, the fluorescent lights that may have been disturbed must be handled and if necessary, disposed of in accordance with O. Reg. 490/09.
Polychlorinated Biphenyls (PCBs)		Light ballasts, such as those associated with the type of fluorescent lights (T8s) observed, are usually an electronic-type which do not contain PCBs. However, this would be confirmed by an electrician at the time of dismantling of the lights, if required. All transformers observed were noted to be of the air-cooled variety and as such, would not contain PCBs.
Silica	Building components containing silica such as in concrete, concrete block, mortar, brick, drywall and drywall tapping joint compound, ceramic tiles and grout/mortar bed.	Any work that involves disturbing materials potentially containing silica must be conducted in accordance with the requirements of Ontario Regulation 490/09 and the recommendations outlined in the Ministry of Labour, Immigration, Training and Skills Development's 'Guideline - Silica on Construction Projects' (April 2011).
Halocarbon-Containing Equipment:	No equipment was observed.	

1.2 General Requirements

- .1 Comply with Federal, Provincial, and local requirements, regulations and guidelines pertaining to identified materials. The requirements as set out in these specifications may, at times, exceed the procedures detailed in the various applicable regulations. All work shall be done in compliance with the specifications, AND the regulations/guidelines. Should there be any discrepancy or conflict between the specifications and the regulation/guidelines, the most stringent shall apply.
- .2 Replacement of the removed materials is not part of this contract unless otherwise noted.
- .3 Coordinate all work with the General Contractor and sub trades as required.
- .4 Refer to Architectural Drawings and project specifications for additional details.
- .5 Where required, mechanical, electrical, communication and life systems isolations and disconnects will be performed by the General Contractor's sub trades prior to commencement of remedial work.

- .6 The Abatement Contractor is responsible for making all arrangements, and for paying for the disposal of all waste materials in accordance with Federal, Provincial, and local requirements, regulations and guidelines.
- .7 The Abatement Contractor is advised that extended hours of work may be required to meet the schedules as detailed in the Scope of Work and shall allow for the cost thereof including shift premiums and overtime. The Owner's Representative shall be advised in writing at least four days in advance of the proposed working hours.
- .8 The Abatement Contractor shall furnish and post on site the name and current phone number of an authorized representative(s) who can be contacted on a 24-hour basis in case of an emergency.
- .9 All precautions shall be taken to control the release of asbestos fibres within the work areas, preventing the release of asbestos fibres outside the work areas, to protect all parties including Demolition/Abatement Contractor's personnel, Owner's Representative, Owner's personnel and the public from asbestos dust exposure during the course of the work. The Contract Documents prescribe required asbestos containment provisions, but are not limited to, complying with all Regulations. Failure to meet any of these conditions will be considered a fundamental breach of the contractual obligations.
- .10 If the Abatement Contractor fails to comply with requirements dealing with the control of asbestos fibres and the health and safety of Abatement Contractor's employees, Owner's Representative, Owner personnel or the Public; the Owner, or the Owner's Representative, may verbally instruct the Abatement Contractor to cease work immediately with written confirmation to follow within two working days. If the Owner's Representative gives a written statement to the Owner and the Abatement Contractor that sufficient cause exists, the Owner may notify the Abatement Contractor in writing that they are in default of their contractual obligations.
- .11 The Owner's Representative shall have the authority to immediately stop the Work through a written instruction if, in their opinion, the Work does not conform to the requirements of the Contract Documents, or if continuance of the Work could subject the Owner, his employees or the public to a hazardous condition. The Work shall not recommence until such time as the deficiency or hazardous situation has been corrected and a written notice to proceed has been issued by the Owner's Representative.
- .12 The Owner's Representative will visit the site at his/her discretion to familiarize themselves with the progress and quality of the Work and to determine if the Work is proceeding in accordance with the Contract Documents.
- .13 Any employee shall be replaced, at the written request of the Owner's Representative, if working, or causing others to work, in violation of O.Reg. 278/05.
- .14 Provide a Certificate signed by the insurance agency naming the Owner, and Owner's representative as additional-insureds.
- .15 The Demolition/Abatement Contractor's insurance coverage limits, per occurrence, shall equal or exceed the following:
 - .1 General Liability \$5 million;
 - .2 Automotive Liability \$2 million;

- .3 Pollution Liability \$5 million including asbestos operations.
- .16 The Abatement Contractor must provide thirty (30) days' notice of cancellation or amendment of coverage.
- .17 The Abatement Contractor's supervisor must have proven experience and proficiency in the type of Work being undertaken under this Contract.
- .18 The Abatement Contractor's supervisor shall be replaced, at the written request of the Owner's Representative, if found to be incompetent or inattentive to the needs of the project.
- .19 Where standards of performance are specified or implied and the Work does not comply with the performance specified or implied, such deficiencies shall be corrected as directed by the Owner's Representative. Any subsequent testing shall be done at the Asbestos Contractor's expense.

END OF SECTION

Designated Substance and Hazardous Materials Survey - Pre-Renovation
Arcadis Project Name: École élémentaire Antonine-Maillet, 615 Ridgeway Ave.
Arcadis Project No.: 30305984

DSHMS Summary

February 26, 2026

Designated Substances and Hazardous Materials Summary

Section 02 81 00 – Hazardous Materials

Section 02 82 00.01 – Asbestos Abatement - Type 1 Precautions

Section 02 82 00.02 – Asbestos Abatement - Type 2 Precautions

Section 02 82 00.03 – Asbestos Abatement - Type 3 Precautions

Part 1 General

1.1 Related Requirements

- .1 Section 02 82 00.01 – Asbestos Abatement – Type 1 Precautions.
- .2 Section 02 82 00.02 – Asbestos Abatement – Type 2 Precautions.
- .3 Section 02 82 00.03 – Asbestos Abatement – Type 3 Precautions.

1.2 References:

- .1 A Guide to the Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations released in November 2007, <http://www.labour.gov.on.ca/english/hs/asbestos/index.html>.
- .2 Arcadis report titled “*Designated Substances and Hazardous Materials Survey – Pre-Renovation, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario*”, February 26, 2026.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-2003, Sealer for Application to Asbestos-Fibre-Releasing Materials.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA Z94.4.1:21, Performance of filtering respirators.
 - .2 CAN/CSA Z94.4-18(R2023), Selection, use and care of respirators.
- .5 Department of Justice Canada
 - .1 Canadian Environmental Protection Act (CEPA), 1999.
 - .2 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
- .6 Environmental Abatement Council of Canada (EACC) – Lead Abatement Guideline, 2015.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .8 Province of Ontario
 - .1 Ontario Regulation 213/91, Construction Projects.
 - .2 Ontario Regulation 278/05, Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations.
 - .3 Ontario Regulation 347/90, General – Waste Management.
 - .4 Ontario Regulation 490/09, Designated Substances.
 - .5 Ontario Regulation 632/05, Confined Spaces.
 - .6 Ontario Regulation 833/90 (as amended) – “Control of Exposure to Biological or Chemical Agents” (O. Reg. 833/90).
 - .7 Ontario Regulation 860/90, Workplace Hazardous Materials Information System (WHMIS).

- .8 Ontario Ministry of Labour, Immigration, Training and Skills Development publication
Guideline – Lead on Construction Projects (Issued September 2004, Updated April 2011).
- .9 Ontario Ministry of Labour, Immigration, Training and Skills Development publication
Guideline – Silica Construction Projects (Issued September 2004, Updated April 2011).
- .10 Ontario Occupational Health and Safety Act, R.S.O. 1990, c. O.1
- .11 Ontario Ministry of the Environment, Conservation and Parks
 - .1 Ontario Environmental Protection Act, R.S.O. 1990, c. E.19
- .12 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
 - .2 Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286)
- .13 Underwriters' Laboratories of Canada (ULC).
- .14 U.S. Environmental Protection Agency (EPA).
- .15 U.S. Department of Health and Human Services/Centers for Disease Control and
Prevention (CDC)/National Institute for Occupational Safety and Health (NIOSH)
 - .1 NIOSH 94-113-August 1994, NIOSH Manual of Analytical Methods (NMAM), 4th
Edition.

1.3 Definitions:

- .1 Dangerous Goods: product, substance, or organism specifically listed or meets hazard criteria established in Transportation of Dangerous Goods Regulations.
- .2 Hazardous Material: product, substance, or organism used for its original purpose; and is either dangerous goods or material that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when released into the environment.
- .3 Hazardous Waste: hazardous material no longer used for its original purpose and that is intended for recycling, treatment, or disposal.
- .4 Mercury: Mercury has been used in electrical equipment such as alkaline batteries, fluorescent light bulbs (lamps), high intensity discharge (HID) lights (mercury vapour, high pressure sodium and metal halide), "silent switches" and in instruments such as thermometers, manometers and barometers, pressure gauges, float and level switches and flow meters. Mercury-containing lamps, the bulk of which are 1.22 m (four foot) fluorescent lamps contain between 7 and 40 mg of mercury each. Mercury compounds have also been used historically as additives in latex paint to protect the paint from mildew and bacteria during production and storage.
- .5 Owner: The entity that holds legal responsibility for the project, typically the client, property owner, or organization commissioning the work. The Owner has contractual authority over the project and makes key decisions regarding scope, budget, and compliance.
- .6 Owner's Representative: A person or organization designated by the Owner to act on

their behalf in overseeing the project.

- .7 Ozone Depleting Substances (ODS): Ozone depleting substances and other Halocarbons, which include, for example, refrigerants used in refrigeration equipment and chillers.
- .8 Polychlorinated Biphenyls (PCBs): primary source of equipment potentially containing PCBs is fluorescent and H.I.D. light ballasts. Small transformers may also be present. In larger industrial facilities, larger transformers and switch gear containing, or potentially containing, PCBs may also be present. PCBs were also commonly added to industrial paints from the 1940s to the late 1970s. PCBs were added directly to the paint mixture to act as a fungicide, to increase durability and flexibility, to improve resistance to fires and to increase moisture resistance.
- .9 WHMIS: Workplace Hazardous Materials Information System

1.4 Action and Informational Submittals

- .1 Quality Control:
 - .1 Provide proof satisfactory to Owner's Representative that employees have had instruction on hazards of WHMIS, lead exposure, asbestos exposure, respirator use, fit testing, PPE use (including Tyvek dress), and aspects of work procedures and protective measures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for hazardous materials and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Submit one copy of WHMIS SDS in accordance to the Owner's Representative for each hazardous material required prior to bringing hazardous material on site.

1.5 Existing Conditions

- .1 The Arcadis report titled "*Designated Substances and Hazardous Materials Survey – Pre-Renovation, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario*", February 26, 2026, indicates the locations of hazardous materials present. Areas requiring special handling under hazardous material precautions are outlined in this Specification package. Asbestos-containing and lead-containing materials identified in the above-referenced report include:
 - .1 Thermal insulation applied to pipe fittings and pipe straight containing 55% Chrysotile in Rooms 101, 102 and 102A.
 - .2 (12"x12") Vinyl floor tile – beige with dark brown and white directional flecks containing 7.4% Chrysotile in Room 101.
 - .3 (9"x9") Vinyl floor tile – Green and associated mastic containing 13.2% Chrysotile and 2% Chrysotile in Room 101A.
 - .4 (9"x9") Vinyl floor tile - beige and associated mastic containing 5% Chrysotile and 2% Chrysotile in Rooms 202 and 203.

- .5 Vinyl sheet flooring and associated paper backing mastic containing 9% Chrysotile and 28.6% Chrysotile in Corridor C102.
- .6 (2'x2') Cement board wall panels containing 28% Chrysotile in Corridors C101 and C102 and Room 202.
- .7 Solid cement board wall panels containing 23% Chrysotile in Room 202.
- .8 Gypsum board with asbestos-containing joint taping compound containing 2.8% Chrysotile applied to walls in Rooms 103, 104, 201, A1 and A2 and to ceilings in Room 101A.
- .9 Concrete block-filler paint applied to walls containing 1% Chrysotile throughout the 1961 construction era.
- .10 Reinforced autoclaved aerated concrete "Siporex" joint caulking containing 2% Chrysotile in Rooms A1, A2, 201, 202 and 203.
- .11 White paint on concrete block walls containing lead greater than or equal to 0.1% (1000 ppm) is present within the study area.
- .12 Blue paint on concrete block walls containing lead less than or equal to 0.1% (1000 ppm) is present within the study area.
- .13 Lead may also be present in the solder on the seals of bell joints of any cast iron drainpipe, in the solder of on the sweated-on joints between copper pipe and fittings and glazing on ceramic tiles.
- .2 Silica-containing materials should be handled in accordance with the measures and procedures outlined the Ontario Ministry of Labour, Immigration, Training and Skills Development Guideline, Silica on Construction Projects, April 2011, should be followed.
- .3 Prior to undertaking demolition activities that involve fluorescent lights, ensure that a licensed electrician inspects ballasts to determine whether or not any light ballasts may contain PCBs. Guidance in identification of PCB ballasts is provided in the Environment Canada publication titled "Identification of Lamp Ballasts Containing PCBs. Report EPS 2/CC/2 (revised)", August 1991.
- .4 Fluorescent light tubes and bulbs should be recycled for mercury.
- .5 All ODS-containing equipment should be removed prior to demolition in the following manner:
 - .1 Any equipment designated for disposal as scrap must be drained of its contents by a certified person and equipped with a label indicating that the equipment no longer contains any refrigerant. The specific requirements for information on the label, as specified in the regulation 2022:SOR/2022-110, must be adhered to;
 - .2 Equipment designated for relocation to another facility held by the owner must be drained and labelled as above; and
 - .3 Any equipment that is drained to facilitate relocation to another facility held by the owner must be tested for leaks prior to re-filling. The equipment must be re-filled within six months of the leak test.

- .6 Workers involved in the demolition of any mould-impacted materials encountered during any renovation or demolition activities should wear appropriate protective clothing and equipment and follow decontamination practices as outlined in the Canadian Construction Association Standard Construction Document CCA-82 2018 – Mould Guidelines for the Canadian Construction Industry, and the Mould Abatement Guidelines. Environmental Abatement Council of Canada. Edition 3. 2015.

1.6 Delivery, Storage and Handling

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Transport hazardous materials and wastes in accordance with Transportation of Dangerous Goods Act, Transportation of Dangerous Goods Regulations, and applicable provincial regulations.
- .4 Storage and Handling Requirements:
 - .1 Co-ordinate storage of hazardous materials with Owner's Representative and abide by internal requirements for labelling and storage of materials and wastes.
 - .2 Store and handle hazardous materials and wastes in accordance with applicable federal and provincial laws, regulations, codes, and guidelines.
 - .3 Store and handle flammable and combustible materials in accordance with National Fire Code of Canada requirements.
 - .4 Keep no more than 45 litres of flammable and combustible liquids such as gasoline, kerosene, and naphtha for ready use.
 - .1 Store flammable and combustible liquids in approved safety cans bearing the Underwriters' Laboratory of Canada or Factory Mutual seal of approval.
 - .2 Storage of quantities of flammable and combustible liquids exceeding 45 litres for work purposes requires the written approval of the Owner's Representative.
 - .5 Transfer of flammable and combustible liquids is prohibited within buildings.
 - .6 Transfer flammable and combustible liquids away from open flames or heat-producing devices.
 - .7 Solvents or cleaning agents must be non-flammable or have flash point above 38 degrees C.
 - .8 Store flammable and combustible waste liquids for disposal in approved containers located in safe, ventilated area. Keep quantities to minimum.
 - .9 Observe smoking regulations, smoking is prohibited in areas where hazardous materials are stored, used, or handled.
 - .10 Storage requirements for quantities of hazardous materials and wastes in excess of 5 kg for solids, and 5 litres for liquids:
 - .1 Store hazardous materials and wastes in closed and sealed containers.

- .2 Label containers of hazardous materials and wastes in accordance with WHMIS.
- .3 Store hazardous materials and wastes in containers compatible with that material or waste.
- .4 Segregate incompatible materials and wastes.
- .5 Ensure that different hazardous materials or hazardous wastes are stored in separate containers.
- .6 Store hazardous materials and wastes in secure storage area with controlled access.
- .7 Maintain clear egress from storage area.
- .8 Store hazardous materials and wastes in location that will prevent them from spilling into environment.
- .9 Have appropriate emergency spill response equipment available near storage area, including personal protective equipment.
- .10 Maintain inventory of hazardous materials and wastes, including product name, quantity, and date when storage began.
- .11 When hazardous waste is generated on site:
 - .1 Co-ordinate transportation and disposal with the Owner's Representative.
 - .2 Comply with applicable federal, provincial, and municipal laws and regulations for generators of hazardous waste.
 - .3 Use licensed carrier authorized by provincial authorities to accept subject material.
 - .4 Before shipping material obtain written notice from intended hazardous waste treatment or disposal facility it will accept material and it is licensed to accept this material.
 - .5 Label containers with legible, visible safety marks as prescribed by federal and provincial regulations.
 - .6 Only trained personnel handle, offer for transport, or transport dangerous goods.
 - .7 Provide copy of shipping documents and waste manifests to Owner's Representative.
 - .8 Track receipt of completed manifests or Bills of Lading describing and listing waste created and final disposal locations from consignee after shipping dangerous goods, to the Owner's Representative.
 - .9 Report discharge, emission, or escape of hazardous materials immediately to the Owner's Representative and appropriate provincial authority. Take reasonable measures to control release.

- .11 Ensure personnel have been trained in accordance with Workplace Hazardous Materials Information System (WHMIS) requirements.
- .12 Report spills or accidents immediately to the Owner's Representative. Submit a written spill report to the Owner's Representative within 24 hours of incident.

Part 2 Products**2.1 Materials**

- .1 Description:
 - .1 Bring on site only quantities hazardous material required to perform Work.
 - .2 Maintain SDS in proximity to where materials are being used. Communicate this location to personnel who may have contact with hazardous materials.

Part 3 Execution**3.1 Cleaning**

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Dispose hazardous waste materials in accordance with applicable federal and provincial acts, regulations, and guidelines.
 - .2 Recycle hazardous wastes for which there is approved, cost effective recycling process available.
 - .3 Send hazardous wastes to authorized hazardous waste disposal or treatment facilities.
 - .4 Burning, diluting, or mixing hazardous wastes for purpose of disposal is prohibited.
 - .5 Disposal of hazardous materials in waterways, storm, or sanitary sewers, or in municipal solid waste landfills is prohibited.
 - .6 Dispose hazardous wastes in timely fashion in accordance with applicable provincial regulations.
 - .7 Minimize generation of hazardous waste to maximum extent practicable. Take necessary precautions to avoid mixing clean and contaminated wastes.
 - .8 Identify and evaluate recycling and reclamation options as alternatives to land disposal, such as:
 - .1 Hazardous wastes recycled in manner constituting disposal.
 - .2 Hazardous waste burned for energy recovery.
 - .3 Lead-acid battery recycling.
 - .4 Hazardous wastes with economically recoverable precious metals.

END OF SECTION

Part 1 General

1.1 Summary

- .1 **All work shall be done in compliance with Ontario Regulation 278/05 – Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations – made under the Occupational Health and Safety Act.** Should there be any discrepancy or conflict between the documents, the most stringent shall apply.
- .2 Comply with requirements of this Section when performing the following work when wetted and using non-powered, hand-held tools only:
 - .1 Removing (12"x12") Vinyl floor tile – beige with dark brown and white directional flecks as required.
 - .2 Removing (9"x9") Vinyl floor tile – green as required.
 - .3 Removing (9"x9") Vinyl floor tile – beige as required.
 - .4 Removing concrete block-filler paint, as required.
 - .5 Removing reinforced autoclaved aerated concrete "Siporex" joint caulking as required.
 - .6 Removing (2'x2') cement board wall panels, as required.
 - .7 Removing solid cement board wall panels, as required.

1.2 Related Requirements

- .1 Section 02 80 00 – Hazardous Materials
- .2 Section 02 82 00.02 – Asbestos Abatement – Type 2 Precautions.
- .3 Section 02 82 00.03 – Asbestos Abatement – Type 3 Precautions.

1.3 References

- .1 A Guide to the Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations released in November 2007, <http://www.labour.gov.on.ca/english/hs/asbestos/index.html>.
- .2 Arcadis report titled "Designated Substances and Hazardous Materials Survey – Pre-Renovation, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario", February 26, 2026.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-2003, Sealer for Application to Asbestos-Fibre-Releasing Materials.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA Z94.4.1:21, Performance of filtering respirators.
 - .2 CAN/CSA Z94.4-18(R2003), Selection, use, and care of respirators
 - .3 CAN/CSA Z317.13-22 Infection control during construction, renovation, and maintenance of health care facilities
- .5 Department of Justice Canada

- .1 Canadian Environmental Protection Act (CEPA), 1999.
- .2 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
- .6 Environmental Abatement Council of Canada (EACC) – Lead Abatement Guideline, 2015.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .8 Province of Ontario
 - .1 Ontario Regulation 213/91, Construction Projects.
 - .2 Ontario Regulation 278/05, Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations.
 - .3 Ontario Regulation 347/90, General – Waste Management.
 - .4 Ontario Regulation 490/09, Designated Substances.
 - .5 Ontario Regulation 632/05, Confined Spaces.
 - .6 Ontario Regulation 833/90 (as amended) – “Control of Exposure to Biological or Chemical Agents” (O. Reg. 833/90).
 - .7 Ontario Regulation 860/90, Workplace Hazardous Materials Information System (WHMIS).
 - .8 Ontario Ministry of Labour, Immigration, Training and Skills Development publication *Guideline – Lead on Construction Projects* (Issued September 2004, Updated April 2011).
 - .9 Ontario Ministry of Labour, Immigration, Training and Skills Development publication *Guideline – Silica Construction Projects* (Issued September 2004, Updated April 2011).
- .10 Ontario Occupational Health and Safety Act, R.S.O. 1990, c. O.1
- .11 Ontario Ministry of the Environment, Conservation and Parks
 - .1 Ontario Environmental Protection Act, R.S.O. 1990, c. E.19
- .9 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
 - .2 Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286)
- .10 Underwriters' Laboratories of Canada (ULC).
- .11 U.S. Environmental Protection Agency (EPA).
- .12 U.S. Department of Health and Human Services/Centers for Disease Control and Prevention (CDC)/National Institute for Occupational Safety and Health (NIOSH)
 - .1 NIOSH 94-113-August 1994, NIOSH Manual of Analytical Methods (NMAM), 4th Edition.

1.4 Definitions

- .1 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.
- .2 Asbestos-Waste Containers: containers for dust and waste shall be dust tight, suitable for the type of waste, impervious to asbestos, identified as asbestos waste and cleaned with a damp

- cloth or High Efficiency Particulate Air (HEPA) filtered vacuum prior to being removed from the work areas.
- .1 Waste shall be placed inside two separate containers.
 - .1 Inner container: 0.15 mm (6 mil) thick sealable polyethylene waste bag.
 - .2 Outer container: sealable metal or fibre type where there are sharp objects included in the waste material; otherwise, outer container may be a sealable metal or fibre type or a second 0.15 mm (6 mil) thick sealable polyethylene bag.
 - .3 Labelling requirements: Affix a pre-printed cautionary asbestos warning in both official languages that is clearly visible when ready for removal to disposal site.
 - .4 Asbestos Waste Containers shall be removed from work areas at regular intervals.
 - .3 Asbestos-Containing Materials (ACMs): materials that contain 0.5 per cent or more asbestos by dry weight and are identified under Existing Conditions including fallen materials and settled dust.
 - .4 Authorized Visitors: Engineers, Consultants or designated representatives, and representatives of regulatory agencies, third party consultant and Owner's Representatives.
 - .5 Competent Person: in relation to specific work and regulatory/guideline requirements, means a worker who:
 - .1 Is qualified because of knowledge, training, and experience to perform the work.
 - .2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.
 - .3 Has knowledge of all potential or actual danger to health or safety in the work.
 - .6 Confined Space:
 - .1 A fully or partially enclosed space,
 - .1 That is not both designed and constructed for continuous human occupancy, and
 - .2 In which atmospheric hazards may occur because of its construction, location or contents or because of work that is done in it.
 - .7 Friable material: material that when dry can be crumbled, pulverized, or powdered by hand pressure and includes such material that is crumbled, pulverized, or powdered.
 - .8 HEPA Vacuum: High Efficiency Particulate Air (HEPA) filtered vacuum equipment with a filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.
 - .9 Integrity Test: testing method used to determine integrity of Negative Pressure unit/vacuum HEPA-filter leak test.
 - .10 Landfill: Ministry of the Environment, Conservation and Parks (MECP) licensed landfill
 - .11 Non-Friable Material: material that when dry cannot be crumbled, pulverized, or powdered by hand pressure.
 - .12 Occupied Area: any area of building or work site that is outside work area.
 - .13 Owner: The entity that holds legal responsibility for the project, typically the client, property owner, or organization commissioning the work. The Owner has contractual authority over the project and makes key decisions regarding scope, budget, and compliance.

- .14 Owner's Representative: A person or organization designated by the Owner to act on their behalf in overseeing the project.
- .15 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.
- .16 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in concentration to provide thorough wetting of asbestos containing material.
- .17 Sealer: flame spread, and smoke developed rating less than 50.
- .18 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.
- .19 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for scope of work.
- .20 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.
- .21 Work Area: area where work takes place which will, or may, disturb ACMs.

1.5 Action and Informational Submittals

- .1 Before beginning work:
 - .1 Submit proof satisfactory to the Owner's Representative that all asbestos workers have received appropriate training and education by a competent person on hazards of asbestos exposure, good personal hygiene, entry and exit from work area, aspects of work procedures and protective measures while working in work areas, and the use, cleaning and disposal of respirators and protective clothing. Submit copies of all training certificates indicating that:
 - .1 *every supervisor of a worker involved in a has successfully completed the Asbestos Abatement Supervisor Training Program approved by the Ministry of Training, Colleges, and Universities. O.Reg. 278/05, s. 20(1).*
 - .2 Ensure supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by the Owner's Representative. Submit proof of attendance in form of certificate. Minimum of one Supervisor for every ten workers. Supervisor must remain on site at all times asbestos removal or cleanup is occurring.
 - .3 Submit proof satisfactory to the Owner's Representative that employees have respirator fitting and testing in accordance with CAN/CSA Z94.4. Workers must be fit tested (irritant smoke test) with respirator that is personally issued.
 - .4 Submit provincial and/or local requirements for Notice of Project form.
 - .5 Submit Workplace Safety and Insurance Board status and transcription of insurance.
 - .6 Submit proof satisfactory to the Owner's Representative that suitable arrangements have been made to dispose of asbestos containing waste in accordance with requirements of authority having jurisdiction.
 - .7 Submit to Owner's Representative necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed within 24 hours of leaving Owner's property.

- .8 Submit documentation including test results, fire and flammability data, and Safety Data Sheets (SDS) for chemicals or materials.
- .2 Submittals upon completion of work:
 - .1 Asbestos waste haulage and disposal documentations including Bills of Lading, waste transfer documents and disposal receipts within 24 hours of removal from Owner's property.
 - .2 All documentation as specified in the contract General Conditions including, but not limited to, Workplace Safety and Insurance Board Certificate, Statutory Declarations and Proof of Publication of Substantial Performance.

1.6 Quality Assurance

- .1 Regulatory Requirements: comply with federal, provincial, and local requirements pertaining to asbestos, provided that in case of conflict among these requirements or with these specifications, more stringent requirement applies. Comply with regulations in effect at time Work is performed.
- .2 Health and Safety:
 - .1 Safety Requirements: worker protection.
 - .1 Protective equipment and clothing to be worn by workers while in work area include:
 - .1 Air purifying half-mask respirator with N-100, R-100, or P-100 particulate filter, personally issued to worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected, and inspected after use on each shift, or more often, if necessary, when issued for the exclusive use of one worker, or after each use when used by more than one worker. The respirator to have damaged or deteriorated parts replaced prior to being used by a worker; and, when not in use, to be stored in a convenient, clean and sanitary location. The employer to establish written procedures regarding the selection, use and care of respirators, and a copy of the procedures to be provided to and reviewed with each worker who is required to wear a respirator. A worker not to be assign physically able to perform the operation while using the respirator.
 - .2 Disposable-type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing to be provided by the employer and worn by every worker who enters the work area, and the protective clothing shall consist of a head covering and full body covering that fits snugly at the ankles, wrists and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing to include suitable footwear, and to be repaired or replaced if torn.
 - .2 Before leaving work area, the worker must decontaminate his or her protective clothing by using a vacuum equipped with a HEPA filter, or by damp wiping, before removing the

protective clothing, or, if the protective clothing will not be reused, place it in a container for dust and waste. The container to be dust tight, suitable for asbestos waste, impervious to asbestos, identified as asbestos waste, cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before removal from the work area, and removed from the work area frequently and at regular intervals.

- .3 Ensure workers wash hands and face when leaving work area. Facilities for washing are to be in close proximity to the work area.
- .4 Eating, drinking, chewing, and smoking are not permitted in work area.
- .5 Provide and post in Clean Change Room and in Equipment and Access Room the procedures described in this section, in both official languages.
- .6 Ensure that no person required to enter a work area has facial hair that affects seal between respirator and face.
- .7 Visitor Protection:
 - .1 Provide protective clothing and approved respirators to Authorized Visitors to work areas.
 - .2 Instruct Authorized Visitors in the use of protective clothing, respirators, and procedures.
 - .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from work area.

1.7 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling and place in designated containers.
- .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, federal, provincial, and municipal regulations.
- .6 Disposal of asbestos waste generated by removal activities must comply with federal, provincial, and municipal regulations. Dispose asbestos waste in sealed double thickness 0.152 mm thick (6 mil) bags or leak proof drums. Label containers with appropriate warning labels.
- .7 Provide Bills of Lading to the Owner's Representative describing and listing waste created and final disposal location. Transport containers by approved means to licensed landfill for burial.
- .8 Submit to Owner's Representative proof that asbestos-containing waste has been received and properly disposed within 24 hours of leaving Owner's property.

1.8 Existing Conditions

- .1 Arcadis report titled "*Designated Substances and Hazardous Materials Survey – Pre-Renovation, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario*", February 26, 2026, indicates the locations of hazardous materials present. Areas requiring special handling

under hazardous material precautions are outlined in this Specification package. Asbestos-containing materials identified in the above-referenced report and covered in applicable sections of this specification package include:

- .1 Thermal insulation applied to pipe fittings and pipe straight containing 55% Chrysotile in Rooms 101, 102 and 102A.
 - .2 (12"x12") Vinyl floor tile – beige with dark brown and white directional flecks containing 7.4% Chrysotile in Room 101.
 - .3 (9"x9") Vinyl floor tile – Green and associated mastic containing 13.2% Chrysotile and 2% Chrysotile in Room 101A.
 - .4 (9"x9") Vinyl floor tile - beige and associated mastic containing 5% Chrysotile and 2% Chrysotile in Rooms 202 and 203.
 - .5 Vinyl sheet flooring and associated paper backing mastic containing 9% Chrysotile and 28.6% Chrysotile in Corridor C102.
 - .6 (2'x2') Cement board wall panels containing 28% Chrysotile in Corridors C101 and C102 and Room 202.
 - .7 Solid cement board wall panels containing 23% Chrysotile in Room 202.
 - .8 Gypsum board with asbestos-containing joint taping compound containing 2.8% Chrysotile applied to walls in Rooms 103, 104, 201, A1 and A2 and to ceilings in Room 101A.
 - .9 Concrete block-filler paint applied to walls containing 1% Chrysotile throughout the 1961 construction era.
 - .10 Reinforced autoclaved aerated concrete "Siporex" joint caulking containing 2% Chrysotile in Rooms A1, A2, 201, 202 and 203.
- .2 Notify the Owner's Representative of suspect asbestos-containing material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Owner's Representative.

1.9 Scheduling

- .1 Hours of Work: perform work during normal working hours (8:00 to 16:00) according to Owner's instructions. Hourly rates are to be provided should after hours work be required. Work beyond the normal working hours may be authorized if the contractor submits the request in writing.
- .2 Provide a bar chart indicating planned progress for critical activities as required under Scope of Work as well as additional information listed below a minimum of 48 hours prior to commencement of any preparatory work indicating:
 - .1 shifts to be worked;
 - .2 proposed workforce;
 - .3 starting date;
 - .4 estimated date of commencement of asbestos removal;
 - .5 estimated date of completion of asbestos removal;

.6 estimated completion date.

1.10 Personnel Training

- .1 Submit proof satisfactory to the Owner's Representative that all asbestos workers and/or supervisor have received appropriate training and education by a competent person in the hazards of asbestos exposure, good personal hygiene and work practices while working in work areas, and the use, cleaning and disposal of respirators and protective clothing.
- .2 Submit proof satisfactory to the Owner's Representative that employees have respirator fitting and testing. Workers must be fit tested (irritant smoke test) with respirator that is personally issued in accordance with CAN/CSA Z94.4.
- .3 Instruction and training related to respirators includes, at minimum:
 - .1 Proper fitting of equipment.
 - .2 Inspection and maintenance of equipment.
 - .3 Disinfecting of equipment.
 - .4 Limitations of equipment.
- .4 Submit proof that supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by the Owner's Representative. Minimum of one supervisor for every ten workers.

Part 2 Products

2.1 Materials

- .1 Asbestos Waste Containers: contain waste in two separate containers.
 - .1 Inner container: 0.15 mm (6 mil) thick sealable polyethylene waste bag.
 - .2 Outer container: sealable metal or fibre type where there are sharp objects included in the waste material; otherwise, outer container may be a sealable metal or fibre type or a second 0.15 mm (6 mil) thick sealable polyethylene bag.
 - .3 Labelling requirements: Affix a pre-printed cautionary asbestos warning in both official languages that is clearly visible when ready for removal to disposal site.
- .2 Drop Sheets:
 - .1 Polyethylene: 0.15 mm thick.
 - .2 FR polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.
- .3 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in a concentration to provide thorough wetting of asbestos-containing material.
- .4 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.
- .5 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.

Part 3 Execution**3.1 Supervision**

- .1 Supervisor must meet the requirements of this specification.
- .2 Minimum of one Supervisor for every ten workers is required.
- .3 Approved Supervisor must remain within work area during disturbance, removal, or other handling of asbestos-containing materials.

3.2 Asbestos Abatement

- .1 Do not begin work until Owner's Representative has provided authorization to proceed.
- .2 Before beginning Work, isolate work area using, minimum, preprinted cautionary asbestos warning signs in sizing as per O. Reg. 278/05 in both official languages in upper case 'Helvetica Medium' letters reading as follows, where number in parentheses indicates font size to be used: 'CAUTION ASBESTOS HAZARD AREA (25 mm) / NO UNAUTHORIZED ENTRY (19 mm) / WEAR ASSIGNED PROTECTIVE EQUIPMENT (19 mm) / BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM (7 mm), that are visible at access routes to work area.
- .3 Before beginning Work remove visible dust from surfaces in work area where dust is likely to be disturbed during course of work.
 - .1 Use HEPA vacuum or damp cloths where damp cleaning does not create a hazard and is otherwise appropriate.
 - .2 Do not use compressed air to clean up or remove dust from any surface.
- .4 Prevent spread of dust from work area using measures appropriate to work to be done.
 - .1 Use FR polyethylene drop sheets over flooring such as carpeting that absorbs dust and over flooring in work area where dust and contamination cannot otherwise be safely contained. Drop sheets are not to be reused.
- .5 Separate the work areas using rope barriers, signage and other appropriate methods.
- .6 Wear an appropriate respirator approved for use with asbestos and suitable protective equipment. Only persons wearing protective clothing and equipment shall be allowed to enter the work area.
- .7 Do not use any power tools. All work is to be completed by non-powered hand tools only.
- .8 Remove any loose materials by HEPA vacuum; thoroughly wet material containing asbestos to be removed or disturbed before and during Work unless wetting creates hazard or causes damage.
 - .1 Use garden reservoir type low - velocity sprayer or airless spray equipment capable of producing mist or fine spray.
 - .2 Perform Work in a manner to reduce dust creation to lowest levels practicable.
 - .3 Work is subject to visual inspection.
 - .4 Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas at no cost to the Owner.

3.3 Cleanup

- .1 Frequently during Work and immediately after completion of work, clean up dust and asbestos containing waste using HEPA vacuum or by damp mopping.
- .2 Place dust and asbestos containing waste in sealed dust tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste and wet and fold to contain dust and then place in waste bags.
- .3 Immediately before their removal from work area and disposal, clean each filled waste bag using damp cloths or HEPA vacuum and place in second clean waste bag.
- .4 Seal and remove double bagged waste from site. Dispose in accordance with requirements of Provincial and Federal Authority having jurisdiction. Supervise dumping and ensure that landfill operator is fully aware of hazardous nature of material to be dumped and that guidelines and regulations for asbestos disposal are followed.
- .5 Perform final thorough clean-up of work areas and adjacent areas affected by Work using HEPA vacuum.

3.4 Inspection

- .1 Prior to the beginning of removal, Owner's Representative will perform a pre-abatement inspection on the work area. The pre-abatement inspection will be completed to ensure all equipment required to complete the measures and procedures that apply to Type 1/low-risk activities are present. Deviation from these requirements that have not been approved in writing by the Owner's Representative and/or Owner may result in work stoppage, at no cost to the Owner.
- .2 Following completion of the work, the Owner's Representative must be contacted to complete a final visual inspection. This inspection must be organised by the contractor with a minimum of twenty-four (24) hours notice.
- .3 Owner's Representative will inspect work for:
 - .1 Adherence to specific procedures and materials requirements.
 - .2 Compliance with specification and governing authority requirements prior to contaminated work; and,
 - .3 Final cleanliness and completion. Work area will be considered clean when all visible dust and debris is removed from the substrate to which it was adhered and deemed acceptable to the Owner's Representative. No distinction will be made about the content of the dust or debris.
- .4 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.

3.5 Re-Establishment of Objects and Systems

- .1 Not Applicable.

END OF SECTION

Part 1 General

1.1 Summary

- .1 **All work shall be done in compliance with Ontario Regulation 278/05 – Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations – made under the Occupational Health and Safety Act.** Should there be any discrepancy or conflict between the documents, the most stringent shall apply.
- .2 Comply with requirements of this Section when performing the following work when wetted and using power tools connected to a dust-collecting device equipped with a HEPA filter where non-powered hand tools cannot be used.
 - .1 Removing thermal insulation applied to pipe fittings using glove bags, as required.
 - .2 Removing (9"x9") vinyl floor tile – green and associated mastic, as required.
 - .3 Removing (9"x9") vinyl floor tile – beige and associated mastic, as required.
 - .4 Removing small quantities (<1m²) of vinyl sheet flooring and associated paper backing, as required.
 - .5 Removing gypsum board with asbestos-containing joint compound, as required.
 - .6 Removing concrete block filler-paint applied to block walls, as required.
 - .7 Removing (2'x2') cement board wall panels, as required.
 - .8 Removing solid cement board wall panels, as required.

1.2 Related Requirements

- .1 Section 02 80 00 – Hazardous Materials
- .2 Section 02 82 00.01 – Asbestos Abatement – Type 1 Precautions.
- .3 Section 02 82 00.03 – Asbestos Abatement – Type 3 Precautions.

1.3 References

- .1 A Guide to the Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations released in November 2007, <http://www.labour.gov.on.ca/english/hs/asbestos/index.html>.
- .2 Arcadis report titled "Designated Substances and Hazardous Materials Survey – Pre-Renovation, A École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario", February 26, 2026.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-2003, Sealer for Application to Asbestos-Fibre-Releasing Materials.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA Z94.4.1:21, Performance of filtering respirators.
 - .2 CAN/CSA Z94.4-18(R2003), Selection, use, and care of respirators
 - .3 CAN/CSA Z317.13-22 Infection control during construction, renovation, and maintenance of health care facilities

- .5 Department of Justice Canada
 - .1 Canadian Environmental Protection Act (CEPA), 1999.
 - .2 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
- .6 Environmental Abatement Council of Canada (EACC) – Lead Abatement Guideline, 2015.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .8 Province of Ontario
 - .1 Ontario Regulation 213/91, Construction Projects.
 - .2 Ontario Regulation 278/05, Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations.
 - .3 Ontario Regulation 347/90, General – Waste Management.
 - .4 Ontario Regulation 490/09, Designated Substances.
 - .5 Ontario Regulation 632/05, Confined Spaces.
 - .6 Ontario Regulation 833/90 (as amended) – “Control of Exposure to Biological or Chemical Agents” (O. Reg. 833/90).
 - .7 Ontario Regulation 860/90, Workplace Hazardous Materials Information System (WHMIS).
 - .8 Ontario Ministry of Labour, Immigration, Training and Skills Development publication *Guideline – Lead on Construction Projects* (Issued September 2004, Updated April 2011).
 - .9 Ontario Ministry of Labour, Immigration, Training and Skills Development publication *Guideline – Silica Construction Projects* (Issued September 2004, Updated April 2011).
 - .10 Ontario Occupational Health and Safety Act, R.S.O. 1990, c. O.1
 - .11 Ontario Ministry of the Environment, Conservation and Parks
 - 1. Ontario Environmental Protection Act, R.S.O. 1990, c. E.19
- .9 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
 - .2 Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286)
- .10 Underwriters' Laboratories of Canada (ULC).
- .11 U.S. Environmental Protection Agency (EPA).
- .12 U.S. Department of Health and Human Services/Centers for Disease Control and Prevention (CDC)/National Institute for Occupational Safety and Health (NIOSH)
 - .1 NIOSH 94-113-August 1994, NIOSH Manual of Analytical Methods (NMAM), 4th Edition.

1.4 Definitions

- .1 Airlock: system for permitting ingress or egress without permitting air movement between contaminated area and uncontaminated area, typically consisting of two curtained doorways at least 2 m apart.

- .2 Air clearance: final air monitoring undertaken at the completion of the asbestos abatement operation.
- .3 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.
- .4 Asbestos-Waste Containers: containers for dust and waste shall be dust tight, suitable for the type of waste, impervious to asbestos, identified as asbestos waste and cleaned with a damp cloth or High Efficiency Particulate Air (HEPA) filtered vacuum prior to being removed from the work areas.
 - .1 Waste shall be placed inside two separate containers.
 - .1 Inner container: 0.15 mm (6 mil) thick sealable polyethylene waste bag.
 - .2 Outer container: sealable metal or fibre type where there are sharp objects included in the waste material; otherwise, outer container may be a sealable metal or fibre type or a second 0.15 mm (6 mil) thick sealable polyethylene bag.
 - .3 Labelling requirements: Affix a pre-printed cautionary asbestos warning in both official languages that is clearly visible when ready for removal to disposal site.
 - .4 Asbestos Waste Containers shall be removed from work areas at regular intervals.
- .5 Asbestos-Containing Materials (ACMs): materials that contain 0.5 per cent or more asbestos by dry weight and are identified under Existing Conditions including fallen materials and settled dust.
- .6 Authorized Visitors: Engineers, Consultants or designated representatives, and representatives of regulatory agencies, third party consultant and Owner's Representatives.
- .7 Competent Person: in relation to specific work and regulatory/guideline requirements, means a worker who:
 - .1 Is qualified because of knowledge, training, and experience to perform the work.
 - .2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.
 - .3 Has knowledge of all potential or actual danger to health or safety in the work.
- .8 Confined Space:
 - .1 A fully or partially enclosed space,
 - .1 that is not both designed and constructed for continuous human occupancy, and
 - .2 in which atmospheric hazards may occur because of its construction, location or contents or because of work that is done in it.
- .9 Curtained doorway: arrangement of closures to allow ingress and egress from one room to another while permitting minimal air movement between rooms, typically constructed as follows:
 - .1 Place two overlapping sheets of polyethylene over existing or temporarily framed doorway, secure each along top of doorway, secure vertical edge of one sheet along one vertical side of doorway, and secure vertical edge of other sheet along opposite vertical side of doorway.

- .2 Reinforce free edges of polyethylene with duct tape and weight bottom edge to ensure proper closing.
- .3 Overlap each polyethylene sheet at openings not less than 1.5 m on each side.
- .10 Friable material: material that when dry can be crumbled, pulverized, or powdered by hand pressure and includes such material that is crumbled, pulverized, or powdered.
- .11 Glove Bag: prefabricated glove bag as follows:
 - .1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.
 - .2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.
 - .3 Equipped with reversible double pull double throw zipper on top and at approximately mid-section of the bag.
 - .4 Straps for sealing ends around pipe.
- .12 HEPA Vacuum: High Efficiency Particulate Air (HEPA) filtered vacuum equipment with a filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.
- .13 Integrity Test: testing method used to determine integrity of Negative Pressure unit/vacuum HEPA-filter leak test.
- .14 Landfill: Ministry of the Environment, Conservation and Parks (MECP) licensed landfill
- .15 Negative pressure: system that extracts air directly from work area, filters such extracted air through High Efficiency Particulate Air filtering system, and discharges this air directly outside work area to exterior of building.
 - .1 System to maintain minimum pressure differential of 0.05 mm (0.02 inches) WC (5 Pa) relative to adjacent areas outside of work areas, be equipped with alarm to warn of system breakdown, and be equipped with instrument to continuously monitor and automatically record pressure differences.
 - .2 Exhaust units fitted with High Efficiency Particulate Aerosol (HEPA) filters used to affect a negative pressure differential in the work area as compared to the immediate surrounding or clean area. The filtering system must be capable of collecting and retaining asbestos fibres to an efficiency of 99.97% for fibres of 0.3 um or larger. The HEPA filters must have been individually tested and certified by the manufacturer and bear a label certifying performance. The unit is to be fitted with instrumentation to indicate pressure differential across the HEPA filter with an audible alarm to sound at a preset low differential pressure.
 - .3 Construction of HEPA filter/fan cabinet units shall be airtight, and all joints shall be caulked. The gasket seal between the filter housing and the retaining frame inside the cabinet shall provide a zero-leakage seal to avoid filter bypassing.
 - .4 Each negative pressure unit shall be integrity tested at the work site prior to commencement of asbestos removal. The procedure must include the testing of the integrity of the entire cabinet. Written confirmation of the test results is to be provided to

the Owner's Representative. Retesting may be requested by the Owner's Representative and performed by the Contractor should the unit be damaged or modified during the work.

.5 Differential Pressure Recorder/Manometer:

.1 Instrument to monitor and record the differential pressure between the Work Area and Clean Area.

.1 sensitivity: 0.05 mm (0.02 inches) WC increments between +0.25 mm to -2.5 mm (+0.010 to 0.100 inches) WC (5Pa) WC increments between +0.25 mm to -2.5 mm (+0.010 to 0.100 inches) WC (5Pa)

.2 accuracy: +/- 1 %

.3 pressure alarms: audible high- and low-level alarm programmable within operating range

.4 printout: minimum 24-hour period at 15 minute intervals

.16 Non-Friable Material: material that when dry cannot be crumbled, pulverized or powdered by hand pressure.

.17 Occupied Area: any area of building or work site that is outside work area.

.18 Owner: The entity that holds legal responsibility for the project, typically the client, property owner, or organization commissioning the work. The Owner has contractual authority over the project and makes key decisions regarding scope, budget, and compliance.

.19 Owner's Representative: A person or organization designated by the Owner to act on their behalf in overseeing the project.

.20 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.

.21 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in concentration to provide thorough wetting of asbestos containing material.

.22 Sealer: flame spread, and smoke developed rating less than 50.

.23 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.

.24 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for scope of work.

.25 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.

.26 Work Area: area where work takes place which will, or may, disturb ACMs.

1.5 Action and Informational Submittals

.1 Before beginning work:

.1 Submit proof satisfactory to the Owner's Representative that all asbestos workers have received appropriate training and education by a competent person on hazards of

asbestos exposure, good personal hygiene, entry and exit from work area, aspects of work procedures and protective measures while working in work areas, and the use, cleaning and disposal of respirators and protective clothing. Submit copies of all training certificates indicating that:

- .1 *every supervisor of a worker involved in a has successfully completed the Asbestos Abatement Supervisor Training Program approved by the Ministry of Training, Colleges, and Universities. O.Reg. 278/05, s. 20(1).*
 - .2 Ensure supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by the Owner's Representative. Submit proof of attendance in form of certificate. Minimum of one Supervisor for every ten workers. Supervisor must remain on site at all times asbestos removal or cleanup is occurring.
 - .3 Submit proof satisfactory to the Owner's Representative that employees have respirator fitting and testing in accordance with CAN/CSA Z94.4. Workers must be fit tested (irritant smoke test) with respirator that is personally issued.
 - .4 Submit provincial and/or local requirements for Notice of Project form.
 - .5 Submit Workplace Safety and Insurance Board status and transcription of insurance.
 - .6 Submit proof satisfactory to the Owner's Representative that suitable arrangements have been made to dispose of asbestos containing waste in accordance with requirements of authority having jurisdiction.
 - .7 Submit to Owner's Representative necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed within 24 hours of leaving Owner's property.
 - .8 Submit layout of proposed enclosures and decontamination facilities to the Owner's Representative for review.
 - .9 Proposed work area emergency exit procedures.
 - .10 Evidence (letter or other suitable documentation) of proper construction, inspection and installation of GFI panel by licensed electrician in compliance to all regulatory requirements and codes.
 - .11 Submit proof that each negative pressure filter/fan unit has been integrity tested at the work site (and passed the test criteria) in accordance with CAN/CSA Z317.13, prior to commencement of asbestos removal operation.
 - .12 Submit documentation including test results, fire and flammability data, and Safety Data Sheets (SDS) for chemicals or materials.
- .2 Submittals upon completion of work:
- .1 Asbestos waste haulage and disposal documentations including Bills of Lading, waste transfer documents and disposal receipts within 24 hours of removal from Owner's

property.

- .2 All documentation as specified in the contract General Conditions including, but not limited to, Workplace Safety and Insurance Board Certificate, Statutory Declarations and Proof of Publication of Substantial Performance.

1.6 Quality Assurance

- .1 Regulatory Requirements: comply with federal, provincial, and local requirements pertaining to asbestos, provided that in case of conflict among these requirements or with these specifications more stringent requirement applies. Comply with regulations in effect at the time work is performed.
- .2 Health and Safety:
 1. Safety Requirements: worker and visitor protection.
 - .1 Protective equipment and clothing to be worn by workers while in work area include:
 - .1 Air purifying half-mask respirator with N-100, R-100, or P-100 particulate filter, personally issued to worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected, and inspected after use on each shift, or more often, if necessary, when issued for the exclusive use of one worker, or after each use when used by more than one worker. The respirator to have damaged or deteriorated parts replaced prior to being used by a worker; and, when not in use, to be stored in a convenient, clean and sanitary location. The employer to establish written procedures regarding the selection, use and care of respirators, and a copy of the procedures to be provided to and reviewed with each worker who is required to wear a respirator. A worker not to be assign physically able to perform the operation while using the respirator.
 - .2 Disposable-type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing to be provided by the employer and worn by every worker who enters the work area, and the protective clothing shall consist of a head covering and full body covering that fits snugly at the ankles, wrists and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing to include suitable footwear, and to be repaired or replaced if torn.
 2. Before leaving work area, the worker must decontaminate his or her protective clothing by using a vacuum equipped with a HEPA filter, or by damp wiping, before removing the protective clothing, or, if the protective clothing will not be reused, place it in a container for dust and waste. The container to be dust tight, suitable for asbestos waste, impervious to asbestos, identified as asbestos waste, cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before removal from the work area, and removed from the work area frequently and at regular intervals.

3. Ensure workers wash hands and face when leaving work area. Facilities for washing are to be in close proximity to the work area.
4. Eating, drinking, chewing, and smoking are not permitted in work area.
5. Provide and post in Clean Change Room and in Equipment and Access Room the procedures described in this section, in both official languages.
6. Ensure that no person required to enter a work area has facial hair that affects seal between respirator and face.
7. Visitor Protection:
 - .1 Provide protective clothing and approved respirators to Authorized Visitors to work areas.
 - .2 Instruct Authorized Visitors in the use of protective clothing, respirators, and procedures.
 - .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from work area.

1.7 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling and place in designated containers.
- .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, federal, provincial and municipal regulations.
- .6 Disposal of asbestos waste generated by removal activities must comply with federal, provincial, and municipal regulations. Dispose asbestos waste in sealed double thickness 0.152 mm thick (6 mil) bags or leak proof drums. Label containers with appropriate warning labels.
- .7 Provide Bills of Lading to the Owner's Representative describing and listing waste created and final disposal location. Transport containers by approved means to licensed landfill for burial.
- .8 Submit to Owner's Representative proof that asbestos-containing waste has been received and properly disposed within 24 hours of leaving Owner's property.

1.8 Existing Conditions

- .1 Arcadis report titled "*Designated Substances and Hazardous Materials Survey – Pre-Renovation, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario*", February 26, 2026, indicates the locations of hazardous materials present. Areas requiring special handling under hazardous material precautions are outlined in this Specification package. Asbestos-containing materials identified in the above-referenced report and covered in applicable sections

of this specification package include:

- .1 Thermal insulation applied to pipe fittings and pipe straight containing 55% Chrysotile in Rooms 101, 102 and 102A.
- .2 (12"x12") Vinyl floor tile – beige with dark brown and white directional flecks containing 7.4% Chrysotile in Room 101.
- .3 (9"x9") Vinyl floor tile – Green and associated mastic containing 13.2% Chrysotile and 2% Chrysotile in Room 101A.
- .4 (9"x9") Vinyl floor tile - beige and associated mastic containing 5% Chrysotile and 2% Chrysotile in Rooms 202 and 203.
- .5 Vinyl sheet flooring and associated paper backing mastic containing 9% Chrysotile and 28.6% Chrysotile in Corridor C102.
- .6 (2'x2') Cement board wall panels containing 28% Chrysotile in Corridors C101 and C102 and Room 202.
- .7 Solid cement board wall panels containing 23% Chrysotile in Room 202.
- .8 Gypsum board with asbestos-containing joint taping compound containing 2.8% Chrysotile applied to walls in Rooms 103, 104, 201, A1 and A2 and to ceilings in Room 101A.
- .9 Concrete block-filler paint applied to walls containing 1% Chrysotile throughout the 1961 construction era.
- .10 Reinforced autoclaved aerated concrete "Siporex" joint caulking containing 2% Chrysotile in Rooms A1, A2, 201, 202 and 203.
- .2 Notify the Owner's Representative of suspect asbestos-containing material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Owner's Representative.

1.9 Scheduling

- .1 Hours of Work: perform work during normal working hours (8:00 to 16:00) according to Owner's instructions. Hourly rates are to be provided should after hours work be required. Work beyond the normal working hours may be authorized if the contractor submits the request in writing.
- .2 Provide a bar chart indicating planned progress for critical activities as required under Scope of Work as well as additional information listed below a minimum of 48 hours prior to commencement of any preparatory work indicating:
 - .1 shifts to be worked;
 - .2 proposed workforce;
 - .3 starting date;
 - .4 estimated date of commencement of asbestos removal;
 - .5 estimated date of completion of asbestos removal;
 - .6 estimated completion date.

1.10 Personnel Training

- .1 Submit proof satisfactory to the Owner's Representative that all asbestos workers and/or supervisor have received appropriate training and education by a competent person in the hazards of asbestos exposure, good personal hygiene and work practices while working in work areas, and the use, cleaning and disposal of respirators and protective clothing.
- .2 Submit proof satisfactory to the Owner's Representative that employees have respirator fitting and testing. Workers must be fit tested (irritant smoke test) with respirator that is personally issued in accordance with CAN/CSA Z94.4.
- .3 Instruction and training related to respirators includes, at minimum:
 - .1 Proper fitting of equipment.
 - .2 Inspection and maintenance of equipment.
 - .3 Disinfecting of equipment.
 - .4 Limitations of equipment.
- .4 Submit proof that supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by the Owner's Representative. Minimum of one supervisor for every ten workers.

Part 2 Products**2.1 Materials**

- .1 Asbestos Waste Containers: contain waste in two separate containers.
 - .1 Inner container: 0.15 mm thick sealable polyethylene bag (or where glove bag method is used, glove bag itself).
 - .2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise, outer container may be sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.
 - .3 Labelling requirements: affix preprinted cautionary asbestos warning, in both official languages, that is visible when ready for removal to disposal site.
- .2 Drop and Enclosure Sheets:
 - .1 Polyethylene: 0.15 mm thick.
 - .2 FR polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.
- .3 Glove bag:
 - .1 Acceptable materials: safe-T-Strip products or suitable alternative, in configuration suitable for Work, or Alternative material approved by addendum during tendering period in accordance with Instructions to Tenderers.
 - .2 The glove bag to be equipped with:
 1. Sleeves and gloves that are permanently sealed to the body of the bag to allow the worker to access and deal with the insulation and maintain a sealed

enclosure throughout the work period.

2. Valves or openings to allow insertion of a vacuum hose and the nozzle of a water sprayer while maintaining the seal to the pipe, duct, or similar structure.
 3. A tool pouch with a drain.
 4. A seamless bottom and a means of sealing off the lower portion of the bag.
 5. A high strength double throw zipper and removable straps, if the bag is to be moved during the removal operation.
- .4 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in concentration to provide thorough wetting of asbestos containing material.
- .5 Sealer: flame spread, and smoke developed rating less than 50.
- .6 Sealant: Slow - drying sealant non-staining, clear, water – dispersible type) that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.
- .7 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.

2.2 Equipment

- .1 All equipment brought on site must be thoroughly clean and free of all fibre, asbestos or otherwise, to the satisfaction of the Field Inspector. The Contractor will be fully responsible for the replacement of equipment rejected by the Inspector and for all costs resulting from site contamination due to dirty or faulty equipment.
- .2 Airless Sprayer:
 - .1 Spray equipment for the application of amended water and sealant such as Graco Hydrospray or equivalent:
 - .1 Fine atomizing spray nozzle: Nozzle for airless sprayer capable of delivering not less than 4.5 L per minute of fine particle spray of amended water.
- .3 Garden Sprayer:
 - .1 Hand pump-type pressure-can garden sprayer fabricated out of either metal or plastic equipped with a wand at the end of a hose that can deliver a stream or spray of liquid under pressure. **Only to be used on small removal and repair projects with the approval of the site inspector.**
- .4 HEPA Vacuum:
 - .1 High Efficiency Particulate Aerosol filtered vacuum equipment. Must have a filtering system capable of collecting and retaining asbestos fibres to an efficiency of 99.97% for fibres of 0.3 um or larger. HEPA filters must have been individually tested and certified by the manufacturer.
 - .2 All HEPA vacuums brought onto the job site shall be visibly clean, shall be in a good state of repair and shall be maintained in such state through completion of the project.
- .5 Ground Fault Panel:

- .1 Electrical Panel equipped with ground fault circuit breakers of sufficient capacity to power all electrical equipment and lights in work area. All breakers shall have 5 mA ground fault protection. Panel should be complete with all necessary accessories including ground fault interrupter lights, test switch to ensure unit is working, and reset switch. Ground fault receptacles on extension cords shall not be used without written authorization by the Owner's Representative.
- .2 The GFI Panel must be constructed under the direction of a licensed Electrician and inspected by a licensed Electrician on a regular basis. Evidence of such construction and inspection shall be submitted to the Owner's Representative prior to installation of the Panel on site.
- .6 Negative Pressure Units:
 - .1 Exhaust units fitted with High Efficiency Particulate Aerosol (HEPA) filters used to affect a negative pressure differential in the work area as compared to the immediate surrounding or clean area. The filtering system must be capable of collecting and retaining asbestos fibres to an efficiency of 99.97% for fibres of 0.3 µm or larger. The HEPA filters must have been individually tested and certified by the manufacturer and bear a label certifying performance. The unit is to be fitted with instrumentation to indicate pressure differential across the HEPA filter with an audible alarm to sound at a preset low differential pressure.
 - .2 Construction of HEPA filter/fan cabinet units shall be airtight and all joints shall be caulked. The gasket seal between the filter housing and the retaining frame inside the cabinet shall provide a zero-leakage seal to avoid filter bypassing.
 - .3 **If installed, each negative pressure unit shall be integrity tested at the work site prior to commencement of asbestos removal.** The procedure must include the testing of the integrity of the entire cabinet. Written confirmation of the test results are to be provided to the Inspector. Retesting may be requested by the Inspector and performed by the Contractor should the unit be damaged or modified during the work.

Part 3 Execution

3.1 Supervision

- .1 Supervisor must meet the requirements of this specification.
- .2 Minimum of one Supervisor for every ten workers is required.
- .3 Approved Supervisor must remain within work area during disturbance, removal, or other handling of asbestos-containing materials.

3.2 Asbestos Abatement

- .1 Do not begin work until Owner's Representative has provided authorization to proceed.
- .2 Before beginning Work, at each access to work area, install warning signs in both official languages in upper case 'Helvetica Medium' letters reading as follows, where number in parentheses indicates font size to be used: 'CAUTION ASBESTOS HAZARD AREA (25 mm) / NO UNAUTHORIZED ENTRY (19 mm) / WEAR ASSIGNED PROTECTIVE EQUIPMENT (19 mm) / BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM (7 mm).

- .3 Before beginning Work remove visible dust from surfaces in work area where dust is likely to be disturbed during course of work.
 - .1 Use HEPA vacuum or damp cloths where damp cleaning does not create hazard and is otherwise appropriate.
 - .2 Do not use compressed air to clean up or remove dust from any surface.
- .4 Prevent spread of dust from work area using measures appropriate to work to be done.
 - .1 Use FR polyethylene drop sheets over flooring such as carpeting that absorbs dust and over flooring in work areas where dust or contamination cannot otherwise be safely contained.
 - .2 When removing suspended ceilings and walls themselves do not enclose work area and when removing asbestos containing material from piping or equipment and "glove bag" method is not used, erect enclosure of polyethylene sheeting around work area, shut off mechanical ventilation system serving work area and seal ventilation ducts to and from work area.
- .5 Separate the work areas using rope barriers, signage and other appropriate methods.
- .6 Construct a two-chamber decontamination facility/frame for the enclosure from 50 mm x 100 mm (2" x 4") studs or other suitable material.
- .7 Cover all sides of the enclosure with clear 0.15 mm opaque polyethylene sheeting sealed with duct tape. Curtains of polyethylene sheeting must be fitted on each side of the entrance of the enclosure (curtain flaps may require weights at the bottom to ensure proper closing).
- .8 Wear an appropriate respirator approved for use with asbestos and suitable protective equipment. Only persons wearing protective clothing and equipment shall be allowed to enter the work area.
- .9 Only power tools connected to a dust-collecting device equipped with a HEPA filter are permitted to be used.
- .10 Remove any loose materials by HEPA vacuum; thoroughly wet material containing asbestos to be removed or disturbed before and during Work unless wetting creates hazard or causes damage.
 - .1 Use garden reservoir type low - velocity sprayer or airless spray equipment capable of producing mist or fine spray.
 - .2 Perform Work in a manner to reduce dust creation to lowest levels practicable.
 - .3 Work is subject to visual inspection.
 - .4 Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas at no cost to the Owner.

3.3 Cleanup

- .1 Frequently during Work and immediately after completion of work, clean up dust and asbestos containing waste using HEPA vacuum or by damp mopping.
- .2 Place dust and asbestos containing waste in sealed dust tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste and wet and fold to contain dust and then place in waste bags.
- .3 Immediately before their removal from work area and disposal, clean each filled waste bag using damp cloths or HEPA vacuum and place in second clean waste bag.
- .4 Seal and remove double bagged waste from site. Dispose in accordance with requirements of Provincial and Federal Authority having jurisdiction. Supervise dumping and ensure that landfill

operator is fully aware of hazardous nature of material to be dumped and that guidelines and regulations for asbestos disposal are followed.

- .5 Perform final thorough clean-up of work areas and adjacent areas affected by Work using HEPA vacuum.

3.4 Inspection

- .1 Prior to the beginning of removal, Owner's Representative will perform a pre-abatement inspection on the work area. The pre-abatement inspection will be completed to ensure all equipment required to complete the measures and procedures that apply to Type 2/moderate-risk activities are present. Deviation from these requirements that have not been approved in writing by the Owner's Representative and/or Owner may result in work stoppage, at no cost to the Owner.
- .2 Following completion of the work, the Owner's Representative must be contacted to complete a final visual inspection. This inspection must be organised by the contractor with a minimum of twenty-four (24) hours notice.
- .3 Owner's Representative will inspect work for:
 - .1 Adherence to specific procedures and materials requirements.
 - .2 Compliance with specification and governing authority requirements prior to contaminated work; and,
 - .3 Final cleanliness and completion. Work area will be considered clean when all visible dust and debris is removed from the substrate to which it was adhered and deemed acceptable to the Owner's Representative. No distinction will be made about the content of the dust or debris.
- .4 When asbestos leakage from work area has occurred or is likely to occur the Owner's Representative may order Work shutdown.
- .5 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.

3.4 Air Monitoring

- .1 Not Applicable.

3.5 Clearance Air Sampling

- .1 Not Applicable.

3.4 Final Cleanup

- .1 Not Applicable.

3.5 Re-Establishment of Objects and Systems

- .1 Not Applicable.

END OF SECTION

February 26, 2026

Part 1 General

1.1 Summary

- .1 **All work shall be done in compliance with Ontario Regulation 278/05 – Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations – made under the Occupational Health and Safety Act.** Should there be any discrepancy or conflict between the documents, the most stringent shall apply.
- .2 Comply with requirements of this Section when performing the following work:
 - .1 Removing large quantities (>1m²) of vinyl sheet flooring, as required.

1.2 Related Requirements

- .1 Section 02 80 00 – Hazardous Materials
- .2 Section 02 82 00.01 – Asbestos Abatement – Type 1 Precautions.
- .3 Section 02 82 00.02 – Asbestos Abatement - Type 2 Precautions

1.3 References

- .1 A Guide to the Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations released in November 2007, <http://www.labour.gov.on.ca/english/hs/asbestos/index.html>.
- .2 Arcadis report titled “Designated Substances and Hazardous Materials Survey – Pre-Renovation, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario”, February 26, 2026.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-2003, Sealer for Application to Asbestos-Fibre-Releasing Materials.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA Z94.4.1:21, Performance of filtering respirators.
 - .2 CAN/CSA Z94.4-18(R2003), Selection, use, and care of respirators
 - .3 CAN/CSA Z317.13-22 Infection control during construction, renovation, and maintenance of health care facilities
- .5 Department of Justice Canada
 - .1 Canadian Environmental Protection Act (CEPA), 1999.
 - .2 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
- .6 Environmental Abatement Council of Canada (EACC) – Lead Abatement Guideline, 2015.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .8 Province of Ontario
 - .1 Ontario Regulation 213/91, Construction Projects.
 - .2 Ontario Regulation 278/05, Designated Substance - Asbestos on Construction Projects

and in Buildings and Repair Operations.

- .3 Ontario Regulation 347/90, General – Waste Management.
- .4 Ontario Regulation 490/09, Designated Substances.
- .5 Ontario Regulation 632/05, Confined Spaces.
- .6 Ontario Regulation 833/90 (as amended) – “Control of Exposure to Biological or Chemical Agents” (O. Reg. 833/90).
- .7 Ontario Regulation 860/90, Workplace Hazardous Materials Information System (WHMIS).
- .8 Ontario Ministry of Labour, Immigration, Training and Skills Development publication *Guideline – Lead on Construction Projects* (Issued September 2004, Updated April 2011).
- .9 Ontario Ministry of Labour, Immigration, Training and Skills Development publication *Guideline – Silica Construction Projects* (Issued September 2004, Updated April 2011).
- .10 Ontario Occupational Health and Safety Act, R.S.O. 1990, c. O.1
- .11 Ontario Ministry of the Environment, Conservation and Parks
 - 1. Ontario Environmental Protection Act, R.S.O. 1990, c. E.19
- .9 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
 - .2 Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286)
- .10 Underwriters' Laboratories of Canada (ULC).
- .11 U.S. Environmental Protection Agency (EPA).
- .12 U.S. Department of Health and Human Services/Centers for Disease Control and Prevention (CDC)/National Institute for Occupational Safety and Health (NIOSH)
 - .1 NIOSH 94-113-August 1994, NIOSH Manual of Analytical Methods (NMAM), 4th Edition.

1.4 Definitions

- .1 Airlock: system for permitting ingress or egress without permitting air movement between contaminated area and uncontaminated area, typically consisting of two curtained doorways at least 2 m apart.
- .2 Air clearance: final air monitoring undertaken at the completion of the asbestos abatement operation.
- .3 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.
- .4 Asbestos-Waste Containers: containers for dust and waste shall be dust tight, suitable for the type of waste, impervious to asbestos, identified as asbestos waste and cleaned with a damp cloth or High Efficiency Particulate Air (HEPA) filtered vacuum prior to being removed from the work areas.
 - .1 Waste shall be placed inside two separate containers.

- .1 Inner container: 0.15 mm (6 mil) thick sealable polyethylene waste bag.
- .2 Outer container: sealable metal or fibre type where there are sharp objects included in the waste material; otherwise, outer container may be a sealable metal or fibre type or a second 0.15 mm (6 mil) thick sealable polyethylene bag.
- .3 Labelling requirements: Affix a pre-printed cautionary asbestos warning in both official languages that is clearly visible when ready for removal to disposal site.
- .4 Asbestos Waste Containers shall be removed from work areas at regular intervals.
- .5 Asbestos Containing Materials (ACMs): materials that contain 0.5 per cent or more asbestos by dry weight and are identified under Existing Conditions including fallen materials and settled dust.
- .6 Authorized Visitors: Engineers, Consultants or designated representatives, and representatives of regulatory agencies, third party consultant and Owner's Representatives.
- .7 Competent Person: in relation to specific work and regulatory/guideline requirements, means a worker who:
 - .1 Is qualified because of knowledge, training, and experience to perform the work.
 - .2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.
 - .3 Has knowledge of all potential or actual danger to health or safety in the work.
- .8 Confined Space:
 - .1 A fully or partially enclosed space,
 - .1 That is not both designed and constructed for continuous human occupancy, and
 - .2 In which atmospheric hazards may occur because of its construction, location or contents or because of work that is done in it.
- .9 Curtained doorway: arrangement of closures to allow ingress and egress from one room to another while permitting minimal air movement between rooms, typically constructed as follows:
 - .1 Place two overlapping sheets of polyethylene over existing or temporarily framed doorway, secure each along top of doorway, secure vertical edge of one sheet along one vertical side of doorway, and secure vertical edge of other sheet along opposite vertical side of doorway.
 - .2 Reinforce free edges of polyethylene with duct tape and weight bottom edge to ensure proper closing.
 - .3 Overlap each polyethylene sheet at openings not less than 1.5 m on each side.
- .10 Friable Materials: material that when dry can be crumbled, pulverized, or powdered by hand pressure and includes such material that is crumbled, pulverized or powdered.
- .11 Glove Bag: prefabricated glove bag as follows:
 - .1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.
 - .2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.
 - .3 Equipped with reversible double pull double throw zipper on top and at approximately

mid-section of the bag.

- .4 Straps for sealing ends around pipe. .12 High Efficiency Particulate Air (HEPA) filtered vacuum equipment with a filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.
- .12 HEPA Vacuum: High Efficiency Particulate Air (HEPA) filtered vacuum equipment with a filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.
- .13 Integrity Test: testing method used to determine integrity of Negative Pressure unit/vacuum HEPA-filter leak test.
- .14 Landfill: Ministry of the Environment, Conservation and Parks (MECP) licensed landfill
- .15 Negative pressure: system that extracts air directly from work area, filters such extracted air through High Efficiency Particulate Air filtering system, and discharges this air directly outside work area to exterior of building.
 - .1 System to maintain minimum pressure differential of 0.05 mm (0.02 inches) WC (5 Pa) relative to adjacent areas outside of work areas, be equipped with alarm to warn of system breakdown, and be equipped with instrument to continuously monitor and automatically record pressure differences.
 - .2 Exhaust units fitted with High Efficiency Particulate Aerosol (HEPA) filters used to affect a negative pressure differential in the work area as compared to the immediate surrounding or clean area. The filtering system must be capable of collecting and retaining asbestos fibres to an efficiency of 99.97% for fibres of 0.3 um or larger. The HEPA filters must have been individually tested and certified by the manufacturer and bear a label certifying performance. The unit is to be fitted with instrumentation to indicate pressure differential across the HEPA filter with an audible alarm to sound at a preset low differential pressure.
 - .3 Construction of HEPA filter/fan cabinet units shall be airtight, and all joints shall be caulked. The gasket seal between the filter housing and the retaining frame inside the cabinet shall provide a zero-leakage seal to avoid filter bypassing.
 - .4 Each negative pressure unit shall be integrity tested at the work site prior to commencement of asbestos removal. The procedure must include the testing of the integrity of the entire cabinet. Written confirmation of the test results is to be provided to the Owner's Representative. Retesting may be requested by the Owner's Representative and performed by the Contractor should the unit be damaged or modified during the work.
 - .5 Differential Pressure Recorder/Manometer:
 - .1 Instrument to monitor and record the differential pressure between the Work Area and Clean Area.
 - .1 sensitivity: 0.05 mm (0.02 inches) WC increments between +0.25 mm to -2.5 mm (+0.010 to 0.100 inches) WC (5Pa) WC increments between +0.25 mm to -2.5 mm (+0.010 to 0.100 inches) WC (5Pa)
 - .2 accuracy: +/- 1 %

- .3 pressure alarms: audible high- and low-level alarm programmable within operating range
- .4 printout: minimum 24-hour period at 15 minute intervals
- .16 Non-Friable Material: material that when dry cannot be crumbled, pulverized or powdered by hand pressure.
- .17 Occupied Area: any area of building or work site that is outside work area.
- .18 Owner: The entity that holds legal responsibility for the project, typically the client, property owner, or organization commissioning the work. The Owner has contractual authority over the project and makes key decisions regarding scope, budget, and compliance.
- .19 Owner's Representative: A person or organization designated by the Owner to act on their behalf in overseeing the project.
- .20 Polyethylene: polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.
- .21 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in concentration to provide thorough wetting of asbestos containing material.
- .22 Sealer: flame spread, and smoke developed rating less than 50.
- .23 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.
- .24 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for scope of work.
- .25 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.
- .26 Work Area: area where work takes place which will, or may, disturb ACMs.

1.5 Action and Informational Submittals

- .1 Before beginning work:
 - .1 Submit proof satisfactory to the Owner's Representative that all asbestos workers have received appropriate training and education by a competent person on hazards of asbestos exposure, good personal hygiene, entry and exit from work area, aspects of work procedures and protective measures while working in work areas, and the use, cleaning and disposal of respirators and protective clothing. Submit copies of all training certificates indicating that:
 - .1 *every supervisor of a worker involved in a has successfully completed the Asbestos Abatement Supervisor Training Program approved by the Ministry of Training, Colleges, and Universities. O.Reg. 278/05, s. 20(1).*
 - .2 Ensure supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by the Owner's Representative. Submit proof of attendance in form of certificate. Minimum of one Supervisor for every ten workers. Supervisor must remain on site at all times asbestos removal or cleanup is occurring.

- .3 Submit proof satisfactory to the Owner's Representative that employees have respirator fitting and testing in accordance with CAN/CSA Z94.4. Workers must be fit tested (irritant smoke test) with respirator that is personally issued.
- .4 Submit provincial and/or local requirements for Notice of Project form.
- .5 Submit Workplace Safety and Insurance Board status and transcription of insurance.
- .6 Submit proof satisfactory to the Owner's Representative that suitable arrangements have been made to dispose of asbestos containing waste in accordance with requirements of authority having jurisdiction.
- .7 Submit to Owner's Representative necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed within 24 hours of leaving Owner's property.
- .8 Submit layout of proposed enclosures and decontamination facilities to the Owner's Representative for review.
- .9 Proposed work area emergency exit procedures.
- .10 Evidence (letter or other suitable documentation) of proper construction, inspection and installation of GFI panel by licensed electrician in compliance to all regulatory requirements and codes.
- .11 Submit proof that each negative pressure filter/fan unit has been integrity tested at the work site (and passed the test criteria) in accordance with CAN/CSA Z317.13, prior to commencement of asbestos removal operation.
- .12 Submit documentation including test results, fire and flammability data, and Safety Data Sheets (SDS) for chemicals or materials.
- .2 Submittals upon completion of work:
 - .1 Asbestos waste haulage and disposal documentations including Bills of Lading, waste transfer documents and disposal receipts within 24 hours of removal from Owner's property.
 - .2 All documentation as specified in the contract General Conditions including, but not limited to, Workplace Safety and Insurance Board Certificate, Statutory Declarations and Proof of Publication of Substantial Performance.

1.6 Quality Assurance

- .1 Regulatory Requirements: comply with federal, provincial and local requirements pertaining to asbestos, provided that in case of conflict among those requirements or with these specifications more stringent requirement applies. Comply with regulations in effect at time work is performed.
- .2 Health and Safety:
 - 1. Safety Requirements: worker and visitor protection.
 - .1 Protective equipment and clothing to be worn by workers while in work area include:

- .1 Air purifying full-mask respirator with N-100, R-100, or P-100 particulate filter, personally issued to worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected, and inspected after use on each shift, or more often, if necessary, when issued for the exclusive use of one worker, or after each use when used by more than one worker. The respirator to have damaged or deteriorated parts replaced prior to being used by a worker; and, when not in use, to be stored in a convenient, clean and sanitary location. The employer to establish written procedures regarding the selection, use and care of respirators, and a copy of the procedures to be provided to and reviewed with each worker who is required to wear a respirator. A worker not to be assign physically able to perform the operation while using the respirator.
- .2 Disposable type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing to be provided by the employer and worn by every worker who enters the work area, and the protective clothing to consist of a head covering and full body covering that fits snugly at the ankles, wrists and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing. It includes suitable footwear, and it to be repaired or replaced if torn.
Requirements for each worker:
 - .1 Remove street clothes in clean change room and put on respirator with new filters or reusable filters that have been tested as satisfactory, clean coveralls and head covers before entering Equipment and Access Rooms or work area. Store street clothes, uncontaminated footwear, towels, and similar uncontaminated articles in clean change room.
 - .2 Remove gross contamination from clothing before leaving work area then proceed to Equipment and Access Room and remove clothing except respirators. Place contaminated work suits in receptacles for disposal with other asbestos - contaminated materials. Leave reusable items except respirator in Equipment and Access Room. Still wearing the respirator, proceed naked to showers. Using soap and water, wash body and hair thoroughly. Clean outside of respirator with soap and water while showering; remove respirator; remove filters and wet them and dispose of filters in container provided for purpose; and wash and rinse inside of respirator. When not in use in work area, store work footwear in Equipment and Access Room. Upon completion of asbestos abatement, dispose of footwear as contaminated waste or clean thoroughly inside and out using soap and water before removing from work area or from Equipment and Access Room.

- .3 After showering and drying off, proceed to clean change room and dress in street clothes at end of each day's work, or in clean coveralls before eating, smoking, or drinking. If re-entering work area, follow procedures outlined in paragraphs above.
 - .4 Enter unloading room from outside dressed in clean coveralls to remove waste containers and equipment from Holding Room of Container and Equipment Decontamination Enclosure system. Workers must not use this system as means to leave or enter work area.
- 2. Eating, drinking, chewing, and smoking are not permitted in work area.
- 3. Provide and post in Clean Change Room and in Equipment and Access Room the procedures described in this section, in both official languages.
- 4. Ensure that no person required to enter a work area has facial hair that affects seal between respirator and face.
- 5. Visitor Protection:
 - .1 Provide protective clothing and approved respirators to Authorized Visitors to work areas.
 - .2 Instruct Authorized Visitors in the use of protective clothing, respirators and procedures.
 - .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from work area.

1.7 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling and place in designated containers.
- .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, federal, provincial and municipal regulations.
- .6 Disposal of asbestos waste generated by removal activities must comply with federal, provincial and Municipal regulations. Dispose asbestos waste in sealed double thickness 0.152 mm thick (6 mil) bags or leak proof drums. Label containers with appropriate warning labels.
- .7 Provide Bills of Lading to the Owner's Representative describing and listing waste created and final disposal location. Transport containers by approved means to licensed landfill for burial.
- .8 Submit to Owner's Representative proof that asbestos-containing waste has been received and properly disposed within 24 hours of leaving DND property.

1.8 Existing Conditions

- .1 Arcadis report titled “*Designated Substances and Hazardous Materials Survey – Pre-Renovation, École élémentaire Antonine-Maillet, 615 Ridgeway Avenue, Oshawa, Ontario*”, February 26, 2026, indicates the locations of hazardous materials present. Areas requiring special handling under hazardous material precautions are outlined in this Specification package. Asbestos-containing materials identified in the above-referenced report and covered in applicable sections of this specification package include:
 - .1 Thermal insulation applied to pipe fittings and pipe straight containing 55% Chrysotile in Rooms 101, 102 and 102A.
 - .2 (12"x12") Vinyl floor tile – beige with dark brown and white directional flecks containing 7.4% Chrysotile in Room 101.
 - .3 (9"x9") Vinyl floor tile – Green and associated mastic containing 13.2% Chrysotile and 2% Chrysotile in Room 101A.
 - .4 (9"x9") Vinyl floor tile - beige and associated mastic containing 5% Chrysotile and 2% Chrysotile in Rooms 202 and 203.
 - .5 Vinyl sheet flooring and associated paper backing mastic containing 9% Chrysotile and 28.6% Chrysotile in Corridor C102.
 - .6 (2'x2') Cement board wall panels containing 28% Chrysotile in Corridors C101 and C102 and Room 202.
 - .7 Solid cement board wall panels containing 23% Chrysotile in Room 202.
 - .8 Gypsum board with asbestos-containing joint taping compound containing 2.8% Chrysotile applied to walls in Rooms 103, 104, 201, A1 and A2 and to ceilings in Room 101A.
 - .9 Concrete block-filler paint applied to walls containing 1% Chrysotile throughout the 1961 construction era.
 - .10 Reinforced autoclaved aerated concrete “Siporex” joint caulking containing 2% Chrysotile in Rooms A1, A2, 201, 202 and 203.
- .2 Notify the Owner’s Representative of suspect asbestos-containing material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Owner’s Representative.

1.9 Scheduling

- .1 Hours of Work: perform work during normal working hours (8:00 to 16:00) according to Owner’s instructions. Hourly rates are to be provided should after hours work be required. Work beyond the normal working hours may be authorized if the contractor submits the request in writing.
- .2 Provide a bar chart indicating planned progress for critical activities as required under Scope of Work as well as additional information listed below a minimum of 48 hours prior to commencement of any preparatory work indicating:
 - .1 shifts to be worked;
 - .2 proposed workforce;

- .3 starting date;
- .4 estimated date of commencement of asbestos removal;
- .5 estimated date of completion of asbestos removal;
- .6 estimated completion date.

1.10 Personnel Training

- .1 Submit proof satisfactory to the Owner's Representative that all asbestos workers and/or supervisor have received appropriate training and education by a competent person in the hazards of asbestos exposure, good personal hygiene and work practices while working in work areas, and the use, cleaning and disposal of respirators and protective clothing. Training requires:
 - .1 *every worker involved in a Type 3 operation has successfully completed the Asbestos Abatement Worker Training Program approved by the Ministry of Training, Colleges and Universities: and*
 - .2 *every supervisor of a worker involved in a Type 3 operation has successfully completed the Asbestos Abatement Supervisor Training Program approved by the Ministry of Training, Colleges and Universities. O.Reg. 278/05, s. 20(1).*
- .2 Submit proof satisfactory to the Owner's Representative that employees have respirator fitting and testing. Workers must be fit tested (irritant smoke test) with respirator that is personally issued in accordance with CAN/CSA Z94.4.
- .3 Instruction and training related to respirators includes, at minimum:
 - .1 Proper fitting of equipment.
 - .2 Inspection and maintenance of equipment.
 - .3 Disinfecting of equipment.
 - .4 Limitations of equipment.
- .4 Submit proof that supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by the Owner's Representative. Minimum of one supervisor for every ten workers.

Part 2 Products

2.1 Materials

- .1 Asbestos Waste Containers: contain waste in two separate containers.
 - .1 Inner container: 0.15 mm thick sealable polyethylene bag (or where glove bag method is used, glove bag itself).
 - .2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise, outer container may be sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.
 - .3 Labelling requirements: affix preprinted cautionary asbestos warning, in both official languages, that is visible when ready for removal to disposal site.
- .2 Drop and Enclosure Sheets:

- .1 Polyethylene: 0.15 mm thick.
- .2 FR polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.
- .3 Glove bag:
 - .1 Acceptable materials: safe-T-Strip products or suitable alternative, in configuration suitable for Work, or Alternative material approved by addendum during tendering period in accordance with Instructions to Tenderers.
 - .2 The glove bag to be equipped with:
 - 1. Sleeves and gloves that are permanently sealed to the body of the bag to allow the worker to access and deal with the insulation and maintain a sealed enclosure throughout the work period.
 - 2. Valves or openings to allow insertion of a vacuum hose and the nozzle of a water sprayer while maintaining the seal to the pipe, duct, or similar structure.
 - 3. A tool pouch with a drain.
 - 4. A seamless bottom and a means of sealing off the lower portion of the bag.
 - 5. A high strength double throw zipper and removable straps, if the bag is to be moved during the removal operation.
- .4 Wetting Agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with water in concentration to provide thorough wetting of asbestos containing material.
- .5 Sealer: flame spread, and smoke developed rating less than 50.
- .6 Sealant: Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.
- .7 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.

2.2 Equipment

- .1 All equipment brought on site must be thoroughly clean and free of all fibre, asbestos. The Contractor will be fully responsible for the replacement of equipment rejected by the Owner's Representative and for all costs resulting from site contamination due to dirty or faulty
 - .1 Airless Sprayer:
 - .1 Spray equipment for the application of amended water and sealant such as Graco *Hydrospray or equivalent*:
 - .1 Fine atomizing spray nozzle: Nozzle for airless sprayer capable of delivering not less than 4.5 L per minute of fine particle spray of amended water.
 - .2 Garden Sprayer:

- .1 Hand pump-type pressure-can garden sprayer fabricated out of either metal or plastic equipped with a wand at the end of a hose that can deliver a stream or spray of liquid under pressure. **Only to be used on small removal and repair projects with the approval of the site inspector.**
- .3 HEPA Vacuum:
 - .1 High Efficiency Particulate Aerosol filtered vacuum equipment. Must have a filtering system capable of collecting and retaining asbestos fibres to an efficiency of 99.97% for fibres of 0.3 um or larger. HEPA filters must have been individually tested and certified by the manufacturer.
 - .2 All HEPA vacuums brought onto the job site shall be visibly clean, shall be in a good state of repair and shall be maintained in such state through completion of the project.
- .4 Ground Fault Panel:
 - .1 Electrical Panel equipped with ground fault circuit breakers of sufficient capacity to power all electrical equipment and lights in work area. All breakers shall have 5 mA ground fault protection. Panel should be complete with all necessary accessories including ground fault interrupter lights, test switch to ensure unit is working, and reset switch. Ground fault receptacles on extension cords shall not be used without written authorization by the Owner's Representative.
 - .2 The GFI Panel must be constructed under the direction of a licensed Electrician and inspected by a licensed Electrician on a regular basis. Evidence of such construction and inspection shall be submitted to the Owner's Representative prior to installation of the Panel on site.
- .5 Negative Pressure Units:
 - .1 Exhaust units fitted with High Efficiency Particulate Aerosol (HEPA) filters used to affect a negative pressure differential in the work area as compared to the immediate surrounding or clean area. The filtering system must be capable of collecting and retaining asbestos fibres to an efficiency of 99.97% for fibres of 0.3 um or larger. The HEPA filters must have been individually tested and certified by the manufacturer and bear a label certifying performance. The unit is to be fitted with instrumentation to indicate pressure differential across the HEPA filter with an audible alarm to sound at a preset low differential pressure.
 - .2 Construction of HEPA filter/fan cabinet units shall be airtight and all joints shall be caulked. The gasket seal between the filter housing and the retaining frame inside the cabinet shall provide a zero-leakage seal to avoid filter bypassing.
 - .3 **If installed, each negative pressure unit shall be integrity tested at the work site prior to commencement of asbestos removal.** The procedure must include the testing of the integrity of the entire cabinet. Written confirmation of the test results are to be provided to the Inspector. Retesting may be requested by the Inspector and performed by the Contractor should the unit be damaged or modified during the work.

Part 3 Execution

3.1 Supervision

- .1 Supervisor must meet the requirements of this specification.

- .2 Minimum of one Supervisor for every ten workers is required.
- .3 Approved Supervisor must remain within work area during disturbance, removal, or other handling of asbestos containing materials.

3.2 Preparation

- .1 Work Areas:
 - .1 Plumbing and drainage
 - .1 Provide a constant supply of water by means of copper or PVC pipe, fittings and valves to the worker area, equipment decontamination room and the shower facility. High pressure hose with appropriate connections may be used with the approval of the Owner's Representative. A master shut-off valve shall be installed adjacent to, and on the clean side, of the decontamination facility. Any hose and hose connections must have a high-pressure rating and be limited to downstream of the master shut-off valve and are not to be left under pressure unattended.
 - .2 Water will be made available to the Contractor within the building, location to be determined during the prior to project commencement. The Contractor is responsible for all tie-ins to existing systems, providing hot water including supply and installation of a temporary hot water tank, as necessary, and making good on completion.
 - .3 The effluent from the shower may be disposed of, through a filter, to the sanitary sewer, location to be determined prior to project commencement. Only shower water may be disposed in this fashion, no asbestos-containing debris, cleaning solutions, encapsulants, sealants, body wastes, etc., may be disposed in the shower. The Contractor is responsible for all tie-ins to the existing systems and making good on completion. Free flowing shower effluent on to the floor or ground is not acceptable.
 - .4 All Work shall be carried out in accordance with the Ontario Plumbing Code.
 - .2 Electrical
 - .1 The Contractor shall become completely familiar with the existing electrical installation prior to project commencement.
 - .2 The Contractor is responsible to provide and install all electrical requirements for the project including but not limited to:
 - .1 De-energize and lockout all electrical circuits in the work area wherever practicable.
 - .2 Identify all systems that cannot be de-energized, and all low voltage systems such as controls and alarms.
 - .3 Identify any electrical conditions which need special protection or consideration during the work.
 - .4 Disconnect, if practicable, or provide suitable protection for, smoke and heat detectors, if any, and advise the authorities.

- .5 Protect existing electrical equipment including but not limited to: transformers, circuit breakers, switch gear, panels, buss ducts, fixtures, conduits, etc., within the work area, de-energized or not. Cover with a minimum of two independently sealed layers of poly, at least one of the layers to be of reinforced poly.
- .6 Provide all additional transformers, circuit breakers, switch gear, panels, ground fault protection and temporary lighting required for the project. The ground fault panel is to have sufficient capacity to service the project needs and have two spare circuits to serve as backup. The work area lighting is to provide appropriate levels of illumination for the work, with a minimum of two separate circuits. Bulbs are to be fitted with cages or other suitable protection against breakage and/or direct contact with insulation materials (wood, plastic, etc.).
- .7 All electrical power within the work area must be ground fault protected.
 - .1 The power cable to the Ground Fault Panel and the panel itself is not typically protected by an interrupter and, as such, it must be located outside the work area or suitably protected from water and physical damage.
 - .2 All Work shall be performed by a licensed electrician and comply with the latest edition of the Ontario Electrical Safety Code and any other local codes and requirements which may govern the installation. The Contractor is responsible for, and shall arrange for, all inspections and approvals which may be required by government regulations, Electrical Safety Authority (ESA) or any other authorities having jurisdiction. The Client is to receive copies of all inspection reports.
- .3 Heat detectors
 - .1 Protect and seal heat detectors with 0.04 mm (1.5 mil) polyethylene, sealed with tape. Tape is not to interfere with function of the unit.
 - .2 System is to be activated and deactivated as arranged with Owner's and monitoring agency with the intent of leaving the entire system active when the Contractor is not on site.
 - .3 Provide an emergency name and contact number to Owner's and monitoring agency.
- .4 Shut off and isolate air handling and ventilation systems to prevent fibre dispersal to other building areas during work phase. Conduct smoke tests to ensure that duct work is airtight. Seal and caulk joints and seams of active return air ducts within work area.
- .5 Preclean fixed casework, plant, and equipment within proposed work areas, using HEPA vacuum and cover with polyethylene sheeting sealed with tape.
- .6 Clean proposed work areas using, where practicable, HEPA vacuum cleaning equipment.

If not practicable, use wet cleaning method. Do not use methods that raise dust, such as dry sweeping, or vacuuming using other than HEPA vacuum equipment.

- .7 The spread of dust from the work area to be prevented by:
 - .1 Using enclosures of polyethylene or other suitable material that is impervious to asbestos (including, if the enclosure material is opaque, one or more transparent window areas to allow observation of the entire work area from outside the enclosure), if the work area is not enclosed by walls.
 - .2 Using curtains of polyethylene sheeting or other suitable material that is impervious to asbestos, fitted on each side of each entrance or exit from the work area.
- .8 Cover ground and wall surfaces, where required, with polyethylene sheeting sealed with tape. Use two layers of FR polyethylene on floors. Cover floors first so that polyethylene extends at least 300 mm up walls then cover walls to overlap floor sheeting.
- .9 Build airlocks at entrances to and exits from work areas so that work areas are always closed off by one curtained doorway when workers enter or exit.
- .10 At each access to work areas install warning signs in both official languages in upper case "Helvetica Medium" letters reading as follows where number in parentheses indicates font size to be used: "CAUTION ASBESTOS HAZARD AREA (25 mm) NO UNAUTHORIZED ENTRY (19 mm) WEAR ASSIGNED PROTECTIVE EQUIPMENT (19 mm) BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM (7 mm)".
- .11 Maintain emergency and fire exits that may exist from work areas, or establish alternative exits satisfactory to the Owner's Representative and Provincial Fire Marshall Authority having jurisdiction.
- .12 Where application of water is required for wetting asbestos containing materials, shut off electrical power, provide 24-volt safety lighting and ground fault interrupter circuits on power source for electrical tools, in accordance with applicable CSA Standard and this specification. Ensure safe installation of electrical lines and equipment.
- .13 After preparation of work areas and Decontamination Enclosure Systems, as described below, for the removal of all asbestos-containing materials, remove within work area and dispose as contaminated waste in specified containers. Spray asbestos debris and immediate work area with amended water to reduce dust, as work progresses.
- .2 Worker Decontamination Enclosure System:
 - .1 Worker Decontamination Enclosure System includes Equipment and Access Room, Shower Room, and Clean Room, as follows:
 - .1 Equipment and Access Room: build Equipment and Access Room between Shower Room and work areas, with two curtained doorways, one to Shower Room and one to work areas. Install portable toilet, waste receptor, and storage facilities for workers' shoes and protective clothing to be re-worn in work areas. Build Equipment and Access Room large enough to accommodate specified facilities, other equipment needed, and at least one worker allowing him /her sufficient space to undress comfortably.

- .2 Shower Room: build Shower Room between Clean Room and Equipment and Access Room, with two curtained doorways, one to Clean Room and one to Equipment and Access Room. Provide one shower for every five workers. Provide constant supply of hot and cold or warm water. Cold and hot water will be provided at the site. Drains to common sewers are available at the site. Provide piping and connect to water sources and drains. Pump wastewater through 5 micrometre filter system before directing into drains. Provide soap, clean towels, and appropriate containers for disposal of used respirator filters.
- .3 Clean Room: build Clean Room between Shower Room and clean areas outside of enclosures, with two curtained doorways, one to outside of enclosures and one to Shower Room. Provide lockers or hangers and hooks for workers' street clothes and personal belongings. Provide storage for clean protective clothing and respiratory equipment. Install mirror to permit workers to fit respiratory equipment properly.
- .3 Container and Equipment Decontamination Enclosure System:
 - .1 Container and Equipment Decontamination Enclosure System consists of Staging Area within work area, Washroom, Holding Room, and Unloading Room. Purpose of system is to provide means to decontaminate waste containers, scaffolding, waste and material containers, vacuum and spray equipment, and other tools and equipment for which Worker Decontamination Enclosure System is not suitable.
 - .1 Staging Area: designate Staging Area in work area for gross removal of dust and debris from waste containers and equipment, labelling and sealing of waste containers, and temporary storage pending removal to Washroom. Equipment Staging Area with curtained doorway to Washroom.
 - .2 Washroom: build Washroom between Staging Area and Holding Room with two curtained doorways, one to Staging Area and one to Holding Room. Provide high - pressure low - volume sprays for washing of waste containers and equipment. Pump wastewater through 5 micrometre filter system before directing into drains. Provide piping and connect to water sources and drains.
 - .3 Holding Room: build Holding Room between Washroom and Unloading Room, with two curtained doorways, one to Washroom and one to Unloading Room. Build Holding Room sized to accommodate at least two waste containers and largest item of equipment used.
 - .4 Unloading Room: build Unloading Room between Holding Room and outside, with two curtained doorways, one to Holding Room and one to outside.
- .4 Construction of Decontamination Enclosures:
 - .1 Build suitable framing for enclosures, and line with polyethylene sheeting sealed with tape. Use two layers of FR polyethylene on the floor.
 - .2 Build curtained doorways between enclosures so that when people move through or when waste containers and equipment are moved through doorway, one of two closures comprising doorway always remains closed.
- .5 Separation of Work Areas from Adjacent Areas:

- .1 Separate parts of building required to remain in use from parts of building used for asbestos abatement by means of airtight barrier system constructed as follows:
 - .1 Build suitable floor to ceiling lumber (50 mm x 100 mm spruce studs) or metal stud framing at 600 mm centres, cover with polyethylene sheeting sealed with tape, and apply 9 mm minimum thick plywood. Seal joints between plywood sheets and between plywood and adjacent materials with surface film forming type sealer, to create airtight barrier.
 - .2 Cover plywood barrier with polyethylene sealed with tape, as specified for work areas.
- .6 Maintenance of Enclosures:
 - .1 Maintain enclosures in tidy condition.
 - .2 Ensure that barriers and polyethylene linings are effectively sealed and taped. Repair damaged barriers and remedy defects immediately upon discovery.
 - .3 Visually inspect enclosures at beginning of each working period.
 - .4 Use smoke methods to test effectiveness of barriers when directed by Owner's Representative.
- .7 Do not begin Asbestos Abatement work until:
 - .1 Arrangements have been made for disposal of waste.
 - .2 For wet stripping techniques, arrangements have been made for containing, filtering, and disposal of waste water.
 - .3 Work areas and decontamination enclosures and parts of building required to remain in use are to be effectively segregated.
 - .4 Tools, equipment, and materials waste containers are on hand.
 - .5 Arrangements have been made for building security.
 - .6 Warning signs are displayed where access to contaminated areas is possible.
 - .7 Notifications have been completed and other preparatory steps have been taken.

3.3 Asbestos Abatement

- .1 Do not begin work until Owner's Representative has provided authorization to proceed.
- .2 Spray asbestos materials with water containing specified wetting agent, using airless spray equipment capable of providing "mist" application to prevent release of fibres. Spray asbestos material repeatedly during work process to minimize asbestos fibre dispersion.
- .3 Remove saturated asbestos material in small sections. Do not allow waste materials to dry out. As it is being removed pack material in sealable plastic bags 0.15 mm minimum thick and place in labelled containers for transport.
- .4 Seal filled containers. Clean external surfaces thoroughly by wet sponging. Remove from immediate working area to Staging Area. Clean external surfaces thoroughly again by wet

sponging before moving containers to decontamination Washroom. Wash containers thoroughly in decontamination Washroom and store in Holding Room pending removal to Unloading Room and outside. Ensure that containers are removed from Holding Room by workers who have entered from uncontaminated areas dressed in clean coveralls.

- .5 After completion of stripping work, wire brushed and wet sponged surfaces from which asbestos has been removed to remove visible material. During this work keep surfaces wet.
- .6 After wire brushing and wet sponging to remove visible asbestos, wet clean entire work area including Equipment and Access Room, and equipment used in process. After 24-hour period to allow for dust settling, wet clean these areas and objects again. During this settling period no entry, activity, or ventilation will be permitted. After inspection by Owner's Representative, apply continuous coat of slow drying sealer to surfaces of work area. Allow at least 16 hours with no entry, activity, ventilation, or disturbance other than operation of negative pressure units during this period.
- .7 Work is subject to visual inspection and air monitoring.
- .8 Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas.

3.4 Cleanup

- .1 Frequently during Work and immediately after completion of work, clean up dust and asbestos containing waste using HEPA vacuum or by damp mopping.
- .2 Place dust and asbestos containing waste in sealed dust tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste and wet and fold to contain dust and then place in waste bags.
- .3 Immediately before their removal from work area and disposal, clean each filled waste bag using damp cloths or HEPA vacuum and place in second clean waste bag.
- .4 Seal and remove double bagged waste from site. Dispose of in accordance with requirements of Provincial and Federal Authority having jurisdiction. Supervise dumping and ensure that landfill operator is fully aware of hazardous nature of material to be dumped and that guidelines and regulations for asbestos disposal are followed.
- .5 Perform final thorough clean-up of work areas and adjacent areas affected by Work using HEPA vacuum.

3.5 Inspection

- .1 Prior to the beginning of removal, Owner's Representative will perform a pre-abatement inspection on the work area. The pre-abatement inspection will be completed to ensure all equipment required to complete the measures and procedures that apply to Type 3/high-risk activities are present. Deviation from these requirements that have not been approved in writing by the Owner's Representative and/or Owner may result in work stoppage, at no cost to the Owner.
- .2 Following completion of the work, the Owner's Representative must be contacted to complete a final visual inspection. This inspection must be organised by the contractor with a minimum of twenty-four (24) hours notice.

- .3 Owner's Representative will inspect work for:
 - .1 Adherence to specific procedures and materials requirements.
 - .2 Compliance with specification and governing authority requirements prior to contaminated work; and,
 - .3 Final cleanliness and completion. Work area will be considered clean when all visible dust and debris is removed from the substrate to which it was adhered and deemed acceptable to the Owner's Representative. No distinction will be made about the content of the dust or debris.
- .4 When asbestos leakage from work area has occurred or is likely to occur the Owner's Representative may order Work shutdown.
- .5 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.

3.4 Air Monitoring

- .1 Not Applicable.

3.5 Clearance Air Sampling

- .1 Air clearance monitoring to be conducted as follows: After Asbestos Work Area has passed visual inspection and an acceptable coat of lock-down agent has been applied to surfaces within enclosure, and appropriate settling period (minimum of 8-hours) has passed, the Owner's Representative will perform air monitoring within the Asbestos Work Area as detailed in O. Reg. 278/05 and COHSR. Air monitoring requirements also need to comply with Section 10.26.9 of the Canada Occupational Health and Safety Regulations.
 - .1 Before dismantling a containment system and after all asbestos dust, waste and debris have been cleaned up, removed or encapsulated, an employer shall ensure that clearance air samples are taken inside the enclosure and that the concentration of airborne asbestos fibres is determined in accordance with Method 7400 set out in the document entitled NIOSH Manual of Analytical Methods, published by the National Institute for Occupational Safety and Health, as amended from time to time, or in accordance with a scientifically proven method used to collect and analyze a representative sample of airborne asbestos fibres.
 - .2 When conducting clearance air sampling, the employer shall ensure that forced air is used inside the enclosure to dislodge any asbestos fibres from all surfaces and keep them airborne.
 - .3 Clearance air sampling shall be taken until the concentrations of airborne asbestos fibres do not exceed the value of 0.01 f/cc as prescribed in O. Reg. 278/05 and the PSPC Asbestos Management Standard of <0.01 f/cc.
- .2 Air Clearance monitoring results must show airborne asbestos fibres levels less than 0.01 f/cc, or must show that airborne fibres are not detected above the analytical detection limit.
- .3 If air monitoring results show airborne asbestos fibre levels in excess of 0.01 f/cc, or detects airborne fibres above the analytical detection limit, re-clean Asbestos Work Area and apply another acceptable coat of lock down agent to surfaces.

February 26, 2026

- .4 Repeat as necessary until airborne asbestos fibre levels are less than 0.01 f/cc, or when airborne fibres are not detected above the analytical detection limit.
- .5 Within 24 hours after obtaining air sampling results, the Owner shall post a copy of the results in a conspicuous place in the workplace; and make the results available to the policy committee (if any), the work place committee and the health and the safety representative,

3.4 Final Cleanup

- .1 Not Applicable.

3.6 Re-Establishment of Objects and Systems

- .1 Not Applicable.

END OF SECTION

1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials, design, and execution of concrete formwork and accessories.

1.2 RELATED SECTIONS

- .1 Section 03 20 00 - Concrete Reinforcing
- .2 Section 03 30 00 - Cast-in-Place Concrete
- .3 Section 07 92 10 - Joint Sealing

1.3 REFERENCES

- .1 American National Standards Institute
 - .1 ASTM D1751-04 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- .2 Canadian Standards Association (CSA International):
 - .1 CSA-A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of test and Standard Practices for Concrete.
 - .2 CAN/CSA-086-01, Engineering Design in Wood and CSA-O86S1-05, Supplement No. 1 to CAN/CSA-086-01, Engineering Design in Wood.
 - .3 CSA O121-M1978 (R2003), Douglas Fir Plywood.
 - .4 CSA O141-05 Softwood Lumber.
 - .5 CSA O151-04, Canadian Softwood Plywood.
 - .6 CSA O153-M1980 (R2003), Poplar Plywood.
 - .7 CAN/CSA-O325.0-07 Construction Sheathing.
 - .8 CSA O437 Series-93 (R2006), Standards on OSB and Waferboard.
 - .9 CSA S269.1-1975 (R2003), Falsework for Construction Purposes.
 - .10 CAN/CSA-S269.3-M92 (R2003), Concrete Formwork.
 - .11 CSA B111 – 1974 (R2003) Wire Nails, Spikes and Staples.
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .4 Conform to Ontario Building Code 2012 and National Building Code of Canada 2010.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit shop drawings for formwork and falsework

- .1 Each shop drawing submission shall bear stamp and signature of qualified professional engineer registered or licensed in the Province of Ontario, and holder of a BCIN number.
- .3 Submit WHMIS MSDS –Material Safety Data Sheets in accordance with Section 01 47 15 – Sustainable Requirements: Construction and Section 02 61 33 Hazardous Materials.
- .4 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts. Comply with CSA S269.1, for falsework drawings. Comply with CAN/CSA-S269.3 for formwork drawings.
- .5 Indicate formwork design data, such as permissible rate of concrete placement, and temperature of concrete, in forms.
- .6 Indicate sequence of erection and removal of formwork/falsework and proposed strengths of concrete at time of stripping forms.
- .7 Submit, for information, final shop drawings for all mechanical and electrical equipment to be installed. Drawings to indicate overall geometry of the equipment, geometry of floor openings, and weight of the unit.
- .8 When slip forms or flying forms are used, submit details of equipment and procedures for review by Consultant.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Store and manage hazardous materials in accordance with section 01 47 15 – Sustainable Requirements: Construction.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 47 19 Construction/Demolition Waste Management and Disposal.
 - .2 Place materials defined as hazardous or toxic waste in designated containers.
 - .3 Divert wood or plastic materials from landfill to a recycling, reuse, or composting facility as approved by Consultant.
 - .4 Divert unused form release material from landfill to an official hazardous material collection site as approved by Architect.

2 PRODUCTS

2.1 MATERIALS

- .1 Materials and resources in accordance with Section 01 47 15 – Sustainable Requirements: Construction..
- .2 Do verification requirements in accordance with Section 01 47 17 – Sustainable Requirements: Contractor Verification.
- .3 Formwork Lumber: Plywood and wood formwork materials to CSA-O121, CAN/CSA-O86.1, CSA O437 Series and/or CSA-O153.
 - .1 For concrete not exposed in finished work use square edged, T&G lumber, solid one side or medium density overlaid one side grade plywood or other material, suitable to retain concrete without leakage or distortion.
 - .2 For exposed concrete, use new, square edged, flat, smooth surfaced, high density one side overlaid Douglas Fir Plywood panels, free of holes, surface markings or other defects to CAN/CSA-A23.1.
 - .3 Lumber to CSA-O141.
- .4 Tubular column forms: round, laminated fiber or steel, internally treated with release material.
 - .1 Where exposed architecturally, vinyl lined (to eliminate projecting spiral edges), sample to be submitted for review.
- .5 Form ties:
 - .1 For unexposed concrete, use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes wider or deeper than 25 mm in concrete surfaces. Use no wire ties.
 - .2 For exposed concrete, use snap ties complete with plastic cones and light grey concrete plugs
- .6 Form Liner:
 - .1 Douglas Fir high density overlay medium density overlay to CSA 0121, Canadian Softwood Plywood to CSA O151, Poplar to CSA O153, T and G square edge, grade and thickness to be submitted for review.
 - .2 Waferboard: to CAN/CSA – 0325.00, grade and thickness to be submitted for review.
- .7 Form release agent: Non-staining, non-toxic, low VOC, biodegradable, chemically active release agent containing compounds that react with free lime present in concrete to provide water insoluble soaps, preventing set of film of concrete in contact with form.
- .8 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 70 and 110s Saybolt Universal, 15 to 24 mm²/s at 40°C, flashpoint minimum 150°C, open cup.
- .9 Falsework materials: to CSA-S269.1.

- .10 Sealant: to Section 07 92 10 – Joint Sealing.
- .11 Joint tape: non-staining, impermeable, self-release type.
- .12 Nails, spikes, staples: galvanized to CSA B111.
- .13 Concrete Accessories:
 - .1 Premoulded joint filler: Bituminous impregnated fiber board: to ASTM D1751-04.
 - .2 Dovetail anchor channels: minimum 0.6 mm thick (24 ga.) galvanized steel with insulation filled slots.
 - .3 Waterstops: Expanding concrete joint Volcray waterstop-Rx.

3 EXECUTION

3.1 FABRICATION AND ERECTION

- .1 Verify lines, levels and column centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.
- .2 Obtain Consultant's approval for use of earth forms. Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .3 Fabricate and erect falsework in accordance with CSA S269.1
- .4 Refer to architectural drawings for concrete members requiring exposed finishes. Use new formwork materials for concrete surfaces which will be exposed to view in finished project.
- .5 Do not place shores and mud sills on frozen ground.
- .6 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .7 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CAN/CSA-A23.1/A23.2.
- .8 Align form joints and make watertight. Keep form joints to minimum.
- .9 Locate horizontal form joints for exposed columns 2400 mm above finished floor elevation, unless otherwise indicated.
- .10 Use 20 mm chamfer strips on exposed corners of beams, columns, walls and curbs, unless otherwise specified.
- .11 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.

- .12 Obtain Consultant's approval before forming into slabs, beams, walls or columns, openings not indicated on drawings.
- .13 Construct forms for exposed concrete with joints and tie patterns as indicated and/or as directed. Joint pattern not necessarily based on using standard size panels or maximum permissible spacing of ties.
- .14 Set anchors, ties, bolts, nailers, templates, cast-in hardware and shelf angles, steel connection units or other inserts into forms and secure against displacement during concreting
- .15 Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections. Assure that all anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .16 Line forms for following surfaces:
 - .1 Outer faces of outside girders beams and vertical edge of bridge sidewalk slab.
 - .2 Soffit of girders and underside of bridge decks if exposed.
 - .3 Exposed faces of abutments, wingwalls, piers and pylons.
- .17 Form linings:
 - .1 Do not stagger joints of form lining material. Align joints to obtain uniform pattern.
 - .2 Secure lining taut to formwork to prevent folds.
 - .3 Pull down lining over edges of formwork panels.
 - .4 Ensure lining is new material.
 - .5 Ensure lining is dry and free of oil when concrete is poured.
 - .6 Application of form release agents on formwork surface is prohibited where drainage lining is used.
 - .7 Cost of textile lining is included in price of concrete for corresponding portion of work.
- .18 Joint Fillers:
 - .1 Locate and form isolation joints as indicated. Install joint filler.
 - .2 Use 6 mm thick joint filler to separate slabs-on-grade from vertical surfaces. Extend joint filler from bottom of slab to within 12 mm of finished slab surface unless indicated otherwise.
- .19 Anchor Channels:
 - .1 Install dovetail anchor channels to forms where masonry abuts concrete walls or columns.
 - .2 Install continuous vertical dovetail anchor channels at 600mm o/c where concrete walls or columns are masonry faced.
- .20 Waterstops:
 - .1 Install waterstops to provide continuous water seal. Do not displace reinforcement when installing. Tie rigidly in place.

- .2 Make straight heat sealed butt joints.
- .21 Dampproof Membrane:
 - .1 Where indicated, install dampproof membrane under concrete slabs-on-grade inside building.
 - .2 Lap dampproof membrane 150mm minimum at joints and seal. Carry up walls to top of slab.
 - .3 Seal punctures in dampproof membrane before placing concrete. Use patching material at least 150mm larger than puncture and seal.
- .22 Clean formwork in accordance with CAN/CSA-A23.1, before placing concrete.
- .23 If slip forms or flying forms are used, submit details of equipment and procedures for Consultant's approval.
- .24 For walls and shearwalls, leave one side of forms open for inspection of reinforcing steel. Close form only after Consultant has reviewed and approved bar placement.
- .25 Re-use of formwork subject to requirements of CAN/CSA-A23.1.

3.2 REMOVAL AND RESHORING

- .1 Leave formwork in place for following minimum periods of time after placing concrete unless otherwise agreed to by Consultant.
 - .1 3 days for walls and sides of beams or as required to meet strength requirements.
 - .2 3 days for columns or as required to meet strength requirements.
 - .3 28 days for beam soffits, slabs, decks and other structural members, or minimum 3 days when replaced immediately with adequate shoring to standards specified for falsework and approved by Consultant and the concrete has reached minimum 75% of its design strength.
 - .4 3 days for footings and abutments or as required to meet strength requirements
- .2 Provide all necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .3 Space reshores in each principal direction not more than 3000 mm apart.
- .4 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter smooth concrete finish.

END OF SECTION

1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials, design, and execution of concrete reinforcing.

1.2 RELATED SECTIONS

- .1 Section 03 30 00 - Cast-In-Place Concrete
- .2 Division 04 - Masonry Specifications

1.3 REFERENCES

- .1 Ontario Building Code 2012 and National Building Code of Canada 2010
- .2 American Concrete Institute (ACI)
 - .1 SP-66(04) – ACI Detailing Manual 2004
- .3 Reinforcing Steel Institute of Ontario / Canada (RSIO / RSIC):
 - .1 Reinforcing Steel Manual of Standard Practice (2004);
- .4 American Society for Testing and Materials (ASTM):
 - .1 ASTM A82 / A82M-05a, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement;
 - .2 ASTM A184 / A184M-06, Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement;
 - .3 ASTM A185 / A185M-06e1, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete;
 - .4 ASTM A496 / A496M-05, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement;
 - .5 Rod Mats for Concrete Reinforcement;
 - .6 ASTM A775 / A775M - 06, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
- .5 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A23.1-04, Concrete Materials and Methods of Concrete Construction.
 - .2 CAN3-A23.3-04, Design of Concrete Structures.
 - .3 CAN/CSA-G30.18-M92 (R2002), Billet-Steel Bars for Concrete Reinforcement.
 - .4 CAN/CSA-G40.21-04, Structural Quality Steel.
 - .5 CAN/CSA-G164-M92 (2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .6 CSA W186-M1990 (R2002), Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings and bar lists in accordance with Section 01 33 00 – Submittal Procedures. Allow ten working days for shop drawing review before commencing fabrication.
- .2 Indicate on shop drawings, bar bending details, lists, quantities of reinforcement and wire mesh, sizes, spacing, locations of reinforcement and mechanical splices if approved by Consultant, with identifying code marks to permit correct placement without reference to structural drawings. Indicate sizes, spacing and locations of chairs, spacers and hangers. Prepare reinforcement drawings in accordance with Reinforcing Steel Manual of Standard Practice - by Reinforcing Steel Institute of Canada. ANSI/ACI 315 and ACI 315R, Manual of Engineering and Placing Drawings for Reinforced Concrete Structure.
- .3 Indicate (and detail) all proposed construction joints.
- .4 Show reinforced concrete and reinforced masonry walls and beams in full elevation and detail all bars.
- .5 When requested, for slab construction, show top and bottom layer slab reinforcing on separate plans. Detail sections to fully illustrate bar placement at dowels, curbs, openings, changes of elevation, beams, stairs, and areas of congested steel, and wherever else required.
- .6 Detail placement of reinforcing where special conditions occur.
- .7 Design and detail lap lengths and bar development lengths to CAN/CSA-A23.1 and CAN3-A23.3, unless otherwise specified on drawings. Use Class "B" tension splices unless otherwise noted.
- .8 Indicate details for placement of dowels.
- .9 CAD drawings of the Consultant may be used as a background for the preparation of shop drawings provided that a license agreement, provided by the Consultant, is signed by the reinforcing trade.

1.5 SUBSTITUTIONS

- .1 Substitute different size bars only if permitted in writing by Consultant.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal and the Waste Reduction Workplan.

2 PRODUCTS

2.1 MATERIALS

- .1 Reinforcing steel: billet steel, grade 400, deformed bars to CAN/CSA-G30.18, unless indicated otherwise.
- .2 Reinforcing steel: weldable low alloy steel deformed bars to CAN/CSA-G30.18.
- .3 Cold-drawn annealed steel wire ties: to ASTM A82/A82M;
- .4 Deformed steel wire for concrete reinforcement: to ASTM A496/A496M;
- .5 Welded steel wire fabric: to ASTM A185/A185M. Provide in flat sheets only.
- .6 Welded deformed steel wire fabric: to ASTM A497 / A497M. Provide in flat sheets only.
- .7 Epoxy coating of non-prestressed reinforcement: to ASTM A775 / A 775M.
- .8 Galvanizing of non-prestressed reinforcement: to CSA G164, minimum zinc coating 600g/m².
- .9 Chairs, bolsters, bar supports, spacers adequate for strength and support of reinforcing under construction conditions: to CAN/CSA-A23.1. Use chairs with plastic coated feet where slab and beam soffits will be exposed.
- .10 Mechanical splices: subject to approval of Consultant.
- .11 Plain round bars: to CAN/CSA-G40.21.

2.2 FABRICATIONS

- .1 Fabricate reinforcing steel in accordance with CAN/CSA-A23.1, ACI SP-66 – Detailing Manual, and RSIO/RSIC Reinforcing Steel Manual of Standard Practice unless indicated otherwise..
- .2 Fabricate to tolerances specified by RSIO/RSIC Reinforcing Steel Manual of Standard Practice unless indicated otherwise.
- .3 Obtain Consultant's approval for locations of reinforcement splices other than those shown on placing drawings.
- .4 Upon approval of Consultant, weld reinforcement in accordance with CSA W186.
- .5 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists. Bundling and transportation of epoxy coated bars shall be in accordance with ASTM A775/A775M.

- .6 Discard and re-fabricate bars having extra bends, cracks, splits, kinks or excessive rust.

2.3 SOURCE QUALITY CONTROL

- .1 Upon request, provide Consultant with certified copy of mill test report of reinforcing steel to be supplied, showing physical and chemical analysis, corresponding to identification tagging of material at the fabrication plant prior to commencing reinforcing work.
- .2 Inform Consultant of proposed source of material to be supplied. Unidentified reinforcement shall not be allowed.

3 EXECUTION

3.1 PLACING REINFORCEMENT

- .1 Place reinforcing steel to CAN/CSA-A23.1 and as indicated on reviewed shop drawings.
- .2 Set tie wires so that ends are directed into concrete, not toward exposed concrete surfaces. Un-coated metal tie wires shall not project more than 5mm into the concrete cover.
- .3 Do not tack weld reinforcing unless shown on the Structural Drawings, or approved by the Consultant.
- .4 Do not displace reinforcing to accommodate sleeves, inserts, waterstops, reglets, or other cast-in hardware.
- .5 Arrange for reinforcing steel personnel to be present at all times concrete is poured to ensure that reinforcing remains in place as tied, and to take remedial action as required.
- .6 Maximum chair spacing unless otherwise required by the Drawings or by "Reinforcing Steel Manual of Standard Practice":

Bar Size	Chair Spacing
10M	600mm
15M	1200mm
20M	1600mm
25M	2000mm

Provide additional chairs and support bars as deemed necessary by the Consultant.

- .7 Place welded wire fabric in as long lengths as practical lapping at least one mesh, (200mm minimum) and tie, unless noted on the Drawings.

- .8 Ensure welded wire fabric is adequately supported at centre of slab, or where indicated in the drawings, during concrete placing.
- .9 Obtain Consultant's approval of reinforcing steel and position before placing concrete. Give 24 hours notice prior to the time at which approval is required. For walls and deep beams, ensure that one side of formwork is left open for inspection of reinforcing steel.
- .10 Ensure that all steel is in place, and tied, at the time at which the Consultant's approval has been requested, and prior to the start of concrete placing.
- .11 Clean reinforcing and forms before placing concrete, and adjust reinforcing and forms immediately before concrete is poured, as required, to ensure bars and inserts are placed correctly.
- .12 Obtain approval from Consultant for all construction joint locations. Ensure additional reinforcement at construction joints is available before commencing pour.
- .13 Do not force reinforcing steel inserts or anchor bolts into fresh or semi-hardened concrete.
- .14 Ensure cover to reinforcement is maintained during concrete pour.
- .15 Placing of the epoxy-coated reinforcing bars, where epoxy coated bars are required on the drawings, shall include:
 - .1 Support epoxy-coated reinforcing bars from formwork on plastic coated wire bar supports, or on bar supports made of dielectric material for a minimum distance of 50mm from the point of contact with the epoxy-coated bar.
 - .2 Reinforcing bars used as support bars shall also be epoxy-coated.
 - .3 In walls having epoxy-coated reinforcing bars, spreader bars shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.
 - .4 Fasten epoxy-coated reinforcing bars with nylon-, epoxy-, or plastic-coated tie wire, or other acceptable material.
 - .5 Splice reinforcing bars only as required or permitted by the Contract Documents, or as authorized by the Consultant.
 - .6 Do not cut reinforcing bars in the field unless permitted by Consultant. When epoxy-coated reinforcing bars are cut in the field, coat ends of bars with same material used for repair of coating damage.
 - .7 Protect epoxy and paint coated portions of bars with covering during transportation and handling.

3.2 FIELD BENDING

- .1 Do not field bend reinforcing bars partially embedded in concrete, except as indicated in the Contract Documents or permitted by the Consultant.

- .2 Do not field bend or field weld reinforcement except where indicated or authorized by Consultant.
- .3 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .4 Replace bars which develop cracks or splits during field bends.
- .5 Bending of epoxy-coated reinforcing bars:
 - .1 Provide adequate ventilation when heat is used to field bend epoxy-coated reinforcing bars.
 - .2 When epoxy-coated reinforcing bars are field bent, repair coating damage in accordance with ASTM A775/A775M.

3.3 HANDLING AND STORAGE OF EPOXY-COATED REINFORCING BARS FOR EPOXY COATED BARS INDICATED ON THE DRAWINGS

- .1 Protect contact areas of all equipment used for handling epoxy-coated bars. Lift bundles of coated bars at multiple pick-up points to minimize bar-to-bar abrasion from sags in the bundles.
- .2 Store coated bars or bundles of coated bars on protective cribbing. Fading of the colour of the coating shall not be cause for rejection of epoxy-coated reinforcing bars.
- .3 Repair areas larger than 10mm square damaged during handling, shipping and placing, in accordance with ASTM A775/A775M. Maximum amount of damage including repaired and unrepaired areas not to exceed 2 percent of the surface area of each bar.

3.4 FIELD TOUCH-UP

- .1 Touch up damaged and cut ends of epoxy coated reinforcing steel with patching material conforming to ASTM A775/A775M, to provide continuous coating.

END OF SECTION

1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 03 10 00 - Concrete Forming and Accessories
- .2 Section 03 20 00 - Concrete Reinforcing
- .3 Section 03 35 00 - Concrete Finishing
- .4 Division 04 - Masonry Specifications
- .5 Section 05 12 23 - Structural Steel For Buildings
- .6 Section 07 18 16 - Vehicular Traffic Coatings

1.2 REFERENCES

- .1 Conform to Ontario Building Code 2012 and National Building Code of Canada 2010.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM C260-06, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .2 ASTM C309-06, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete;
 - .3 ASTM C494/C494M-05a, Standard Specification for Chemical Admixtures for Concrete.
 - .4 ASTM C679-03, Standard Test Method for Tack-Free Time of Elastomeric Sealants;
 - .5 ASTM C979-05, Standard Specification for Pigments for Integrally Colored Concrete.
 - .6 ASTM C1017/C1017M-03, Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete.
 - .7 ASTM D412-06a, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension;
 - .8 ASTM D638-03, Standard Test Method for Tensile Properties of Plastics;
 - .9 ASTM D2240-05, Standard Test Method for Rubber Property – Durometer Hardness;
- .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A3000-03, Cementitious Materials Compendium.
 - .2 CAN/CSA-A23.1-04, Concrete Materials and Methods of Concrete Construction.
 - .3 CAN/CSA-A23.2-04, Methods of Test and Standard Practices for Concrete.

1.3 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Where requested, submit samples of proposed colour of cement and type of proposed aggregate, for all exposed-aggregate and other architecturally-exposed concrete, for approval by Architect. Minimum sample panel size 600x600x75.

1.4 CERTIFICATES

- .1 Provide certification that mix proportions selected will produce concrete of specified quality and yield and that strength will comply with CAN/CSA-A23.1, Clause 4.4.6.
- .2 Provide certification that plant, equipment, and all materials to be used in concrete comply with the requirements of CAN/CSA-A23.1.

1.5 QUALITY ASSURANCE

- .1 Inspection and testing of concrete and concrete materials shall be carried out by a testing laboratory designated by the Owner, in accordance with CAN/CSA-A23.1 and A23.2.
- .2 Costs of tests will be paid under a cash allowance. See Section 01 22 00
- .3 Ship prepaid, 3 control cylinders of each strength of concrete from each pour, and not less than 3 from each 60m³ of concrete or part thereof. Make, handle, store and cure in accordance with CAN/CSA-A23.1. Make strength test of one cylinder from each sampling at 7 days, and of the other two cylinders at 28 days.
- .4 Prepare one additional test cylinder when concrete is being placed at temperatures of 10°C or less, and cure at site under same conditions as concrete it represents. Additional test cylinders shall be prepared at the discretion of the Engineer or Testing Agency.
- .5 Provide equipment and make slump tests with air entrainment tests in accordance with CAN/CSA-A23.2.
- .6 Field-cured (pull-out) cylinders shall be prepared to verify in-situ concrete strengths for stripping of formwork, particularly in cold weather. Pull-out cylinders shall be cast and stored on site until time of testing, in accordance with the recommendations of the Testing Agency. Alternate means of establishing in-situ strength shall be to the approval of the Testing Agency and the Engineer.
- .7 Report test results in writing to the Owner, Engineer and Contractor on the same day tests are made. Include in reports location of pours in construction, date and time of pour, time in mixer prior to discharge, temperature of concrete, weather, slump, air content, density, and class of concrete. Report non-conformance with the Contract Documents in detail.

- .8 Maintain accurate records of poured concrete items to indicate date, quantity, mix identification, admixtures, design slump, design density, aggregate size, design strength, time of batching, time of delivery, location of pour in building, quality, air temperature, and test samples taken. File duplicate copies of concrete delivery slips. Make these records available for inspection at all times.
- .9 Testing Agency shall advise Contractor and Engineer, without delay, of concrete in non-conformance with this Specification, and/or where rejection of the concrete is deemed warranted. Concrete shall be rejected by the Contractor if the specified requirements of CAN/CSA-A23.1 and this Specification are not met.
- .10 Permit access to the batching plant by the Testing Agency.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal and the Waste Reduction Workplan.
- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate a cleaning area for tools to limit water use and runoff
- .4 Carefully coordinate the specified concrete work with weather conditions
- .5 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .6 Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or streams. Using appropriate safety precautions collect liquid or solidify liquid with an inert, noncombustible material and remove for disposal. Dispose of all waste in accordance with applicable local, provincial and national regulations
- .7 Choose least harmful, appropriate cleaning method which will perform adequately

2 PRODUCTS

2.1 MATERIALS

- .1 Portland Cement shall conform to CAN/CSA-A3000-03, Type 10, or as otherwise indicated on Drawings, or in the Soil Report, from the same source for the entire project.
- .2 Where used, supplementary cementing materials, such as cementitious hydraulic slag, blended hydraulic cement and Pozzolanitic mineral admixtures shall conform to CAN/CSA-A3000-03.

- .3 Water, fine aggregates, and normal density coarse aggregates shall conform to CAN/CSA-A23.1. Coarse aggregate size to meet the requirements of CAN/CSA-A23.1, Clause 4.2.3., and the drawings. Coarse aggregates for slab-on-grade to be 20mm (minimum) crushed stone.
- .4 Air-entrainment admixtures shall conform to ASTM C260;
- .5 Chemical admixtures shall conform to ASTM C494;
- .6 Pozzolanic mineral admixtures shall conform to ASTM C1017;
- .7 Superplasticizing admixtures shall conform to ASTM C494;
- .8 Non-shrink grout shall be premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, of pouring consistency, and containing not less than 50% by mass of cement and not more than 0.06% soluble chloride ion by mass of cement, with an expansion of not less than 0.04% at 28 days, capable of developing compressive strength of 50 MPa at 28 days.
- .9 Dry pack shall be premixed compound of non-metallic aggregate, cement and sufficient water for the mixture to retain its shape when made into a ball by hand and capable of developing a compressive strength of 50MPa at 28 days.
- .10 Membrane-Forming Curing Compound: chlorinated rubber resin formulation to meet specified requirements of CAN/CSA-A23.1 and to ASTM C309, Type I, subject to the approval of the Engineer. Curing compounds are not to be used for slabs to receive a waterproofing membrane, traffic-resistant wearing course, surface sealers, ceramic tile or other bonded finishes.

2.2 CONCRETE MIXES

- .1 Prepare concrete mix designs, and be responsible for all mix design costs including related testing.
- .2 Base design on CAN/CSA-A23.1, Clause 4 to produce concretes having the 28 day compressive strengths and slumps specified on the structural drawings. Where compressive strengths or slumps are not noted on the drawings, provide the following:

LOCATION	28 DAY STRENGTH	SLUMP *	CLASS OF EXPOSUR E
All concrete work in areas exposed to de-icing material	35 MPa	75	C-1
Interior slabs on grade	25 MPa	75	N
Footings unless noted	30 MPa	75	N
Foundation walls	30 MPa	75	F-2

Suspended slabs & beams	30 MPa	75	N
Columns & shear walls (see drawings):	30 , 35 & 40 MPa	80	N
Slab on steel joists or deck	30 MPa	50	N
Retaining walls & exterior curbs	35 MPa	75	C-1
Pavements & Walks	32 MPa	50	C-2
Exterior concrete with rebar either exposed or not	35 MPa	50	C-1
Exterior concrete with no rebar either exposed or not	32 MPa	50	C-2

* Obtain these slumps with aid of specified water reducing agent.

- .3 Concrete for slabs to receive resilient sheet flooring shall meet flooring manufacturer's requirements while providing adequate workability and compliance with specified slumps.
- .4 Design mix to meet the specified exposure requirements of CAN/CSA-A23.1, with the appropriate water/cement ratio and entrained air content given in Tables 1 to 9 of A23.1. Refer to Drawings for required design exposure classifications.
- .5 For all columns, walls, suspended slabs, and ramps in truck docks, and all exterior exposed structural concrete near finished grade, concrete shall be designed to CAN/CSA-S413 and CAN/CSA-A23.1 for Class C1 exposure.
- .6 Concrete for all exposed work shall be of uniform colour and aggregate, and shall be to the approval of the Architect.
- .7 Only use admixtures which have been tested and accepted in mix designs. Obtain the approval of the Engineer before using chemical admixtures, or supplementary cementing materials.
- .8 The use of calcium chloride or chloride-containing admixtures is strictly prohibited, for all concrete mixes.
- .9 Design concrete with normal rate of hardening. If advantageous to employ modified rates of hardening to facilitate Work and to improve workmanship, Engineer may give approval for use of admixtures.
- .10 Where testing or inspection indicates excessive bleeding, segregation, poor workability of fresh concrete, or insufficient strength of hardened concrete, then mixes shall be redesigned to acceptable standards.

- .11 Submit, to the Engineer and Testing Agency, in writing, proposed mix designs for each proposed concrete mix, at least 20 days prior to the start of work. Specify intended use for each mix design. Provide mix designs for both winter and summer concrete. Mix designs may be adjusted when job conditions or other circumstances warrant, provided revised mixes are submitted for review in the above manner. Failure to make the necessary submissions may be cause for the classification of the Work as being defective.
- .12 Proceed with concreting operations with the approved mix designs but if, at any time, tests of job concretes indicate failure to meet strength, slumps, density, air content and rate of hardening requirements, or if appearance is unacceptable, adjust the standard proportions to meet requirements. Advise Engineer of changes to approved mix designs during progress of Work.
- .13 Use of Slag or fly ash as a partial replacement of cement shall be used as set out herein. The use of slag or fly ash shall be maximized as much as is practical for the project with the following considerations and restrictions:
 - .1 Floor finishing must be able to commence 4 hours after the commencement of placing of concrete and must be able to be completed within an 8 hour time period or less.
 - .2 The strength of the concrete on site for suspended slabs must be at 75% of the specified strength at 3 days.
 - .3 The concrete shall have sufficient strength and stiffness to allow formwork for all vertical surfaces to be removed 24 hours after placing of concrete.
 - .4 The specified strength of the concrete on site for columns and shear walls must be reached at 56 days or less, unless otherwise noted.
 - .5 The amount of fly ash or slag must be adjusted for site temperature conditions at the time of placing of concrete to ensure that the requirements above can be met.
 - .6 The fly ash content for all C-1 concrete shall not exceed 20% replacement of cement.
 - .7 Submit for review the amount of fly ash or slag as a percentage of replacement of cement for each mix design.
 - .8 At the completion of the project, provide in writing the overall average of the percentage replacement of cement with the use of slag and/or fly ash for all concrete supplied for the project.
- .14 Polypropylene fibres: Where specified, add 1 kg/m³, in small quantities at plant, with minimum 7 minutes mixing time.

2.3 ADDITIONAL CONCRETE MIX REQUIREMENTS FOR TRUCK DOCKS OR OTHER AREAS SUPPORTING VEHICLES

- .1 All the provisions of Section 2.2 apply, except as provided below.
- .2 The provisions for concrete apply to all components of the structure, including footings, retaining walls, columns, suspended slabs, toppings on suspended slabs, and upstand beams.

- .3 Concrete mix for all components to include a calcium nitrate corrosion inhibitor applied at the rate of 10 l/m³.
- .4 Submit for review the name of types of calcium nitrate to be used and the proposed supplier.
- .5 For information only, the suspended floor slabs will have a membrane topping.

3 EXECUTION

3.1 PREPARATION

- .1 Obtain Engineer's approval for planned sequence and form of communications before each concrete pour. See Clause 3.2.5 Placing of Concrete.
- .2 Pumping of concrete is permitted only after approval of equipment and mix.
- .3 Anchor reinforcement and inserts to ensure they will not be displaced during concrete placement.
- .4 Prior to placing of concrete obtain Engineer's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .5 Do not place concrete prior to receiving written acceptance from the Engineer of the weight of the mechanical and electrical equipment to be installed on the slab.
- .6 Plan locations of sawn control joints in slabs on grade and arrange to have equipment on site and ready to cut joints as soon as surface has hardened sufficiently to resist raveling. Place joints at 4.5m max spacing each way, unless otherwise noted on drawings. See CSA A23.1 Clause 7.3.2.
- .7 Sleeves and inserts.
 - .1 No sleeves, ducts, pipes or other openings shall pass through joists, beams, column capitals or columns, except where indicated or approved by Engineer.
 - .2 Where approved by Engineer, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 x 100 mm not indicated, on the structural drawings must be approved by Engineer.
 - .3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from Engineer before placing of concrete. Provide additional reinforcing as directed.
 - .4 Check locations and sizes of sleeves and openings shown on structural, architectural and mechanical drawings. Report discrepancies to Engineer for direction.
 - .5 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

- .8 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .10 In locations where new concrete is dowelled to existing work, drill holes in existing concrete. Place steel dowels of deformed steel reinforcing bars and pack solidly with shrinkage compensating grout epoxy grout to anchor and hold dowels in positions as indicated.
- .11 Where required, set anchorage devices for tie-back and life-line (roof) anchors, davit bases, or other window-washing anchor inserts, in accordance with manufacturer's instructions, and with reviewed shop drawings.
- .12 Dovetail anchor slots:
 - .1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
 - .2 Install continuous vertical anchor slots at 800 mm c/c where concrete walls are masonry faced.
- .13 Dissimilar embedded metals shall be separated by a minimum of 40mm of concrete or shall be protected by electrically insulating coatings or separators, for all concrete in parking garage or concrete otherwise likely to be exposed to moisture. Stainless steel and plain steel shall be considered dissimilar metals.
- .14 Openings in concrete walls which are required for the installation of temporary shoring rakers are to be built as construction joints with keys. Remove raker by cutting flush with soldier pile, touch up with epoxy paint, and fill opening with concrete matching remainder of wall.
- .15 Obtain Geotechnical Engineer's approval of foundation bearing surfaces for bearing capacity, depths, and dimensions, prior to placing concrete. Assist Geotechnical Engineer as required. Maintain accurate records of as-built founding elevations, and submit record drawings to Owner.
- .16 For slabs-on-grade, obtain written approval of Geotechnical Engineer prior to concreting that the underfloor drainage system (if required) has been satisfactorily installed, that compaction tests have been carried out and that any necessary recompaction has been completed.
- .17 Obtain Engineers review of conduit routing in slabs prior to placing concrete.

3.2 CONSTRUCTION

- .1 Do cast-in-place concrete work in accordance with CAN/CSA-A23.1.
- .2 Do not place load upon new concrete until authorized by Engineer.

- .3 Slabs to receive resilient sheet flooring shall:
 - .1 Have sealers and curing compounds compatible with flooring systems and acceptable to flooring manufacturer and installer,
 - .2 Meet moisture and alkalinity requirements of the flooring manufacturer. Allow for "drying out" time acceptable to flooring manufacturer and installer. Carry out test patches to ensure that moisture content of slabs are compatible with flooring system and acceptable to flooring manufacturer and installer.
- .4 Construction Joints
 - .1 Provide construction joints in horizontal or vertical surfaces in accordance with CAN/CSA-A23.1, and as indicated on the Drawings.
 - .2 Locate construction joints so as not to reduce the strength and appearance of the structure.
 - .3 Unless noted, locate construction joints at high points in slabs
 - .4 Unless noted, run reinforcement through construction joints, and form keys as indicated on the Drawings
 - .5 Where vertical drainage system for foundation walls is indicated in the Soil Report, align vertical construction joints in foundation walls with drainage courses
 - .6 Sawcut control joints in slabs-on-grade in accordance with Clause 3.1.5 (above) and the drawings.
- .5 Placing of Concrete
 - .1 Obtain Engineer's approval of reinforcing placement before placing concrete. Provide Engineer minimum 24 hours notice prior to placing concrete. Notify the Testing Agency in sufficient time to allow necessary tests or other preparatory work to be done. In slab construction, ensure all steel is in place and inspected before commencing concrete placement. Do not begin to place concrete until the work of other trades affecting concrete is complete. Failure to meet this requirement may be cause for classification of the Work as being defective.
 - .2 Immediately before concrete placement, moisten all absorbent material that will be in direct contact with the fresh concrete. Take care to prevent ponding.
 - .3 For concrete placed on metal deck or precast floor units, co-ordinate placement technique with deck supplier for strength and shoring requirements, so as not to damage the deck.
 - .4 Place concrete in accordance with CAN/CSA-A23.1, under the supervision of a competent foreman at all times. Do not permit disapproved or rejected materials on the site.
 - .5 Water, cement, aggregates or admixtures shall not be added to the concrete after the initial introduction of the mixing water to the batch.
 - .6 Concrete shall not be placed, if in the opinion of the Engineer or Testing Agency, it cannot be placed and properly consolidated without the addition of any other water to the batch.
 - .7 In no case shall the time between batching and complete discharge of the concrete exceed 90 minutes.

- .8 Concrete shall be completely placed within 30 minutes of leaving the transit mixer
 - .9 Ensure reinforcement and inserts are not disturbed during concrete placement and vibration.
 - .10 Place concrete in a continuous operation within planned construction joints. Deposit concrete as nearly as practicable to its final position to avoid segregation due to rehandling or flowing. Handle concrete from the point of delivery to the locations of final deposit as rapidly as practicable, using conveying methods which will prevent segregation or loss of concrete mix materials. Do not transport concrete using vibrators.
 - .11 Consolidate placed concrete using mechanical vibrators supplemented by hand-spacing, rodding or tamping. Vibrate concrete evenly and uniformly but limit the duration of vibration to the minimum time necessary to consolidate the concrete and to embed the reinforcing and inserts, without causing segregation.
 - .12 Do not allow vibrator to touch formwork. Take particular care to prevent formation of surface defects and honeycombing.
- .6 Hot/Cold Weather
- .1 Place concrete in cold weather as specified in CAN/CSA-A23.1, Clause 7.4.1.8. Protect concrete from physical damage or reduced strength due to premature drying or weather extremes.
 - .2 Carry out hot weather concreting in accordance with CAN/CSA-A23.1, Clauses 5.2 and 7.4, including use of approved moisture retention film, if applicable.
 - .3 De-icing chemicals shall not be used on the concrete formwork, or on the finished concrete.
 - .4 If rain or snow begins after concrete is placed, and before it is set, protect with waterproof covers until set.
 - .5 Obtain approval from the Engineer and Testing Agency for proposed method for protection of concrete during placing and curing in adverse weather, prior to placing of concrete.
 - .6 To ensure that concrete cures without suffering damage, take precautions by protective methods, provision of heat, maintenance of humidity, free circulation of warm moist air at concrete surfaces, and other means made necessary by conditions that arise. Do not use unvented heaters.
- .7 Finishing, General
- .1 Finish concrete in accordance with CAN/CSA-A23.1.
 - .2 Rub exposed sharp edges of concrete with carborundum to produce 3mm radius edges unless otherwise detailed.
 - .3 Refer to Architectural Drawings and Specifications for special finishes.
- .8 Finishing Slabs
- .1 General:
 - .1 Finish concrete floor slabs to CSA-A23.1 Clause 7.5.1 and Table 22 for Class A buildings, unless otherwise indicated.

- .2 Use procedures acceptable to Engineer and those noted in CAN/CSA-A23.1 to remove excess bleed water. Ensure surface is not damaged
- .3 Steel trowel slabs to be left exposed or to receive flooring or carpeting.
- .4 Other slabs to be screened off to true lines and levels and left ready to receive specified finish. Depress slabs where required and/or indicated.
- .5 Ensure that floor drains are located at low points so that no ponding will occur. Where floor drains occur, floors to be leveled around the walls and have a minimum 5mm per meter (0.5%) uniform pitch to drains, unless indicated otherwise.
- .6 Apply non-metallic surface hardener to exposed concrete floors in accordance with Section 03 35 05.
- .7 Use curing compounds compatible with applied finish on concrete surfaces.
- .2 Plain Floor Finish (Unexposed):
 - .1 Roll or tamp concrete to force coarse aggregate into concrete mix, then screed.
 - .2 Float surface with wood or metal float or with power finishing machine and bring surface to true elevation.
 - .3 Steel trowel to smooth and even surface.
 - .4 Follow with second steel trowelling to produce smooth burnished surface to within 8mm tolerance when measured in any direction using 3m straight edge, unless noted otherwise. Do not over-trowel.
 - .5 Sprinkling of dry cement or dry cement and sand mixture over concrete surfaces is not acceptable.
 - .6 Apply curing compound in accordance with manufacturer's instructions. Do not use curing compound when slab is to receive bonded finish. Wet curing for a minimum of seven days with burlap and polyethylene over shall then be employed.
 - .7 Sawcut crack-control joints in slabs on grade to CAN/CSA-A23.1 (maximum 24 hours after placement), or as noted on drawings. Fill joints with joint sealant as applicable.
 - .8 After curing and when concrete is dry, fill control joints and joints at junction with vertical surfaces with weak cementitious grout.
- .3 Floor Finish (exposed):
 - .1 Finish concrete floors as per Paragraph 3.2.8.2, Clauses .1 to .5, and apply floor hardener, non-metallic aggregate at a rate of 3.5 kg/m² to manufacturer's instructions.
 - .2 Apply approved curing/sealing compound to manufacturer's instructions, except for slabs on grade and garage slabs, which shall be wet cured for a minimum of seven days with burlap and polyethylene over.
 - .3 Sawcut crack-control joints in slabs on grade to CAN/CSA-A23.1-04 (maximum 24 hours after placement), or as noted on drawings. Seal with joint filler.

- .4 After curing/sealing and when concrete is dry, seal control joints and joints at junction with vertical surfaces with sealant.
- .5 Clean surfaces and apply second coat curing/sealing compound before handing building over to Owner.
- .9 Toppings.
 - .1 Topping mixture to meet following requirements:
Monolithic, mm thick: 50
Bonded overlay, mm thick: 100.
 - .2 In pouring base course, make allowance for monolithic and bonded overlay topping thickness
 - .3 Place monolithic topping before base course has completely set in accordance with CAN/CSA-A23.1 and topping manufacturer's recommendations
 - .4 Place bonded topping over hardened base course in accordance with CAN/CSA-A23.1 and topping manufacturer's recommendations.
 - .5 Apply cement/sand grout latex bonding agent modified cement/sand grout epoxy bonding agent to base course in accordance with CAN/CSA-A23.1 and manufacturer's recommendations before placing bonded topping. Observe manufacturer's safety recommendations.
 - .6 Ensure that joints in topping are of the same as those in base course. Also ensure that their locations precisely match those in base course. Provide dividers edge strips reinforcing mesh as indicated

3.3 FORMWORK REMOVAL AND RESHORING

- .1 Refer to Section 03 10 00 for specified requirements.

3.4 CURING

- .1 Cure concrete as specified in CAN/CSA-A23.1 and in Section 03 35 00.
- .2 Do not use curing compounds that would have a detrimental effect on bonding, adhesion, curing, appearance, or similar qualities of materials to be applied to concrete surfaces. Use only moisture curing (wet burlap with polyethylene sheeting) at a temperature of at least 10°C for surfaces where applied coatings or finishes are incompatible with curing compound, and maintain continuously moist for a minimum of 7 days.

3.5 ARCHITECTURAL CONCRETE

- .1 Architectural concrete is concrete which will be permanently exposed to view in interior finished areas and on unclad portions of building exterior. Final appearance is as important a factor as the engineering properties of the concrete and failure of the as-cast concrete to meet the required standard of appearance may be a cause for rejection.

- .2 Ensure that exposed surfaces are dense, even, uniform in colour, texture and distribution of exposed aggregate. They shall be free from defects such as honeycombing, voids, loss of fines, visible flow lines and cold joints. Defects of this nature shall be cause for rejection of the Work.
- .3 Ensure that concrete members have sharp accurate definitions of corners, reglets, etc. and are free from chips and spalls.
- .4 Protect finished Work from damage and staining during the construction period. Pay special attention to the protection of projecting reinforcing at construction joints.

3.6 OTHER CONCRETE

- .1 Provide electrical and mechanical equipment bases and toppings including floating slabs and toppings, isolation pads, inertia bases and other concrete pads, as required.
- .2 Provide mechanical sump pits and electrical manholes, as cast in place concrete.
- .3 Provide concrete bases for exterior lighting fixtures and other landscape features, and for buried electrical duct banks.
- .4 Unless otherwise detailed, form curbs around duct shafts, electrical shafts, pipe shafts and other floor openings for mechanical and electrical services in sprinklered and parking areas. Curbs shall be minimum 150mm wide, 100mm high, with coved bases and chamfered corners or as otherwise detailed on the Drawings. Finish with steel trowel. Unless otherwise shown on the Drawings, reinforcing shall be one 15M longitudinal bar, with 10M dowels from supporting floor slab at 400mm centres. Where curb height exceeds 400mm, provide 1-10M additional horizontal bar at mid-height.
- .5 Provide any additional cast-in-place concrete required under the work of Divisions 22, 23 and 26, but not stated above.
- .6 Refer to Mechanical, Electrical and Architectural drawings for miscellaneous concrete not indicated on structural drawings.
- .7 Provide concrete fill in landings and stair pans, for metal stairs required under the Work of Division 05.

3.7 CONCRETE FOR LANDSCAPING

- .1 For exterior landscaping concrete, either exposed or not, if reinforcing steel is present, provide C-1 concrete with calcium nitrate additive and epoxy coated reinforcing steel.
- .2 For exterior landscaping concrete, with no reinforcing steel, concrete shall be C-2. If the concrete is not visually exposed, provide poly-fiber reinforcement.

3.8 GROUTING AND PATCHING

- .1 Grout underside of steel column and beam bearing plates with specified non-shrink type grout to Manufacturer's instructions. Provide 100% contact over grouted bearing areas.
- .2 Touch up concrete foundation walls following removal of raker/tieback system, ensuring that patching method precludes penetration of water or corrosion products into the finished building, in a manner acceptable to the Engineer.
- .3 Where new construction abuts or adjoins existing structure(s), grout joints between new and existing framing, unless shown otherwise on the Drawings.
- .4 Take necessary precautions to ensure good bond of grout to substrate and to exclude entrapped air from grouted joints.

3.9 DEFECTIVE CONCRETE

- .1 Remove damage, discoloured or defective concrete, blemishes, honeycombing, excessive laitance and embedded debris as directed by Engineer.
- .2 Where the results of specified concrete tests indicate non-compliance with the requirements of this Specification, or where such tests have not been carried out, or when conditions exist such as to cause doubt about the safety, serviceability or durability of the structure, or part thereof, the Engineer shall have the right to order non-destructive testing, and/or field coring for supplementary testing. Such additional tests (including patching of core holes) shall be made at no cost to the Contract.
- .3 Contractor shall submit in writing, details of proposed method of remedial work, for approval by Engineer.
- .4 Where deemed necessary, doweling of reinforcing into hardened concrete shall be by the "Hilti HIT technique" or approved alternate.
- .5 Defects shall be repaired at no cost to the Contract.

END OF SECTION

PART 1 - GENERAL

1.1 Reference Standards

- .1 Do concrete floor finishing work in accordance with A23.1-94 except where specified otherwise.

PART 2 - PRODUCTS

2.1 Materials

- .1 Concrete materials to Section 03300 - Cast-in-Place Concrete and reinforcement to Section 03200 - Concrete Reinforcement.
- .2 Metallic floor hardener: premixed, metallic hardener.
- .3 Wax: concrete floor buffing compound.
- .4 Use compatible additives, admixtures and hardeners.

PART 3 - EXECUTION

3.1 Floor Finish

- .1 Finish concrete in accordance with A23.1-94 94 Class A.

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- .2 Do not sprinkle dry cement or dry cement and sand mixture over concrete surfaces.
 - .3 Saw cut crack-control joints to A23.1-94 94.
 - .4 Apply floor hardener to manufacturer's instructions. Cure to manufacturers recommendations.
 - .5 Apply concrete floor wax in accordance with manufacturer's instructions.
 - .6 Cure concrete in accordance with A23.1-94 except where specified otherwise.
 - .7 Depress slab maintaining minimum specified thickness as required to accommodate flush floor finishes.

1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for chemical floor treatment of new and old, cured and set, concrete floor surfaces.

1.2 RELATED SECTIONS

- .1 Section 03 30 00 - Cast-In-Place Concrete
- .2 Section 02 61 33 - Hazardous Materials

1.3 REFERENCES

- .1 Ontario Building Code 2012 and National Building Code of Canada 2010.
- .2 Health Canada – Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS)
- .3 American Society for Testing and Materials (ASTM)
 - .1 ASTM C309-06, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete;
 - .2 ASTM C679-03, Standard Test Method for Tack-Free Time of Elastomeric Sealants;
 - .3 ASTM D412-06a, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension;
 - .4 ASTM D638-03, Standard Test Method for Tensile Properties of Plastics;
 - .5 ASTM D2240-05, Standard Test Method for Rubber Property – Durometer Hardness;
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-25.20-95, Surface Sealer for Floors.
- .5 Canadian Standards Association (CSA)
 - .1 CSA-A23.1-94, Concrete Materials and Methods of Concrete Construction.

1.4 PERFORMANCE REQUIREMENTS

- .1 Product quality and quality of work in accordance with Section 01 61 00 – Common Product Requirements.
- .2 Submit written declaration that components used are compatible and will not adversely affect finished flooring products and their installation adhesives.

1.5 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit WHMIS MSDS – Material Safety Data Sheets in accordance with Section 02 61 33 – Hazardous Materials. WHMIS MSDS acceptable to Labour Canada for Concrete floor treatment materials. Indicate VOC content.
- .3 Include application instructions for floor treatments.

2 PRODUCTS

2.1 CHEMICAL HARDENERS

- .1 Non-metallic floor hardener: dry granular material with selected mineral aggregate preblended with Portland cement and a dispersing agent, with a minimum compressive strength of 200 MPa, minimum hardness 6 on the MOH scale, and maximum 11% loss abrasion resistance based on ASTM Class C test.
- .2 Type 1 – Sodium silicate, Type 2 – Magnesium fluosilicate or Type 2 - Zinc fluosilicate blend, as indicated.
- .3 Water: potable.
- .4 Concrete additives and hardeners to be compatible.

2.2 SEALING COMPOUNDS

- .1 Surface Sealer: to CAN/CGSB-25.20, Type 1 – Solvent-based or Type 2 – Water-based, clear or coloured, as indicated.
- .2 Surface sealer: acrylic carnauba wax, colour, as indicated.
- .3 Surface sealers may not be manufactured or formulated with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium or hexavalent chromium and their compounds.
- .4 Sealing compound: chlorinated rubber-based to ASTM C309-03, Type 1.
- .5 Sawcut joint sealant:
 - .1 Slab on grade to be left exposed: two component, epoxy-urethane, load-bearing, self-leveling control joint filler, with a tack-free time of maximum 12 hours and full cure 4 days (ASTM C679), a minimum tensile strength of 4.8 MPa at 28 days (ASTM D638), a minimum elongation at break of 130% at 28 days (ASTM D412), a minimum Shore A hardness of 80 at 28 days and 20°C (ASTM D2240).
 - .2 Slab on grade to receive carpet or bonded finish: low strength sand / cement mix.

2.3 CURING COMPOUNDS

- .1 Curing compound: chlorinated rubber-based to ASTM C309-03, Type 1.
- .2 Select low VOC, water-based and organic-solvent free curing compounds.

2.4 CONCRETE STAINS

- .1 Select low VOC, water-based and organic-solvent free concrete stains.

2.5 MIXES

- .1 Provide mixes, ratios and application in accordance with manufacturer's instructions.

3 EXECUTION

3.1 EXAMINATION

- .1 Verify that slab, substrate and site condition surfaces are ready to receive work and elevations are as indicated.

3.2 PREPARATION OF EXISTING SLAB

- .1 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radiused edges unless otherwise indicated.
- .2 Saw cut control joints to CSA-A23.1, 24 hours maximum after placing of concrete.
- .3 Use strong solvent or mechanical stripping to remove chlorinated rubber or other existing surface coatings.
- .4 Use protective clothing, eye protection, and respiratory equipment during stripping of chlorinated or other existing surface coatings.

3.3 APPLICATION

- .1 After floor treatment is dry, seal control joints and joints at junction with vertical surfaces with sealant.
 - .1 Sealants: conforming to section 07 92 10 – joint sealing.
- .2 Apply floor treatment in accordance with Sealer manufacturer's written instructions.
- .3 Clean overspray. Clean sealant from adjacent surfaces.

3.4 PROTECTION

- .1 Protect finished installation in accordance with manufacturer's instructions.

END OF SECTION

PART 1 - GENERAL

1.1 References

- .1 CSA A179-M76 Mortar and Grout for Unit Masonry.
- .2 A371-94 Masonry Construction for Buildings.

1.2 Source Quality Control

- .1 Submit laboratory test reports in accordance with Section 01300 - Submittals.
- .2 Submit laboratory test reports certifying compliance of masonry units and mortar ingredients with specification requirements.
- .3 For clay units, in addition to requirements set out in referenced CSA and ASTM Standards include data indicating initial rate of absorption for units proposed for use.

1.3 Samples

- .1 Submit samples in accordance with Section 01300 - Submittals.
- .2 Submit samples:
 - .1 Two of each type of masonry unit specified.
 - .2 One of each type of masonry accessory specified.
 - .3 One of each type of masonry reinforcement and tie proposed for use.
 - .4 As required for testing purposes.

1.4 Product Delivery, Storage and Handling

- .1 Deliver materials to job site in dry condition.
- .2 Keep materials dry until use, except where wetting of bricks is specified.
- .3 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.

1.5 Cold Weather Requirements

- .1 Supplement Clause 5.15.2 of A371-94 with following requirements:
 - .1 Maintain temperature of mortar between 5°C and 50°C until used.

1.6 Hot Weather Requirements

- .1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.

1.7 Protection

- .1 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.
- .2 Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.
- .3 Provide temporary bracing of masonry work during and after erection until permanent lateral support is in place.

PART 2 - PRODUCTS

2.1 Materials

- .1 Masonry materials are specified in other sections.

PART 3 - EXECUTION

3.1 Workmanship

- .1 Do masonry work in accordance with A371-94 except where specified otherwise.
- .2 Build masonry plumb, level, and true to line, with vertical joints in alignment.
- .3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.2 Tolerances

- .1 Tolerances in notes to Clause 5.3 of A371-94 apply.

3.3 Exposed Masonry

- .1 Remove chipped, cracked, and otherwise damaged units in exposed masonry and replace with undamaged units.

3.4 Jointing

- .1 Allow joints to set just enough to remove excess water, then tool with round jointer to provide smooth, compressed, uniformly concave joints where concave joints are indicated.

- .2 Allow joints to set just enough to remove excess water, then rake joints uniformly to 6 mm depth and compress with square tool to provide smooth, compressed, raked joints of uniform depth where raked joints are indicated.
- .3 At all exposed horizontal masonry, strike mortar across exposed masonry to drain water and prevent accumulation of snow. Apply clear waterproof sealer.
- .4 Strike flush all joints concealed in walls and joints in walls to receive plaster, tile, insulation, or other applied material except paint or similar thin finish coating.

3.5 Cutting

- .1 Cut out neatly for electrical switches, outlet boxes, and other recessed or built-in objects.
- .2 Make cuts straight, clean, and free from uneven edges.

3.6 Building-In

- .1 Build in items required to be built into masonry.
- .2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
- .3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.

3.7 Wetting of Bricks

- .1 Except in cold weather, wet clay bricks having an initial rate of absorption exceeding 1 g/minute/1000 mm²: wet to uniform degree of saturation, 3 to 24 hours before laying, and do not lay until surface dry.
- .2 Wet tops of walls built of bricks qualifying for wetting, when recommencing work on such walls.

3.8 Parging

- .1 Use parging mortar specified in Section 04100 - Mortar and Grout for Masonry.
- .2 Apply parging in uniform coating not less than 10 mm thick, where indicated.

3.9 Support of Loads

- .1 Use 25 MPa concrete to Section 03300 - Cast-in-Place Concrete, where concrete fill is used in lieu of solid units.
- .2 Use grout to CSA A179-94(R1999) where grout is used in lieu of solid units.
- .3 Install building paper below voids to be filled with concrete grout; keep paper 25 mm back from faces of units.

3.10 Provision for Movement

- .1 Leave 3 mm space below shelf angles.
- .2 Leave 6 mm space or space as required to accommodate anticipated deflection between top of non-load bearing walls and partitions and structural elements. Do not use wedges. Pack joint with mineral wool batts, and caulk with fire stop material. Provide lateral support at 1200 o.c. as required, unless otherwise specified.
- .3 Build masonry to tie in with stabilizers, with provision for vertical movement.

3.11 Loose Steel Lintels

- .1 Install loose steel lintels. Centre over opening width.

3.12 Control Joints

- .1 Provide continuous control joints at 6.0 m o.c. maximum or as indicated.

3.13 Existing Work

- .1 Make good existing work. Use materials to match existing.

3.14 Recessed Devices

- .1 Recess wall mounted electrical devices in Gymnasium and any other wall mounted equipment which may be prone to damage. Recess concrete block face panel minimum 50mm, size to suit but not smaller than 200mm x 200mm. Provide bullnose blocks at exposed vertical corners. Submit summary of equipment to be recessed and review with Consultant prior to commencement of work.

3.15 Testing

- .1 Inspection and testing will be carried out by Testing Laboratory designated by Consultant.
- .2 Cost of testing will be paid from cash allowance specified in Section 01021 - Allowances.

PART 1 - GENERAL

1.1 Related Work

- .1 Masonry procedures: Section 04050 Masonry Procedures

1.2 References

- .1 CSA A179-94(R1999) Mortar and Grout for Unit Masonry.

1.3 Samples

- .1 Submit samples in accordance with Section 01300 - Submittals.
- .2 Submit two samples of coloured mortar.

PART 2 - PRODUCTS

2.1 Materials

- .1 Mortar and grout: CSA A179-94(R1999).
- .2 Lime Mortars:
 - .1 Portland cement type 10, in accordance with CAN/CSA-A5-93.
 - .2 Hydrated lime type 'S', in accordance with C207-91 (1992).
 - .3 Colouring pigments: pigments constituted of ground coloured natural aggregates or mettalic oxide pigments, colour as selected by consultant from manufacturer's available range. The ratio of

colouring agent/density of cementitious material shall not exceed 10%.

- .4 Do not use admixtures.
- .3 Water: potable, clean exempt from ice, oils, acids, alkalis, organic matter, sediments or any other harmful matter.
- .4 Sand: fine grain aggregates, grading in accordance with A179-94.
- .5 Use aggregate passing 1.18 mm sieve where 6 mm thick joints are indicated.
- .6 Colour: ground coloured natural aggregates or metallic oxide pigments to Consultants selection from manufacturer's standard range, one colour for each masonry type.
- .7 Provide materials in strict accordance with mortar and masonry manufacturers' specifications.

2.2 Material Source

- .1 Use same brands of materials and source of aggregate for entire project.

2.3 Mortar Types

- .1 Mortar for exterior masonry above grade:
 - .1 Loadbearing: Type S based on Property specifications.
 - .2 Non-loadbearing: Type S based on Property specifications.
 - .3 Parapet walls, chimneys, unprotected walls: Type S based on Proportion specifications.
- .2 Mortar for foundation walls, manholes, sewers, pavements, walks, patios and other exterior masonry at or below grade: Type M based on Property specifications.
- .3 Mortar for interior masonry:
 - .1 Loadbearing: Type S based on Property specifications.
 - .2 Non-loadbearing: Type N based on Property specifications.
- .4 Following applies regardless of mortar types and uses specified above:
 - .1 Mortar for calcium silicate brick and concrete brick: Type O based on Proportion specifications.

- .2 Mortar for grouted reinforced masonry: Type S based on Proportion specifications.
- .3 Mortar for pointing: Type O based on Proportion specifications.
- .4 Mortar for glass block: 1 part white portland cement, 1 part hydrated lime, 6 parts white sand aggregate by volume.

2.4 Coloured Mortar

- .1 Coloured mortar: use colouring admixture not exceeding 10% of cement content by mass, or integrally coloured masonry cement, or portland/lime to produce coloured mortar to match approved sample.
- .2 Use coloured mortar for brick, one colour for each brick type..

2.5 Grout

- .1 Grout: to CSA A179-94 (R1999) Table 3.

2.6 Parging

- .1 Parging mortar: Type N to CSA A179-94 (R1999).

PART 3 - EXECUTION

3.1 Mixing

- .1 Do masonry mortar and grout work in accordance with CSA A179-94 (R1999) except where specified otherwise.
- .2 Mix grout to semi-fluid consistency.
- .3 Incorporate colour and admixtures into mixes in accordance with

manufacturer's instructions.

- .4 Use clean mixer for coloured mortar.
- .5 Prehydrate pointing mortar by mixing ingredients dry, then mix again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than 1 hour nor more than 2 hours then remix with sufficient water to produce mortar of proper consistency for pointing.

3.2 Parging

- .1 Apply parging in uniform coating not less than 10mm thick, where indicated.

PART 1 - GENERAL

1.1 References

- .1 ASTM D 2240-02b Test Method for Rubber Property - Durometer Hardness.
- .2 A371-94 Masonry Construction for Buildings.

1.2 Samples

- .1 Submit samples in accordance with Section 1300.

PART 2 - PRODUCTS

2.1 Materials

- .1 Control joint filler: purpose-made elastomer 90 durometer hardness to ASTM D 2240-02b of size and shape indicated.
- .2 Nailing inserts: 0.6 mm thick purpose-made galvanized steel inserts for setting in mortar joints.
- .3 Masonry flashing:
 - .1 Membrane masonry flashing and through-wall dampproof course: Blue Skin TWF as manufactured by Bakor Inc. or Colphene 3000 as manufactured by Soprema Inc.
 - .2 Lap adhesive: recommended by manufacturer of flashing material.
- .4 Weep hole vents: purpose-made PVC designed to drain cavities to exterior, complete with insect screens and mortar guards.

- .5 Cavity spacers: purpose made to prevent accumulation of mortar droppings from obstructing cavity. Submit samples and technical information for review.

PART 3 - EXECUTION

3.1 Control Joints

- .1 Install continuous control joint fillers in control joints at locations indicated.

3.2 Weep Hole Vents

- .1 Install weep hole vents in vertical joints immediately over flashings, sills and at top of cavities, in exterior wythes of cavity wall and masonry veneer wall construction, at maximum horizontal spacing of 600 mm oc.

3.3 Nailing Inserts

- .1 Install nailing inserts in mortar joints at 400 mm oc each way, for attachment of wall strapping.

3.4 Masonry Flashing

- .1 Install flashings in masonry in accordance with A371-M94 as follows:
 - .1 Install flashings under exterior masonry bearing on foundation walls, slabs, shelf angles, and steel angles over openings. Install flashings under weep hole courses and as indicated.
 - .2 In double wythe walls and veneered walls, carry flashings from front edge of masonry, under outer wythe, then up backing not less than 150 mm, and as follows:

- .1 For masonry backing embed flashing 25 mm in joint.
- .2 For concrete backing, insert flashing into reglets.
- .3 For wood frame backing, staple flashing to walls behind sheathing paper.
- .4 For gypsum board backing, bond to wall using manufacturer's recommended adhesive.
- .3 Lap joints 150 mm and seal with adhesive.
- .4 Lap and seal through-wall dampproof course flashings to air and vapour barrier membranes.
- .5 Lap and seal minimum 150 through-wall dampproof course flashings to adjacent roof flashing membranes. Extend with backing film intact surplus dampproof course membrane for this purpose.
- .6 Provide masonry flashing membrane where continuity of trowelled air/vapour barriers may be compromised.

3.5 Cavity Spacers

- .1 Provide in accordance with manufacturer's specifications cavity spacers minimum 150mm at bottom of cavities above throughwall dampproof courses/masonry flashings.

PART 1 - GENERAL

1.1 References

- .1 CAN/CSA-A23.1-00, Concrete Materials and Methods of Concrete Construction.
- .2 A370-94, Connectors for Masonry.
- .3 A371-94, Masonry Construction for Buildings.
- .4 CSA G30.3-M1983 (R1998) (R1998), Cold-Drawn Steel Wire for Concrete Reinforcement.
- .5 CSA G30.12-M1977, Billet-Steel Bars for Concrete Reinforcement.
- .6 CAN3-S304-M84 (R1997) (R1997), Masonry Design for Buildings.
- .7 CSA W186-M1990 (R1998) (R1998), Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.2 Source Quality Control

- .1 Upon request, provide Consultant with certified copy of mill test report of reinforcement steel and connectors, showing physical and chemical analysis, minimum 5 weeks prior to commencing reinforcement work.
- .2 Upon request inform Consultant of proposed source of material to be supplied.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300.
- .2 Shop drawings consist of bar bending details, lists and placing drawings.

- .3 On placing drawings, indicate sizes, spacing, location and quantities of reinforcement and connectors.

PART 2 - PRODUCTS

2.1 Materials

- .1 Bar reinforcement: to A371-M94 and CSA G30.12.
- .2 Wire reinforcement: to A371-M94 and CSA G30.3-M1983 (R1998) (R1998), truss type.
- .3 Connectors: to A370-M94 and CAN3-S304-M84 (R1997) (R1997).
 - .1 Interior walls: corrosion resistant or non corroding connectors.
 - .2 Exterior walls: Adjustable hot-dipped galvanized DW130 as manufactured by Dur-O-Wall Limited or approved equal as recommended by manufacturer for intended use.
- .4 Corrosion protection: to CAN3-S304-M84 (R1997) (R1997), galvanized.

2.2 Fabrication

- .1 Fabricate reinforcing in accordance with CAN/CSA-A23.1-00 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Ontario.
- .2 Fabricate connectors in accordance with A370-M94.
- .3 Obtain Consultant's approval for locations of reinforcement splices other than shown on placing drawings.
- .4 Upon approval of Consultant, weld reinforcement in accordance with CSA W186-M1990 (R1998) (R1998).
- .5 Ship reinforcement and connectors, clearly identified in accordance with drawings.

PART 3 - EXECUTION

3.1 Installation

- .1 Install masonry connectors and reinforcement in accordance with A370-M94, A371-M94 and CAN3-S304-M84 (R1997) (R1997), unless indicated otherwise.
- .2 Prior to placing concrete mortar grout, obtain Consultant's approval of placement of reinforcement and connectors.
- .3 Do additional reinforcement of masonry as indicated.

3.2 Bonding and Tying

- .1 Bond walls of two or more wythes using metal connectors in accordance with NBC, CAN3-S304-M84 (R1997) (R1997), A371-94 and as indicated.
- .2 Tie masonry veneer to backing in accordance with NBC, CAN3-S304-M84 (R1997) (R1997), A371-94 and as indicated.

3.3 Reinforced Lintels and Bond Beams

- .1 Reinforce masonry lintels and bond beams as indicated.
- .2 Place and grout reinforcement in accordance with CAN3-S304-M84 (R1997) (R1997).

3.4 Grouting

- .1 Grout masonry in accordance with CAN3-S304-M84 (R1997) (R1997) and as indicated.

3.5 Metal Anchors

- .1 Do metal anchors as indicated.

3.6 Lateral Support and Anchorage

- .1 Do lateral support and anchorage in accordance with CAN3-S304-M84 (R1997) (R1997) and as indicated.

3.7 Control Joints

- .1 Terminate reinforcement 25 mm short of each side of control joints unless otherwise indicated.

3.8 Field Bending

- .1 Do not field bend reinforcement and connectors except where indicated or authorized by Consultant.
- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars and connectors which develop cracks or splits.

3.9 Field Touch-up

- .1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcement steel and connectors with compatible finish to provide continuous coating.

PART 1 - GENERAL

1.1 References

- .1 A165 Series-94 Series (CAN3-A165.1)-M85 CSA Standards on Concrete Masonry Units.

PART 2 - PRODUCTS

2.1 Materials

- .1 Standard concrete masonry units: to A165 Series-94 Series (CAN3-A165.1).
 - .1 Classification: H/15/A /M.
 - .2 Size: modular.
 - .3 Special shapes: provide bull- nosed units for exposed corners. Provide purpose-made shapes for lintels and bond beams. At window openings, provide solid bull-nose sill blocks laid on side. Provide additional special shapes as indicated. Provide solid blocks at first course above foundation and as indicated on structural drawings.
 - .4 Colour: standard grey.
- .2 Prefaced concrete block units: to A165 Series-94 Series (CAN3-A165.3). Ledge.
 - .1 Classification of body of unit: S/15/A/M to CAN3-A165.1.
 - .2 Size: modular.
 - .3 Special shapes: provide special shapes indicated. Provide purpose made shapes for bullnose block, lintels and bond beams.
 - .4 Colour: to match existing ledge block selected from manufacturer's standard range.

2.2 Acceptable Manufacturers

- .1 Products in accordance with this specification by only the following manufacturers will be accepted.
 - .1 Permacon
 - .2 Brampton Brick
 - .3 Richvale York
 - .4 Shouldice

PART 3 - EXECUTION

3.1 Laying Concrete Masonry Units

- .1 Bond: running bond for interior units.
- .2 Coursing height: 200 mm for one block and one joint.
- .3 Jointing: concave where exposed or where paint or other finish coating is specified.

3.2 Laying Pre-faced Concrete Masonry Units

- .1 Bond: running.
 - .1 Coursing height: 200 mm for one block and one joint.
 - .2 Jointing: provide concave joints.
 - .3 Clean block faces using soft cloths before mortar hardens rake to 10 mm depth. After completion of block laying fill joints with pointing mortar then point to provide concave joints. Repeat cleaning of faces.

3.3 Concrete Masonry Lintels

- .1 Install reinforced concrete block lintels over openings in masonry where steel or reinforced concrete lintels are not indicated.
- .2 End bearing: not less than 200 mm as indicated on drawings.

3.4 Corridor Bullnose Blocks With Ceramic Tile Base

- .1 At exterior concrete block corners with ceramic tile base, at first course provide square block with upper corner ground to single facet at 45 degree chamfer at corner.

3.5 Cleaning

- .1 Allow mortar droppings on unglazed concrete masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block and finally by brushing.

PART 1 - GENERAL

1.1 Related Work

- .1 Installation of Section 03300 anchors: Cast-in-Place Concrete
- .2 Installation of steel Section 04050 angle lintels: Masonry Procedures
- .3 Structural steel: Section 05120 Structural Steel
- .4 Metal joists: Section 05210 Steel Joists
- .5 Finish painting: Section 09900 Painting

1.2 Reference Standards

- .1 ASTM A 53/A 53M-02 53M-02, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- .2 ASTM A 269-02a, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- .3 ASTM A 307-02, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- .4 CAN/CGSB-1.40-M89, Primer, Structural Steel, Oil Alkyd Type.
- .5 CAN/CGSB-1.108-M89, Bituminous Solvent Type Paint.
- .6 CAN/CGSB-1.181-99, Ready-Mixed, Organic Zinc-Rich Coating.
- .7 CSA G40.21-98, Structural Quality Steels.
- .8 CAN/CSA-G164-M92 (R1998) (R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .9 CSA S16.01, Limit States Design of Steel Structures.
- .10 CSA W59-1989 (R2001) (R2001), Welded Steel Construction (Metal Arc Welding).

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300 - Submittals.
- .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

PART 2 - PRODUCTS

2.1 Materials

- .1 Steel sections and plates: to CSA G40.21-98, Grade 300W 350W.
- .2 Steel pipe: to ASTM A 53/A 53M-02 53M-02 extra strong, black finish.
- .3 Welding materials: to CSA W59-1989 (R2001) (R2001).
- .4 Welding electrodes: to CSA W48-01 Series.
- .5 Bolts and anchorbolts: to ASTM A 307-02.
- .6 Grout: non-shrink, non-metallic, flowable, 24h, MPa 15, pull-out strength 7.9 MPa.

2.2 Fabrication

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
- .2 Use self-tapping shake-proof oval headed screws on items requiring assembly by screws or as indicated.
- .3 Where possible, fit and shop assemble work, ready for erection.

- .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 Finishes

- .1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m² to CAN/CSA-G164-M92 (R1998) (R1998).
- .2 Chromium plating: chrome on steel with plating sequence of 0.009 mm thickness of copper 0.010 mm thickness of nickel and 0.0025 mm thickness of chromium.
- .3 Shop coat primer: to CAN/CGSB-1.40-M89.
- .4 Zinc primer: zinc rich, ready mix to CAN/CGSB-1.181-99.
- .5 Bituminous paint: to CAN/CGSB-1.108-M89.

2.4 Isolation Coating

- .1 Isolate aluminum from following components, by means of bituminous paint:
 - .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.

2.5 Shop Painting

- .1 Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.
- .2 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7°C.
- .3 Clean surfaces to be field welded; do not paint.

2.6 Angle Lintels

- .1 Steel angles: galvanized at exterior locations, prime painted at interior locations, sizes indicated for openings. Provide 150 mm minimum bearing at ends.
- .2 Weld or bolt back-to-back angles to profiles as indicated.
- .3 Finish: shop painted.

2.7 Pipe Balustrades

- .1 Construct balusters and handrails from steel pipe.
- .2 Cap and weld exposed ends of balusters and handrails.
- .3 Terminate at abutting wall with end flange.

2.8 Bar Balustrades

- .1 Construct bar balustrades as follows except as indicated otherwise on drawings:
 - .1 Balusters: 25 x 25 mm bar.
 - .2 Top rail: 2" dia. pipe.
 - .3 Bottom rail: 25 x 10 mm bar.
 - .4 Pickets: 1/2" dia. bar at 100 mm oc.
- .2 Fabricate supports for wood balustrade from 38 x 38 mm steel tubing with both ends capped and welded.
- .3 Weld balustrades to stringers as indicated.

2.9 Guards

- .1 Construct guards in accordance with drawings. Provide plates, anchors, brackets as required. Weld components.

2.10 Access Ladders

- .1 Stringers: 90 x 8mm thick, steel.
- .2 Steel Rungs: 20 mm diameter, welded to stringers at both sides each rung.
- .3 Brackets: sizes and shapes as indicated and as required, weld to stringers at 800 mm c.c., complete with fixing anchors.
- .4 Prime paint for interior.

2.11 Bench Brackets

- .1 Provide bench brackets to configuration as shown on drawings.

PART 3 - EXECUTION

3.1 Erection

- .1 Do welding work in accordance with CSA W59-1989 (R2001) (R2001) unless specified otherwise.
- .2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .3 Provide suitable means of anchorage acceptable to Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .4 Exposed fastening devices to match finish and be compatible with material through which they pass.
- .5 Provide components for building by other sections in accordance with shop drawings and schedule.
- .6 Make field connections with bolts to CSA S16.01, or weld.

- .7 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .8 Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

PART 1 - GENERAL

1.1 References

- .1 Canadian Standards Association (CSA)
 - .1 CSA B111-1974 (R1998) (R1998), Wire Nails, Spikes and Staples.
 - .2 CAN/CSA-G164-M92 (R1998) (R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CSA O121-M1978 (R1998) (R1998), Douglas Fir Plywood.
 - .4 CAN/CSA-O141-91 (R1999) (R1999), Softwood Lumber.
 - .5 CSA O151-M1978 (R1998) (R1998), Canadian Softwood Plywood.
 - .6 CAN/CSA-O325.0-92 (R1998) (R1998), Construction Sheathing.
- .2 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber 1991.

1.2 Quality Assurance

- .1 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: by grade mark in accordance with applicable CSA standards.
- .3 Plywood, OSB and wood based composite panel construction sheathing identification: by grademark in accordance with applicable CSA standards.

1.3 Waste Management and Disposal

- .1 Do not burn scrap at the project site.
- .2 Fold up metal banding, flatten, and place in designated area for recycling.

1.4 Source Quality

- .1 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: by grade mark in accordance with applicable CSA standards.

PART 2 - PRODUCTS

2.1 Lumber Material

- .1 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% or less in accordance with following standards:
 - .1 CAN/CSA-O141-91 (R1999) (R1999).
 - .2 NLGA Standard Grading Rules for Canadian Lumber, latest edition.
- .2 Machine stress-rated lumber is acceptable for all purposes.
- .3 Glued end-jointed (finger-jointed) lumber is not acceptable.
- .4 Framing and board lumber: in accordance with NBC 1985 Subsection 9.3.2.
- .5 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:
 - .1 Board sizes: "Standard" or better grade.
 - .2 Dimension sizes: "Standard" light framing or better grade.
 - .3 Post and timbers sizes: "Standard" or better grade.

2.2 Panel Standards

- .1 Panel standards: type, grade and thickness as indicated, in accordance with following standards:
 - .1 Douglas fir plywood (DFP): to CSA O121-M1978 (R1998) (R1998), standard construction.

- .2 Canadian softwood plywood (CSP): to CSA O151-M1978 (R1998) (R1998), standard construction.
- .3 Poplar plywood (PP): to CAN/CSA-O15-90 (R1999) (R1999), standard construction.
- .4 Interior mat-formed wood particleboard: to CAN3-0188.1.
- .5 Waferboard: to CAN3-0188.2.
- .6 Hardboard: to CAN/CGSB-11.3-M87.
- .7 Insulating fiberboard sheathing: to CAN/CSA-A247-M86 (R1996) (R1996).
- .8 Glass fibre board sheathing: non- structural, rigid, faced, fiberglass, insulating exterior sheathing board.
- .9 Poly-isocyanurate sheathing: to CGSB 51- GP-21M.
- .10 Expanded polystyrene sheathing: to CAN/CGSB-51.20-M87.
- .11 Gypsum sheathing: to CAN/CSA-A82.27-M91.

2.3 Panel Materials End Uses

- .1 Roof sheathing:
 - .1 Plywood, DFP or CSP sheathing grade or PP standard sheathing grade, T&G square edge, 16 mm thick.
- .2 Exterior wall sheathing:
 - .1 Plywood, DFP or CSP sheathing grade or PP standard sheathing grade, square edge, 16 mm thick.

2.4 Sheathing Paper

- .1 Exterior wall sheathing paper: to CAN/CGSB-51.32-M77 laminated type impregnated .

2.5 Dampproof Membrane

- .1 Polyethylene film: to CAN/CGSB-51.33-M89, Type 1, 0.15 mm thick.
- .2 Roll roofing: to CSA A123.2-M1979 (R2001) (R2001), Type S.

2.6 Adhesives

- .1 Subflooring adhesive: to CAN/CGSB-71.26-M88, cartridge loaded.

2.7 Fasteners

- .1 Nails, spikes and staples: to CSA B111-1974 (R1998) (R1998).
- .2 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
- .3 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.
- .4 Galvanizing: to CAN/CSA-G164-M92 (R1998) (R1998), use galvanized fasteners for exterior work, interior highly humid areas, pressure-preservative, fire-retardant treated lumber.
- .5 Joist hangers: minimum 1 mm thick sheet steel, galvanized ZF001 coating designation.
- .6 Nailing discs: flat caps, minimum 25 mm diameter, minimum 0.4 mm thick, sheet metal, fibre, formed to prevent dishing. Bell or cup shapes not acceptable.

2.8 Wood Preservative

- .1 Surface-applied wood preservative: clear, copper naphthenate or 5% pentachlorophenol solution, water repellent preservative. All lumber utilized at roof and exterior applications to be treated with wood preservative.
- .2 Pentachlorophenol use is restricted to building components that are in ground contact and subject to decay or insect attack only. Where used, pentachlorophenol-treated wood must be covered with two coats of an appropriate sealer.
- .3 Structures built with wood treated with pentachlorophenol and inorganic arsenicals must not be used for storing food nor should the wood come in contact with drinking water.

PART 3 - EXECUTION

3.1 Construction

- .1 Comply with requirements of the Ontario Building Code NBC 1985 Part 9 supplemented by following paragraphs.

3.2 Erection of Framing Members

- .1 Install members true to line, levels and elevations.
- .2 Construct continuous members from pieces of longest practical length.
- .3 Install spanning members with "crown-edge" up.
- .4 Use caution when working with particle board. Use dust collectors and high quality respirator masks.

3.3 Erection

- .1 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.

3.4 Defacement Marks

- .1 Install lumber and panel materials so that grade-marks and other defacing marks are not visible or are removed by sanding.

3.5 Wall Sheathing

- .1 Install wall sheathing in accordance with manufacturer's printed instructions.

3.6 Furring and Blocking

- .1 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding and other work as required.
- .2 Install furring to support siding applied vertically where there is no blocking and where sheathing is not suitable for direct nailing.
- .3 Align and plumb faces of furring and blocking to tolerance of 1:600.

3.7 Nailing Strips, Grounds and Rough Bucks

- .1 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.

3.8 Cants, Curbs, Fascia Backing

- .1 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.
- .2 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation for roof hopper.

3.9 Sleepers

- .1 Install sleepers as indicated.

3.10 Fasteners

- .1 Countersink bolts where necessary to provide clearance for other work.
- .2 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

3.11 Surface- Applied Wood Preservative

- .1 Treat surfaces of material with wood preservative, before installation.
- .2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.
- .3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.
- .4 Treat all material as follows:
 - .1 Wood cants, fascia backing, curbs, nailers, sleepers on roof deck.
 - .2 Wood furring for outside surface of exterior masonry concrete walls.
 - .3 Wood sleepers supporting wood subflooring over concrete slabs in contact with ground or fill.

3.12 Electrical Equipment Backboard

- .1 Provide backboards for mounting electrical equipment as indicated. Use 19 mm thick plywood on 19 x 38 mm furring around perimeter and at maximum 300 mm intermediate spacing.

PART 1 - GENERAL

1.1 Related Work

- .1 Laminated plastic Section 06240 work: Laminated plastic
- .2 Architectural Section 06400 woodwork: Architectural Woodwork
- .3 Supply of finishing Section 08710 hardware: Finish Hardware
- .4 Painting and Section 09900 finishing: Painting

1.2 References

- .1 CSA B111-1974 (R1998) (R1998) Wire Nails, Spikes and Staples.
- .2 CAN/CSA-G164-M92 (R1998) (R1998) Hot Dip Galvanizing of Irregularly Shaped Articles.
- .3 CSA O115-M1982(R2001) Hardwood and Decorative Plywood.
- .4 CSA O121-M1978 (R1998) (R1998) Douglas Fir Plywood.
- .5 CAN/CSA-O141-91 (R1999) (R1999) Softwood Lumber.
- .6 CSA O151-M1978 (R1998) (R1998) Canadian Softwood Plywood.
- .7 CSA O153-M1980 (R1998) (R1998) Poplar Plywood.
- .8 CAN3-O188.1-M78 Interior Mat-Formed Wood Particleboard.
- .9 CAN4-S104-M80(R1985) Fire Tests of Door Assemblies.
- .10 CAN4-S105-M85(R1992) Fire Door Frames.
- .11 CAN/CGSB-11.3-M87 Hardboard.
- .12 ANSI A208.1-1999 Particleboard, Matformed Wood.

- .13 AWMAC Quality Standards for Architectural Woodwork 1991.
- .14 National Lumber Grades Authority (NLGA) Standard Grading Rules for Canadian Lumber 1987.
- .15 National Hardwood Lumber Association (NHLA) Rules for the Measurement and Inspection of Hardwood and Cypress January 1986.

1.3 Reference Standards

- .1 Do finish carpentry to Millwork Standards of the Architectural Woodwork Manufacturers Association of Canada (AWMAC) 1998, except where specified otherwise.

1.4 Requirements of Regulatory Agencies

- .1 Wood fire rated frames and panels: listed and labelled by an organization accredited by Standards Council of Canada in conformance with CAN4-S104-M80 (R1985) and CAN4-S105-M85 (R1992) for ratings specified or indicated.

1.5 Samples

- .1 Submit samples in accordance with Section 01300 - Submittals.
- .2 Submit duplicate samples: sample size 300 x 300 mm or 400 mm long unless specified otherwise.

1.6 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300 - Submittals.
- .2 Indicate details of construction, profiles, jointing, fastening and other related details.
- .3 Indicate all materials, thicknesses, finishes and hardware.

1.7 Product Delivery, Storage and Handling

- .1 Protect materials against dampness during and after delivery.
- .2 Store materials in ventilated areas, protected from extreme changes of temperature or humidity.

PART 2 - PRODUCTS

2.1 Lumber Material

- .1 Softwood lumber: unless specified otherwise, S4S, moisture content 19% or less in accordance with following standards:
 - .1 CAN/CSA-O141-91 (R1999) (R1999).
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
 - .3 AWMAC premium grade, moisture content as specified.
- .2 Machine stress-rated lumber is acceptable for all purposes.
- .3 Hardwood lumber: moisture content 7% or less in accordance with following standards:
 - .1 National Hardwood Lumber Association (NHLA).
 - .2 AWMAC premium grade, moisture content as specified.

2.2 Panel Materials

- .1 Douglas fir plywood (DFP): to CSA O121-M1978 (R1998) (R1998), standard construction.
- .2 Canadian softwood plywood (CSP): to CSA O151-M1978 (R1998) (R1998), standard construction.
- .3 Hardwood plywood: to CSA O115-M1982 (R2001).
- .4 Poplar plywood (PP): to CSA O153-M1980 (R1998) (R1998), standard construction.

- .5 Interior mat-formed wood particleboard: to CAN3-0188.1.
- .6 Hardboard: to CAN/CGSB-11.3-M87.
- .7 Medium density fibreboard (MDF): to ANSI A208.2-1994, density 769 kg/m³.
- .8 Melamine overlaid panelboards:
 - .1 Melamine overlay, heat and pressure laminated with phenolic resin to thickness indicated mm thick particleboard core.
 - .2 Overlay bonded to both faces where exposed two sides, and when panel material require surface on one side only, reverse side to be overlaid with a plain (buff) balancing sheet.
 - .3 Furniture finish: matched wood grain pattern selected by Consultant.
 - .4 Edge finishing: matching melamine and polyester overlay edge strip with self-adhesive.

2.3 Fasteners

- .1 Nails and staples: to CSA B111-1974 (R1998) (R1998); galvanized to CAN/CSA-G164-M92 (R1998) for exterior work, interior humid areas and for treated lumber; plain finish elsewhere.
- .2 Wood screws: to CSA B35.4-72 electroplated steel, size and type to suit application.
- .3 Splines: metal.
- .4 Adhesive: as recommended by manufacturer.

2.4 Standing and Running Trim

- .1 Interior:
 - .1 Grade: Clear select.
 - .2 Solid stock: Maple species.
 - .3 Veneered stock: Maple veneer, clear select grade, quarter cut.

2.5 Shelving

- .1 Hardwood plywood:
 - .1 Thickness: 16mm.
 - .2 Number of plies: 5.
 - .3 Face veneer: Maple species, clear select grade, rotary cut.
 - .4 Back veneer: Maple species, clear select grade, rotary cut.
 - .5 Core: veneer.
 - .6 Bond: Type II.
 - .7 Sanding: regular sanding.
 - .8 Grain direction longitudinal.
- .2 Edge banding: provide 10mm thick solid matching wood strip on plywood edges 12 mm or thicker, exposed in final assembly. Strips same width as plywood .

PART 3 - EXECUTION

3.1 Workmanship

- .1 Do finish carpentry to Quality Standards of the Architectural Woodwork Manufacturers Association of Canada (AWMAC), except where specified otherwise.
- .2 Scribe and cut as required to fit abutting walls, and surfaces, to fit properly into recesses and to accommodate piping, columns, fixtures, outlets, or other projecting, intersecting or penetrating objects.
- .3 Form joints to conceal shrinkage.

3.2 Fastening

- .1 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.
- .2 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
- .3 Set finishing nails to receive filler. Where screws are used to secure members countersink screw in round cleanly cut hole and plug with wood

plug to match material being secured.

- .4 Replace items of finish carpentry with damage to wood surfaces including hammer and other bruises.

3.3 Standing and Running Trim

- .1 Butt and cope internal joints of baseboards to make snug, tight, joint. Cut right angle joints of casing and base with mitred joints.
- .2 Fit backs of baseboards and casing snugly to wall surfaces to eliminate cracks at junction of base and casing with walls.
- .3 Make joints in baseboard, where necessary using a 45° scarfe type joint.
- .4 Install door and window trim in single lengths without splicing.

3.4 Shelving

- .1 Install shelving on adjustable shelf brackets with recessed steel pilasters.

3.5 Hardware

- .1 Install hardware supplied under Section 08710 - Finish Hardware, coat hooks and closet rod brackets.

PART 1 - GENERAL

1.1 Samples

- .1 Submit samples in accordance with Section 01300 - Submittals.
- .2 Submit duplicate samples: sample size 600 x 600 mm or 600 mm long unless specified otherwise.
- .3 Submit duplicate colour samples of laminated plastic for colour selection.
- .4 Submit duplicate samples of laminated plastic joints, edging, cutouts and postformed profiles.
- .5 Submit samples of all casework hardware for approval.

1.2 Reference Standards

- .1 American National Standards Institute (ANSI)
 - .1 ANSI A208.2-1994 1986 , Medium Density Fiberboard for Interior Use.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM E 1333-96(2002) 90 , Standard Test Method for Determining Formaldehyde Levels From Wood Products Under Defined Test Conditions Using a Large Chamber.
- .3 Architectural Woodwork Manufacturers Association of Canada (AWMAC)
 - .1 AWMAC Architectural Woodwork Standards, latest edition and updates.
- .4 Canadian Standards Association (CSA)
 - .1 CAN3-A172-M79 (R1999) (R1999) M79 , High Pressure Paper Base, Decorative Laminates.
 - .2 CSA B111-1974 (R1998) (R1998) 1974 , Wire Nails, Spikes and Staples.

- .3 CSA 0115-M1982 (R2001) M1982 , Hardwood and Decorative Plywood.
- .4 CSA 0121-M1978 (R1998) (R1998) M1978 , Douglas Fir Plywood.
- .5 CAN/CSA-0141-91 (R1999) (R1999) 91 , Softwood Lumber.
- .6 CSA 0151-M1978 (R1998) (R1998) M1978 , Canadian Softwood Plywood.
- .7 CSA 0153-M1980 (R1998) (R1998) M1980 , Poplar Plywood.
- .8 CAN3-0188.1-M78 M78 , Interior Mat-Formed Wood Particleboard.
- .9 CAN/CGSB-11.3-M87 M87 , Hardboard.

- .5 National Hardwood Lumber Association (NHLA)
 - .1 Rules for the Measurement and Inspection of Hardwood and Cypress January 1996 .

- .6 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber 1991 .

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300 - Submittals.
- .2 Indicate details of construction, profiles, jointing, fastening and other related details.
 - .1 Scale: profiles full size, details 1/2 full size.
- .3 Indicate all materials, thicknesses, finishes and hardware.
- .4 Indicate locations of all service outlets in casework, typical and special installation conditions, and all connections, attachments, anchorage and location of exposed fastenings.

1.4 Product Delivery, Storage and Handling

- .1 Protect millwork against dampness during and after delivery.
- .2 Store millwork in ventilated areas, protected from extreme changes of temperature or humidity.

1.5 Guarantee

- .1 This architectural woodworker shall furnish the owner with a two (2) year AWMAC Guarantee Certificate, or an equivalent maintenance bond,

to the full value of the architectural woodwork sub-contract, certifying that the architectural woodwork has been manufactured and/or installed in accordance with the standards incorporated in the AWMAC Quality Standards manual (edition in effect at time of tender). Those providing the maintenance bond, instead of the Guarantee Certificate, to submit a letter from their insurer stating that they will provide the bond. A copy of this letter to be attached to their tenders. The Guarantee shall cover replacing and/or refinishing to make good any defects in architectural woodwork due to faulty workmanship or defective materials supplied by this architectural woodworker, which appear during a two (2) year period following the date of substantial completion of the project.

- .2 Recognized qualifications and/or proof of ability to comply with all applicable AWMAC guidelines and quality standards may be required for the Guarantee and Inspection service. Any associated costs shall be borne by the Contractor and included in the Contract Price.

PART 2 - PRODUCTS

2.1 Lumber Material

- .1 Softwood lumber: unless specified otherwise, S4S, moisture content 15% or less in accordance with following standards:
 - .1 CAN/CSA-O141-91 (R1999) (R1999).
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
 - .3 AWMAC premium grade, moisture content as specified.
- .2 Machine stress-rated lumber is acceptable for all purposes.
- .3 Hardwood lumber: moisture content 7% or less in accordance with following standards:
 - .1 National Hardwood Lumber Association (NHLA).
 - .2 AWMAC premium grade, moisture content as specified.

2.2 Panel Materials

- .1 Douglas fir plywood (DFP): to CSA O121-M1978 (R1998) (R1998), standard construction.

- .2 Canadian softwood plywood (CSP): to CSA O151-M1978 (R1998) (R1998), standard construction.
- .3 Hardwood plywood: to CSA O115-M1982 (R2001).
- .4 Poplar plywood (PP): to CSA O153-M1980 (R1998) (R1998), standard construction.
- .5 Interior mat-formed wood particleboard: to CAN3-0188.1.
- .6 Birch plywood: to AWMAC Natural.
- .7 Fibreboard must contain less than 10 % roundwood by weight, using a weighted average over a three month period at each manufacturing location. (Roundwood refers to logs, with bark, delivered to a pulp mill, cut in lengths up to 3 m).
- .8 Hardboard
 - .1 to CAN/CGSB-11.3-M87.
 - .2 manufactured such that formaldehyde emissions do not exceed 0.15 ppm (180 µg/m³) when tested in accordance with ASTM E 1333-96(2002).
 - .3 if manufactured using a wet process:
 - .1 be made by a process that does not release matter in the undiluted product plant effluent generating a BOD₅ in excess of 50 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment;
 - .2 be made by a process that does not release TSS in excess of 60 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment;
 - .4 contain at least 50 % recycled materials.
- .9 Medium density fibreboard (MDF): to ANSI A208.2-1994, density 769 kg/m³.
- .10 Medium density fibreboard must:
 - .1 meet the performance requirements of ANSI A208.2-1994.
 - .2 be manufactured such that formaldehyde emissions do not exceed 0.15 ppm (180 µg/m³) when tested in accordance with ASTM E 1333-96(2002).
 - .3 contain at least 15 % recycled materials by weight.
- .11 Melamine Panels: Pre-fabricated melamine faced particle board panels to ANSI A208.1-1999 Standards and ALA 1992, "Panval" by Uniboard Canada Inc., "Panolam" by Panolam Industries or "Flakeboard" by Flakeboard Company Ltd. as distributed by Wandarosa or McFaddens. At exposed edges provide 3mm polyvinylchloride in colour to match melamine face. Colours as selected by Consultant from manufacturer's complete range.

2.3 Fasteners

- .1 Nails and staples: to CSA B111-1974 (R1998) (R1998).
- .2 Wood screws: steel, type and size to suit application to CSA B35.4-72.

2.4 Sealants

- .1 Sealant: to Section 07900.

2.5 Casework

- .1 Fabricate caseworks to AWMAC premium quality grade.
- .2 Furring, blocking, nailing strips, grounds and rough bucks and sleepers.
 - .1 S2S is acceptable for non-visible locations.
 - .2 Board sizes: "Standard" or better grade.
 - .3 Dimension sizes: "Standard" light framing or better grade.
- .3 Framing spruce species, NLGA Clear select grade.
- .4 Case bodies (ends, divisions and bottoms).
 - .1 19mm melamine panels with continuous 3mm PVC strip at exposed edges.
- .5 Backs.
 - .1 6mm white hardboard except where visible ie. without doors or with glass panels in doors, 6mm melamine panels.
- .6 Shelving.
 - .1 19mm melamine panels with continuous 3mm PVC strip at exposed edges.

2.6 Drawers

- .1 Fabricate drawers to AWMAC premium grade supplemented as follows:

- .2 Sides and Backs.
 - .1 Softwood and poplar plywood DFP or CSP or PP G2S grade, square edge, 13 mm thick.
- .3 Bottoms.
 - .1 Softwood and poplar plywood DFP or CSP or PP G2S grade, square edge, 6 mm thick.
- .4 Fronts.
 - .1 19mm melamine panels with continuous 3mm PVC strips at exposed edges. Softwood plywood:

2.7 Casework Doors and Cupboard and Closet Gables

- .1 Fabricate doors to AWMAC premium grade supplemented as follows:
- .2 19mm melamine panels with continuous 3mm PVC strips at exposed edges.
- .3 At teacher's closets, 38mm melamine panels solid core: to CAN/CSA-0132.2.1 with continuous 3mm PVC strips at exposed edges.

2.8 Laminated Plastic Counter Tops and Splashbacks

- .1 Countertops and splashbacks and visible counter gables: one piece, factory laminated, self-edge type.
 - .1 Laminated plastic: General Purpose, Colour as selected by Consultant.
 - .2 Core: 19 Particle Board.
 - .3 Adhesive: waterproof as recommended by manufacturer.
 - .4 Draw bolts: nickel plated.

2.9 Hardware

- .1 Hinges: 91.275 x 195.710, 2 per door leaf minimum, spaced at 800mm maximum.
- .2 Door and drawer pulls: Stainless Steel "D" pulls, 220 x 3 1/2 - 32D. One per door and drawer.

- .3 Catches: Magnetic, 323A, one per door leaf.
- .4 Drawer slide: two-piece pre-painted steel with neoprene bearing rollers, each side, 230 x length to suit.
- .5 Drawer or door lock: Stainless steel, cylinder type with latch and receiving plate, key operated, 8138-26D-MK, one per drawer and door. Locks to be keyed alike per room and master keyed.
- .6 Adjustable shelving standards: recessed pilaster KV255 2 per side adjustable clips Richelieu Hardware Cat. No. 2432G, 4 per shelf. www.richelieu.com, tel#1-800-361-6000.
- .7 Closet rod: KV770 x 1 5/16" complete with flange KV764, one set per closet.
- .8 Coat Hooks: Canadian Builders Hardware CBH 61 brushed aluminum screwed to min. 2mm x 130mm steel plate with ground corners anchored to wall assembly.
- .9 Automatic door bolt: Richelieu LOCDL200 or LOCDL300 to suit.

2.10 Edge Banding

- .1 3mm solid PVC to match melamine panels. Strips same width as finished panel.

2.11 Fabrication

- .1 Set nails and countersink screws, apply stained wood filler to indentations, sand smooth and leave ready to receive finish.
- .2 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.
- .3 Shelving to cabinetwork to be adjustable unless otherwise noted.
- .4 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.
- .5 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.

2.12 Finishing

- .1 Factory stain finish according to AWMAC Part 5 Article 8.5.3.

2.13 Change Table

- .1 Kool and Galt model 077-G268 with panelled doors with pinch-free hinges, castors, and two adjustable shelves 0077-G245 ,15cm deep padded pan of seamless medical-grade vinyl covering foam cushion, automatically retracting steps, tilt-out diaper hamper, accessories shelf. 112cm x 57cm x 95cm H.

PART 3 - EXECUTION

3.1 Installation

- .1 Install prefinished millwork at locations shown on drawings. Position accurately, level, plumb straight.
- .2 Fasten and anchor millwork securely. Provide heavy duty fixture attachments for wall mounted cabinets.
- .3 Use draw bolts in countertop joints.
- .4 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.
- .5 At junction of plastic laminate counter back splash and adjacent wall finish, apply small bead of sealant.
- .6 Apply water resistant building paper or bituminous coating over wood framing members in contact with masonry or cementitious construction.
- .7 Fit hardware accurately and securely in accordance with manufacturer's directions.
- .8 Seal cut-outs at all penetrations through countertops.

- .9 Install chnage table in accordance with manufacturer's specifications.

3.2 Cleaning

- .1 Clean millwork and cabinet work inside cupboards and drawers and outside surfaces.

3.3 Protection

- .1 Protect millwork and cabinet work from damage until final inspection .

PART 1 - GENERAL

1.1 Related Work

- .1 Fire stopping and smoke seals within mechanical assemblies (i.e inside ducts, dampers) and electrical assemblies (i.e. inside cable trays) are specified in Division 15 and 16 respectively.

1.2 References

- .1 ULC-S115-M95, Standard Method of Fire Tests of Firestop Systems.

1.3 Samples

- .1 Submit samples in accordance with Section 01300 Submittals.

1.4 Shop Drawings

- .1 Submit shop drawings and product data in accordance with Section 1300-Submittals.
- .2 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.
- .3 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site. Include manufacturer's printed instructions for installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 Fire stopping and smoke seal systems: in accordance with ULC-S115-M95.
 - .1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC-S115-M95 and not to exceed opening sizes for which they are intended.
 - .2 Firestop system rating: to suit rating of penetrated assembly, minimum 1 hr.
- .2 Service penetration assemblies: certified by ULC in accordance with ULC-S115-M95 and listed in ULC Guide No. 40 U19.
- .3 Service penetration firestop components: certified by ULC in accordance with ULC-S115-M95 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.
- .4 Fire-resistance rating of installed fire stopping assembly not less than the fire-resistance rating of surrounding floor and wall assembly.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .10 Sealants for vertical joints: non-sagging.

PART 3 - EXECUTION

3.1 Preparation

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials. Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.2 Installation

- .1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to a neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

3.3 Inspection

- .1 Notify Consultant when ready for inspection and prior to concealing

or enclosing firestopping materials and service penetration assemblies.

3.4 Schedule

- .1 Firestop and smoke seal at:
 - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
 - .2 Top of fire-resistance rated masonry and gypsum board partitions.
 - .3 Intersection of fire-resistance rated masonry and gypsum board partitions.
 - .4 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
 - .5 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
 - .6 Openings and sleeves installed for future use through fire separations.
 - .7 Around mechanical and electrical assemblies penetrating fire separations.
 - .8 Rigid ducts: greater than 129 cm²: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

3.5 Clean Up

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application.
- .2 Remove temporary dams after initial set of fire stopping and smoke seal materials.

PART 1 - GENERAL

1.1 Summary

- .1 This Section specifies caulking and sealants not specified in other Sections.
- .2 Refer to other sections for other caulking and sealants.

1.2 References

- .1 CAN/CGSB-19.1-M87, Putty, Linseed Oil Type.
- .2 CAN/CGSB-19.2-M87, Glazing Compound, Nonhardening, Modified Oil Type.
- .3 CGSB 19-GP-5M, Sealing Compound, One Component, Acrylic Base, Solvent Curing.
- .4 CAN/CGSB-19.6-M87, Caulking Compound, Oil Base.
- .5 CAN/CGSB-19.13-M87, Sealing Compound, One-component, Elastomeric, Chemical Curing.
- .6 CGSB 19-GP-14M, Sealing Compound, One Component, Butyl-polyisobutylene Polymer Base, Solvent Curing.
- .7 CAN/CGSB-19.17-M90, One-Component Acrylic Emulsion Base Sealing Compound.
- .8 CAN/CGSB-19.18-M87, Sealing Compound, One Component, Silicone Base, Solvent Curing.
- .9 CAN/CGSB-19.20-M87, Cold-applied Sealing Compound, Aviation Fuel-resistant.
- .10 CAN/CGSB-19.21-M87, Sealing and Bedding Compound Acoustical.
- .11 CAN/CGSB-19.22-M89, Mildew Resistant, Sealing Compound for Tubs and Tiles.

- .12 CAN/CGSB-19.24-M90, Multi-component, Chemical Curing Sealing Compound.

1.3 Samples

- .1 Submit samples in accordance with Section 01300 - Submittals.
- .2 Submit duplicate samples of each type of material and colour. Colours to be as selected by Consultant from manufacturer's standard and premium colour range.

1.4 Delivery, Storage, and Handling

- .1 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture and water.

1.5 Environmental and Safety Requirements

- .1 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .2 For interior caulking work, ventilate areas as directed by Consultant.

1.6 Compatibility

- .1 Contractor together with manufacturer to recommend materials most appropriate for use intended and to assure compatibility of caulking materials with adjacent materials. Commencement of Work shall be deemed conformance with this Article.
- .2 Examine substrates prior to commencing work and report to Consultant deficiencies which may impede the work of this Section. Commencement of Work shall be deemed acceptance of substrate.

PART 2 - PRODUCTS

2.1 Sealant Materials

- .1 Sealants and caulking compounds must:
 - .1 meet or exceed all applicable governmental and industrial safety and performance standards; and
 - .2 be manufactured and transported in such a manner that all steps of the process, including the disposal of waste products arising therefrom, will meet the requirements of all applicable governmental acts, by laws and regulations including, for facilities located in Canada, the fisheries Act and the Canadian Environmental Protection Act (CEPA).
- .2 Sealant and caulking compounds must not be formulated or manufactured with: aromatic solvents, fibrous talc or asbestos, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium, barium or their compounds, except barium sulfate.
- .3 Sealant and caulking compounds must not contain a total of volatile organic compounds (VOCs) in excess of 5% by weight as calculated from records of the amounts of constituents used to make the product;
- .4 Sealant and caulking compounds must be accompanied by detailed instructions for proper application so as to minimize health concerns and maximize performance, and information describing proper disposal methods.
- .5 Caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant shall not be used in air handling units.
- .6 When low toxicity caulks are not possible, confine usage to areas which offgas to the exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off-gas time.
- .7 In the selection of the products and materials of this section preference will be given to those with the following characteristics: Water based, water soluble, water clean-up, non-flammable, Biodegradable , low Volatile Organic Compound (VOC) content, manufactured without compounds which contribute to ozone depletion in the upper atmosphere, manufactured without compounds which contribute to smog in the lower atmosphere, does not contain methylene chloride, does not contain chlorinated hydrocarbons.
- .8 The manufacturing process must adhere to Lifecycle Assessment Standards

as per CSA Z760-94 LCA Standards .

- .9 Sealants acceptable for use on this project except CAN/CGSB-19.1-M87 and CAN/CGSB-19.18-M87 must be listed on CGSB Qualified Products List issued by CGSB Qualification Board for Joint Sealants. Where sealants are qualified with primers use only these primers.

2.2 Sealant Material Designations

- .1 Sealants for vertical and horizontal non-traffic bearing joints, to Table 1, CGSB 19-GP-23:
 - .1 Normal temperature range, dry conditions, movement range to 25%: CGSB 19-GP-9Ma+Amd- Oct-80, CAN/CGSB-19.13-M87, CAN/CGSB-19.18-M87, Can2-19.24-M80.
 - .2 Normal temperature range, wet conditions, movement range to 25%: CAN/CGSB-19.13-M87, Can2-19.24-M80.
 - .3 Low temperature range, dry conditions, movement range to 25%: CGSB 19-GP-9Ma+Amd- Oct-80, CAN/CGSB-19.13-M87, CAN/CGSB-19.18-M87, Can2-19.24-M80.
 - .4 Low temperature range, wet conditions, movement range to 25%: CAN/CGSB-19.13-M87, Can2-19.24-M80.
- .2 Sealants in interior applications subject to high humidity and dampness to be silicone type with integral fungicide.

2.3 Back-up Materials

- .1 Polyethylene, Urethane, Neoprene or Vinyl Foam
 - .1 Extruded closed cell foam backer rod.
 - .2 Size: oversize 30 to 50%.
- .2 Neoprene or Butyl Rubber
 - .1 Round solid rod, Shore A hardness 70.
- .3 High Density Foam.
 - .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.
 - .2 Bond Breaker Tape.
 - .1 Polyethylene bond breaker tape which will not bond to sealant.

- .3 Ensure compatibility with sealants.

2.4 Sealant Selection

- .1 Use sealant as recommended by manufacturer for use intended. Submit sealant schedule to Consultant for review prior to commencement of work.

2.5 Joint Cleaner

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.
- .2 Primer: as recommended by manufacturer.

PART 3 - EXECUTION

3.1 Protection

- .1 Protect installed work of other trades from staining or contamination.

3.2 Preparation of Joint Surfaces

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair work.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.

- .4 Ensure joint surfaces are dry and frost free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

3.3 Priming

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 Backup Material

- .1 Apply bond breaker tape where required to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape.

3.5 Mixing

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 Application

- .1 Sealant.
 - .1 Apply sealant in accordance with manufacturer's instructions at all joints between dissimilar materials.
 - .2 Apply sealant in continuous beads.
 - .3 Apply sealant using gun with proper size nozzle.
 - .4 Use sufficient pressure to fill voids and joints solid.
 - .5 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .6 Tool exposed surfaces to give slightly concave shape.
 - .7 Remove excess compound promptly as work progresses and upon completion.

- .2 Curing.
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.
- .3 Cleanup.
 - .1 Clean adjacent surfaces immediately and leave work neat and clean.
 - .2 Remove excess and droppings, using recommended cleaners as work progresses.
 - .3 Remove masking tape after initial set of sealant.

PART 1 - GENERAL

1.1 Related Work

- .1 Building-in and Section 04050 grouting frames Masonry Procedures in masonry:
- .2 Building-in frames Section 06100 into wood stud 06101 walls: Rough Carpentry
- .3 Caulking of joints Section 07900 between frames and Sealants other building components:
- .4 Supply of finish Section 08710 hardware, including Finish Hardware weatherstripping and mounting heights:
- .5 Glazing: Section 08800 Glazing
- .6 Building-in frames Section 09111 into steel stud Metal Stud System walls:
- .7 Painting: Section 09900

1.2 References

- .1 American Society for Testing and Materials (ASTM).
 - .1 ASTM A 653/A 653M-02a 653M-02a, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM B 29-92(1997), Specification for Pig Lead.
 - .3 ASTM B 749-97, Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
 - .2 CGSB 41-GP-19Ma, Rigid Vinyl Extrusions for Windows and Doors.
 - .3 CAN/CGSB-51.20-M87, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

- .4 CGSB 51-GP-21M, Thermal Insulation, Urethane and Isocyanurate, Unfaced.
- .3 Canadian Standards Association (CSA).
 - .1 CSA A101-M1983, Thermal Insulation, Mineral Fibre, for Buildings.
 - .2 CSA G40.21-98, Structural Quality Steels.
 - .3 CSA W59-M1989 (R2001) (R2001), Welded Steel Construction (Metal Arc Welding).
- .4 Canadian Steel Door and Frame Manufacturers' Association, (CSDFMA).
 - .1 CSDFMA, Specifications for Commercial Steel Doors and Frames, 1990.
 - .2 CSDFMA, Recommended Selection and Usage Guide for Commercial Steel Doors, 1990.
- .5 National Fire Protection Association (NFPA).
 - .1 ANSI/NFPA 80-1998, Fire Doors and Windows.
 - .2 ANSI/NFPA 252-1999, Door Assemblies, Fire Tests of.
- .6 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN4-S104-M80 (R1985) M80 (R1985), Fire Tests of Door Assemblies.
 - .2 CAN4-S105-M85 (R1992), Fire Door Frames.

1.3 Design Requirements

- .1 Design exterior frame assembly to accommodate to expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.
- .2 Maximum deflection for exterior steel entrance screens under wind load of 1.2 kPa not to exceed 1/175th of span.

1.4 Requirements of Regulatory Agencies

- .1 Steel fire rated doors and frames: labelled and listed by an organization accredited by Standards Council of Canada in conformance with CAN4-S104-M80 (R1985) revised 1985 and CAN4-S105-M85 (R1992) for ratings specified or indicated.
- .2 Install labelled steel fire rated doors and frames to ANSI/NFPA 80-1998 except where specified otherwise.

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300 - Submittals.
- .2 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazed louvred, arrangement of hardware and fire rating.
- .3 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings and finishes.

PART 2 - PRODUCTS

2.1 Materials

- .1 Hot dipped galvanized steel sheet: to ASTM A 653/A 653M-02a 653M-02a, ZF75, minimum base steel thickness in accordance with CSDFMA Table 1 - Thickness for Component Parts.
- .2 Reinforcement channel: to CSA G40.21-98, Type 44W, coating designation to ASTM A 653/A 653M-02a 653M-02a, ZF75.
- .3 Composites: balance of core materials used in conjunction with lead: in accordance with manufacturers' proprietary design.

2.2 Door Core Materials

- .1 Stiffened: face sheets welded, vertically stiffened, uninsulated core.
 - .1 Polyurethane: to CGSB 51-GP-21M rigid, modified poly/isocyanurate, closed cell board. Density 32 kg/m³.
- .2 Temperature rise rated (TRR): core composition to limit temperature rise on unexposed side of door to 250°C at 30 60minutes. Core to be tested as part of a complete door assembly, in accordance with CAN4-S104-M80(R1985), ASTM E 152-81a or ANSI/NFPA 252-1999, covering Standard Method of Tests of Door Assemblies and listed by nationally recognized testing agency having factory inspection service.

- .3 Thermal insulation material must:
 - .1 not require being labelled as poisonous, corrosive, flammable or explosive under the Consumer Chemical and Container Regulations of the Hazardous Products Act;
 - .2 be manufactured using a process that uses chemical compounds with the minimum ozone depletion potential (ODP) available.
- .4 Board-type thermal insulation materials must:
 - .1 contain, when calculated on a 12-month rolling basis:
 - .1 over 35 % recycled material by weight of the finished product if made from glass fibre,
 - .2 over 45 % recycled material by weight of the finished product if made from mineral composition,
 - .3 over 10 % recycled material by weight of the finished product, if made from plastic.

2.3 Adhesives

- .1 Select Adhesives which:
 - .1 do not contain volatile organic compounds in excess of 5 % by weight as measured by EPA Method 24-24A, 40 C.F.R., Part 60, Appendix A (1991), Method 18,48 Federal Register 48, no. 202, October 18, 1983 Method 1400 NIOSH Manual of Analytical Methods, Volume 1, February 1984, Environmental Protection Agency Method 8240 GC/MS Method for Volatile Organics, September 1986, as demonstrated through calculation from records of the amounts of constituents used to make the product;
 - .2 are accompanied by detailed instructions for proper application so as to minimize health concerns and maximize performance;
 - .3 are accompanied by information describing proper disposal methods for containers.
- .2 Steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
- .3 Polystyrene and polyurethane cores: heat resistant, epoxy resin based, low viscosity, contact cement.
- .4 Lock-seam doors: fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

2.4 Primers

- .1 Touch-up prime CAN/CGSB-1.181-99.

2.5 Accessories

- .1 Door silencers: single stud rubber/neoprene type GJ-64.
- .2 Exterior and interior top and bottom caps: rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19Ma steel.
- .3 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.
- .4 Door bottom seal.
- .5 Metallic paste filler: to manufacturer's standard.
- .6 Fire labels: metal riveted.
- .7 Sealant: in accordance with Section 07900.
- .8 Glazing: in accordance with Section 08800.
- .9 Make provisions for glazing as indicated and provide necessary glazing stops.
 - .1 Provide removable stainless steel glazing beads for use with glazing tapes and compounds and secured with countersunk stainless steel screws or dry glazing of snap-on type.
 - .2 Design exterior glazing stops to be tamperproof.

2.6 Frames Fabrication General

- .1 Fabricate frames in accordance with CSDFMA specifications.
- .2 Fabricate frames to profiles and maximum face sizes as indicated and to suit wall conditions. Frame depths to cover masonry cavities where applicable. All exposed corner blocks are bullnosed. Generally, for 150 concrete block walls, throat size to cap block. For cavity walls, frame depth to be minimum 178mm with fasteners to suit anchorage into masonry veneer and back-up block.

- .3 Exterior frames: 1.6 mm welded thermally broken type construction.
- .4 Interior frames: 1.6 mm welded knocked-down type construction.
- .5 Blank, reinforce, drill and tap frames for mortised, templated hardware, and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.
- .6 Protect mortised cutouts with steel guard boxes except for gypsum board installations.
- .7 Prepare frame for door silencers, 3 for single door, 2 at head for double door.
- .8 Manufacturer's nameplates on frames and screens are not permitted.
- .9 Conceal fastenings except where exposed fastenings are indicated.
- .10 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.
- .11 Insulate exterior frame components with polyurethane insulation.
- .12 Steel frames to exterior and interior openings 1200 mm or less in unsupported width 1.52 mm base thickness.
 - .1 Steel frames exterior and interior openings over 1200 mm in unsupported width 1.52 mm base thickness. Reinforce head with framed steel reinforcing channel for full width. Reinforce for all hardware.

2.7 Frame Anchorage

- .1 Provide appropriate anchorage to floor and wall construction.
- .2 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.
- .3 Provide 2 anchors for rebate opening heights up to 1520 mm and 1 additional anchor for each additional 760 mm of height or fraction thereof.
- .4 Locate anchors for frames in existing openings not more than 150 mm from top and bottom of each jambs and intermediate at 660 mm o.c. maximum.
- .5 At masonry cavity walls, use galvanized offset T-anchors set into concrete block wythe.

2.8 Frames: Welded Type

- .1 Welding in accordance with CSA W59-1989 (R2001) (R2001).
- .2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.
- .3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.
- .4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.
- .5 Securely attach floor anchors to inside of each jamb profile.
- .6 Weld in 2 temporary jamb spreaders per frame to maintain proper alignment during shipment.
- .7 Securely attach lead to inside of frame profile from return to jamb soffit (inclusive) on door side of frame only.

2.9 Door Fabrication General

- .1 Doors: swing type, vertically stiffened, flush, with provision for glass and/or louvre openings as indicated.
- .2 Exterior doors: hollow steel construction. Interior doors: hollow steel construction.
- .3 Fabricate doors with longitudinal edges fully welded. Seams: grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.
- .4 Doors: manufacturers' proprietary construction, tested and/or engineered as part of a fully operable assembly, including door, frame, gasketing and hardware in accordance with ASTM E 330-02.
- .5 Blank, reinforce, drill doors and tap for mortised, templated hardware and electronic hardware.
- .6 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, on site, at time of hardware installation.

- .7 Reinforce doors where required, for surface mounted hardware.
- .8 Provide flush steel top caps to exterior doors. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.
- .9 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.
- .10 Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in strict conformance with CAN4-S104-M80(R1985), ASTM E 152-81a or ANSI/NFPA 252-1999 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
- .11 Manufacturer's nameplates on doors are not permitted.
- .12 Bevel lock and hinge edges 3mm in 50mm unless builder's hardware or door swing dictates otherwise.
- .13 Fabricate door faces without visible seams, free of scale, pitting, coil brakes, buckles and waves. Formed edges shall be true and straight with a minimum radius for the thickness of steel used.
- .14 Top and bottom of doors shall be provided with inverted, recessed, 16 ga. steel end channels, welded to each face sheet at 150mm o.c. minimum.

2.10 Hollow Steel Construction

- .1 Form each face sheet for exterior doors from 1.6 mm sheet steel.
- .2 Form each face sheet for interior doors from 1.2 sheet steel.
- .3 Reinforce doors with vertical stiffeners, securely welded to each face sheet at 150 mm on centre maximum.
- .4 Fill voids between stiffeners of exterior doors with polyurethane core.
- .5 Fill voids between stiffeners of interior doors with temperature rise rated core.

2.11 Thermally Broken Doors and Frames

- .1 Fabricate thermally broken doors by using insulated core and separating exterior parts from interior parts with continuous interlocking thermal break.
- .2 Thermal break: rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19Ma.
- .3 Fabricate thermally broken frames separating exterior parts from interior parts with continuous interlocking thermal break.
- .4 Apply insulation.

PART 3 - EXECUTION

3.1 Installation General

- .1 Install in accordance with National Fire Codes, Volume 4, produced by National Fire Protection Association (ANSI/NFPA 80-1998).
- .2 Install doors and frames to CSDFMA Installation Guide.

3.2 Door Installation

- .1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08710 - Finish Hardware.
- .2 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.
 - .1 Hinge side: 1.0 mm.
 - .2 Latchside and head: 1.5 mm.
 - .3 Finished floor, top of carpet noncombustible sill and thresholds: 13 mm.
- .3 Adjust operable parts for correct function.
- .4 Install louvres.

3.3 Frame Installation

- .1 Set frames plumb, square, level and at correct elevation.
- .2 Secure anchorages and connections to adjacent construction.
- .3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.
- .4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- .5 Caulk perimeter of frames between frame and adjacent material.
- .6 Maintain continuity of air barrier and vapour retarder.

3.4 Finish Repairs

- .1 Touch up with primer galvanized finish damaged during installation.
- .2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish.

3.5 Glazing

- .1 Install glazing for doors and frames in accordance with Section 08800 - Glazing.

PART 1 - GENERAL

1.1 References

- .1 CAN3-A172-M79 High Pressure Paper Base, Decorative Laminates.
- .2 CSA O112.4-M1977 Polyvinyl Adhesives for Wood.
- .3 CSA O112.5-M1977 Urea Resin Adhesives for Wood (Room and High Temperature Curing).
- .4 CSA O112.7-M1977 Resorcinol and Phenol-Resorcinol Resin Adhesives for wood (Room and Intermediate Temperature Curing).
- .5 CSA O115-M1982 Hardwood and Decorative Plywood.
- .6 CAN/CSA-O132.2 Series-90 Series-90 Series-90 Wood Flush Doors.
- .7 CAN/CGSB-71.19-M88 Adhesive, Contact, Sprayable.
- .8 CAN/CGSB-71.20-M88 Adhesive, Contact, Brushable.

1.2 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01001 - Submittals.
- .2 Indicate door types and cutouts for lights and louvres.

1.3 Regulatory Requirements

- .1 Fire-resistance rated for wood doors: ULC labelled as required.

1.4 Protection

- .1 Protect doors from dampness. Arrange for delivery after work causing abnormal humidity has been completed.

.2 Store doors in well ventilated room, off floor, in accordance with manufacturer's recommendations.

.3 Protect doors from scratches, handling marks and other damage.

1.5 Extended Warranty

.1 Submit warranty for one year beyond the expiration of the warranty period specified in the General Conditions to the Contract, and in any case not less than 2 years.

.2 Defects in doors shall include, but not be restricted to surface blemishes, showing of core ghost lines, splitting, delamination, sagging, deterioration of core, and warping and twisting in excess of deformation allowed by CSA Standard 0132.2.

.3 Replacement under the warranty shall include fitting, installation, reinstallation of hardware, grilles and glass and finishing to match replaced door.

PART 2 - PRODUCTS

2.1 Wood Flush Doors

.1 Solid core: to CAN/CSA-0132.2.1.

.1 Construction:

.1 Solid particleboard core: stile and rail frame bonded to particleboard core with wood lock blocks.

.2 Solid wood core:

- .1 Glued block core with wood edge band.
- .2 Framed block glued core.
- .3 Framed block nonglued core.
- .4 Stile and rail core.

.3 Solid, wood block, lined core: with two core liners:

- .1 Glued block with wood edge band.
- .2 Framed block glued core.
- .3 Framed block nonglued core.
- .4 Stile and rail core.

.2 Face Panels:

- .1 Hardwood; veneer grades: Grade I (Premium), Maple Species.
- .2 Hardboard: composition face

.3 Adhesive: Type I (waterproof)

2.2 Fabrication

- .1 Vertical edge strips to match face.
- .2 Prepare doors for louvres and glass and provide pre-finished metal glazing stops and stickings with mitred corners finished to match door facings.
- .3 Bevel vertical edges of single acting doors 3 mm in 50 mm on lock side and 1.5 mm in 50 mm on hinge side.
- .4 Radius vertical edges of double acting doors to 60 mm radius.
- .5 Provide waterproof non-staining membrane at cutouts on exterior doors to exclude moisture from core.

PART 3 - EXECUTION

3.1 Installation

- .1 Install doors and hardware in accordance with manufacturer's printed instructions.
- .2 Adjust hardware for correct function.
- .3 Install louvres and stops.
- .4 Secure transom and side panels by means of stops.

3.2 Adjustment

- .1 Re-adjust doors and hardware just prior to completion of building to function freely and properly.

SECTION 08710 FINISHING HARDWARE

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with requirements listed in Division 1

1.2 WORK INCLUDED

- .1 Supply finishing hardware as listed in the hardware schedule. Refer to Door Hardware list prepared by Commercial Doors and Hardware Ltd.

1.3 QUALITY ASSURANCE

- .1 Meet all requirements of the local building code and all other applicable regulations.
- .2 Products listed in Part 2 of this specification establish the minimum requirements for this project. Alternate products must be applied for and approved in writing prior to tender closing. Deviation from specified products will require the supply and installation of correct products, any/all associated costs.
- .3 Qualified suppliers must have in their employ a Certified A.H.C. (Architectural Hardware Consultant), licensed by the Door and Hardware Institute. The supplier must have a minimum of five (5) years experience furnishing hardware for similar projects. It is the responsibility of the successful bidder to review the hardware schedule, the door and frame schedule and details, both to familiarize themselves with the scope of work and ensure product compatibility. Failure to report discrepancies, prior to tender closing, assures the owners/architect and consultant that these documents have been reviewed and are satisfactory to the bidder.
- .4 Inspection of supplied Finishing Hardware will be done by a Certified A.H.C. A complete Site Inspection Report will be issued to the Architect.
- .5 Acceptable bidders Commercial doors and Hardware Ltd.
Upper Canada Hardware
Trillium Architectural Hardware.
Great lakes Door and Hardware.

1.4 SUBMITTALS

- .1 Upon request provide mounted samples of hardware items to be supplied.
- .2 Prepare and submit two (3) copies of a detailed hardware schedule listing product Numbers, size and finishes. Include two (2) sets of catalog cuts.
- .3 Furnish other sections with two (2) complete sets of hardware templates for Related fabricating and installation.
- .4 Submit for owner review and comments two (2) key schedules listing the door number, hardware heading or item, and the key group.

- .5 Where electrical hardware is supplied, provide wiring diagrams showing all wire termination points. Where electrical hardware is supplied and installed provide the contractor with riser diagrams listing the correct wire runs and back box sizes as well as 115 VAC requirements.
- .6 Where required in Division 1, provide two (2) operating manuals for the owners use. Include copies of the hardware schedule, templates, installation instructions and all maintenance data.

1.5 PRODUCT DELIVERY, HANDLING, AND STORAGE

- .1 Deliver each hardware item in its original package complete with all fasteners, keys, templates, and installation instructions required for installation.
- .2 Clearly mark each container with the door opening number and the hardware schedule item or heading number.
- .3 The contractor must store hardware delivered in a secure area. The storage area must contain adequate shelf space to hold all the hardware off the floor. Ensure the area is kept dry and clean.
- .4 When requested, package items of hardware separately for delivery to other Fabricators for their installation.

1.6 WARRANTY

- .1 Provide a written warranty for a period as follows:
 - Five (5) years on Cylindrical Lever sets.
 - Five (5) years on Exit Devices.
 - Twenty (20) years on Door Closers.
 - One (2) year on Electronic Products.
 - One (1) year on balance of products.
- .2 When requested provide extended warranties listed in Division 1.

PART 2 PRODUCTS

2.1 BUTT HINGES

- .1 All butt type hinges will be Ball bearing type.
- .2 Exterior out swing door hinges must be non-ferrous and have non-removable pins (NRP).
- .3 Where the door width exceeds 3'0" (950mm) supply 5" (127) high hinges.
- .4 Supply two (2) hinges for doors up to 5'0" (1525 mm) high and an additional hinge for each 2'5" (760 mm) or fraction thereof in door height.
- .5 Approved products:

ACCEPTABLE MANUFACTURERS	ITEM	ITEM	ITEM
MCKINNEY	T4A 3786	T4A 3386	TA 2714
STANLEY	FBF168	FBF199	FBF179

2.1.1 .8 CONTINUOUS HINGES:

ACCEPTABLE MANUFACTURERS	ITEM	ITEM
MARKAR	FM100 SERIES	
MCKINNEY	MCK12-HD	
IVES	112HD	

.1 Interior: 628 finish.2 Exterior: 628 finish

2.2 LOCKS AND LATCHSETS

- .1 Locks and latch sets are to be cylindrical, full feature, freewheeling, and ANSI Grade 1 lever sets.
- .2 Lever trim must have concealed through bolt mounting. The lever is to be solid cast with a return to the door face. The back plates (rosettes) are to be cold forged brass or bronze in the finish listed.
- .3 Provide $\frac{3}{4}$ " latch throw for pairs of labeled doors.
- .4 Approved products:

ACCEPTABLE MANUFACTURERS	ITEM	ITEM	ITEM	ITEM	ITEM	ITEM
SCHLAGE	ND53	ND60	ND70	ND73	ND80	ND81

2.3 CYLINDERS and KEYING

- .1 Exterior locks and cylinders shall be keyed to a new LFIC Sargent GMK system , to the owners requirements.
- .2 All Interior locks and cylinders shall be GMK to a new factory registered system.
- .3 Cylinders supplied to site must have a construction core cylinder. Permanent Master keyed cores keyed to owners requirements are to be shipped to site as directed by the owner.
- .4 All locks and cylinders shall be keyed to the owners requirements. Provide a Keying schedule for approval.
- .5 Include the following with the key system:

-All keys should be stamped with key code

2.4 EXIT DEVICES

- .1 All exit devices will be low profile push pad style devices. Outside trim will have the same trim design as the locksets. Exit hardware must have the correct life safety or fire rated labels attached to the active case. Ensure that the actuating push pad covers 1/2 of the door opening.
- .2 Interior doors requiring exit devices are to be equipped with standard Pullman deadlatching latchbolts, accident hazard or fire labeled as necessary.
- .3 Provide alarm exit devices where noted at exterior doors. Alarm exit devices are to be supplied with a cylinder operated on/off switch and decal warning of alarmed door.
- .4 Equip exterior aluminum door exit devices with necessary fasteners and features included where thermally broken doors are specified.
- .5 Approve products:

ACCEPTABLE MANUFACTURERS	ITEM	ITEM	ITEM
SARGENT	8800 SERIES 630	8843 ETL 630	8515 ETL 630
VON DUPRIN	98 SERIES 630	98L 630	98L-BE 630

2.5 ELECTRIC STRIKES

- .1 Furnish Electric Strikes to exceed ANSI/BHMA A156.5, and listed by Underwriters Laboratories where required. Electric Strikes are to be manufactured from investment casting and stainless steel for durability and corrosion resistance. Furnish strikes with appropriate latch bolt keepers, monitors as listed in the schedule.
- .2 It is the responsibility of the finishing hardware supplier to provide Riser Diagrams, Point-to-Point Diagrams and method of operation notes for each of the openings utilizing these products.
- .3 Approved products:

ACCEPTABLE MANUFACTURERS	ITEM	ITEM	ITEM
HES	9500 SERIES LBM 630	9600 SEIES 630	1006 SERIES 630
VON DUPRIN	6300 SERIES LBM 630	6300 SERIES 630	6200 SERIES 630

2.6 DOOR CLOSERS

- .1 Door closers will all have full adjustment features including back check, general speed, and latch speed control.
- .2 All interior door closers will have reduced opening force spring power to meet the barrier free codes of 22N (5 lbs.)
- .3 Surface mounted door closers are to be located on the room side of the door whenever possible or as directed by the architect.
- .4 Where listed, door closers are to have full body covers to match the project finishes. Installation instructions must be inside all door closer covers.
- .5 Template closers to permit full shock absorber action.
- .6 Approved products.

ACCEPTABLE MANUFACTURER	ITEM	ITEM	ITEM
NORTON	R8501 689	7500 SERIES	CLP 7500
SARGENT	1430 SERIES 689	350 SERIES 689	350 PS

- arms.
- .1 Where required, out swinging doors and interior doors shall have closers with parallel
 - .2 Back-checking feature shall be of a proper size to operate the door efficiently.
 - .3 All closers shall be complete with full cover of same design and manufacturer.
 - .4 All interior closers shall be reduced-force type.
 - .5 All interior doors for barrier-free use shall be delayed action and reduced-force type, meeting OBC requirements.
 - .6 Mount closers on interior room side of doors.
 - .7 All door closers shall be mounted with through-bolts.

2.7 DOOR OPERATORS

- .1 Electro-mechanical operator, powered by 1/4 hp motor. Completely assembled and sealed unit which includes helical gear drive transmission and interconnected rack and gear system for compression of exterior replaceable heavy duty spiral spring, all contained within a die cast aluminum housing and filled with special lubricant for extreme temperature conditions.
- .2 Drive shaft is minimum 15/16" (24mm) thick containing 14 tooth splines to maximize bearing surface contact with drive arm assembly to eliminate slippage.
- .3 Interfaced with the transmission system is a DC shunt-wound permanent magnet motor with sealed ball bearings. System operates from 120 VAC-60 cycle-1 phase power supply. Operator is mounted in the header case housing using vibration isolators to maintain quiet operation.
- .4 Approved product.

ACCEPTABLE MANUFACTURERS	ITEM	1ITEM
GYRO-TECH or approved equal	8700 CLEAR ALUM	HD GT 8500

- All Actuators/ visual indicators supplied in French Language.
- Operators Supplied and installed by this section Finishing Hardware 08710.

2.8 PULLS AND PLATES

- .1 Supply door trim as listed in the hardware schedule. Pulls are supplied with back to back (BTB) or through bolt mounting as required. When push plates are listed with door pulls, install the push plate to conceal the through bolt. Verify all heights of full length door pulls prior to ordering. Co-ordinate heights with related door hardware products.
- .2 All kickplates, push plates, and bumper plates must have beveled sides and corners rounded to ensure there are no sharp edges. Supply plates with counter sunk screw holes. The plates will be .050 gauge. Size to suit door width. Supply stainless steel type 315 as listed.
- .3 All exterior door pulls shall be specified as the hospital pull type.

ACCEPTABLE MANUFACTURERS	ITEM	ITEM	ITEM
CBH	7109-1	CBH 353 TB	7130-1
GALLERY	1181-2	2616H MOD TB	4212-2
STANDARD METAL	3112-2	H12 TB	2112-2

2.9 DOOR STOPS AND HOLDERS

- .1 Wall stops are only to be used on proper wall conditions such as block or masonry. Supply floor stops with sufficient height to suite the floor condition or undercut of doors.
- .2 Overhead stops and holders will be surface mounted unless there is a conflict with door closers or other hardware. Provide door stays with friction action in locations that do not have door closers. Install all overhead stops and holders for 90 DEG stop unless otherwise specified.
- .3 Electronic door holder will be supplied to suit the specified voltage and be connected to the fire alarm system to release the door when signaled.
- .4 Approved Manufacturers:

ACCEPTABLE MANUFACTURERS	ITEM	ITEM	ITEM
RIXSON	1 SERIES	9 SERIES	FM 998 TRIVOLT
GLYN JOHNSON	100 SERIES	90 SERIES	SEM7830
DORMA	1020 SERIES	9020 SERIES	2100 TRIVOLT

2.10 DOOR SEALS

- .1 Perimeter seals must be supplied to fully cover all gaps between the door, frame, and floor condition to seal against weather, sound, or smoke.
- .2 Frame gasketing must be closed cell neoprene. Extruded housing must have a rib to prevent distortion during installation. Aluminum frames will be equipped with felt inserts by the frame supplier.
- .3 Door bottoms will be heavy duty and have an adjustment screw to ensure proper contact with the floor. Supply the correct drop insert for carpet where required.
- .4 Thresholds must be installed to ensure the door bottom makes full contact. Supply thermally broken thresholds for all exterior door openings.
- .5 Approved products:
 1. KN CROWDER MFTG.
 2. PEMKO MFTG.
 3. ZERO MFTG .

2.11 FASTENINGS

- .1 Supply screws, bolts, expansion shields and other fastening devices required for the Satisfactory installation and operation of hardware, and as recommended by the Hardware manufacturers for long life under hard use.
- .2 Exposed screws for installing hardware shall have Phillips or Robertson heads.
- .3 Where a door pull is scheduled on one side of door and a push plate on the other side,
fastening devices, and install so the pull can be secured through the door from the reverse side. Install push plate to cover fasteners.
- .4 Exposed fastening devices shall match the finish and material of hardware.

PART 3 EXECUTION

3.1 INSPECTION

- .1 The hardware supplier must inspect all the door openings to ensure that installation is complete and that all items are operating as intended. When requested, provide a written report on all site inspections made.

3.2 INSTALLATION

- .1 The installer shall obtain a copy of ANSI/DHI A115.1G-94, **"Installation Guide for Doors and Hardware"**. It is the intent of this document to be used as a reference guide in the proper handling, storage, and installation of finishing hardware, and doors and frames. This document can be obtained through the Door and Hardware Institute.
- .2 Installers of hardware must follow all manufacturer's instructions including door closer adjustment, handing of locksets as required, and degree of door swing. Advise the consultants if door frames are not square and plumb and prevent proper door installation.
- .3 All finishing hardware and electronic hardware are to be bid as a supply and install package.

Testing and verification of all electronic products and systems is the responsibility of this division.

- .4 Mount hardware to suit door elevations. Unless otherwise directed by the consultant, install hardware at the following mounting heights:

Locksets	40"	(1015mm)
Exit device	40"	(1015mm)
Push/Pull	42"	(1065mm)
Deadlock	48"	(1200mm)

- .5 When requested, the hardware supplier will instruct the installer on installation of newer or unusual.

3.3 HARDWARE SCHEDULE

- .1 See attached hardware list.

END OF SECTION

PART 1 - GENERAL

1.1 References

- .1 ASTM E 330-02 Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
- .2 ASTM C 542-94(1999) Specification for Lock-Strip Gaskets.
- .3 ASTM D 790-02 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- .4 ASTM D 1003-00 Test Method for Haze and Luminous Transmittance of Plastics.
- .5 ASTM D 1929-96(2001)e1e1 Test Method for Ignition Properties of Plastics.
- .6 ASTM D 2240-02b Test Method for Rubber Property - Durometer Hardness.
- .7 ASTM E 84-01 Test Method for Surface Burning Characteristics of Building Materials.
- .8 ASTM F 1233-98 Test Method for Security Glazing Materials and Systems.
- .9 CAN/CGSB-12.1-M90 Tempered or Laminated Safety Glass.
- .10 CAN/CGSB-12.2-M91 Flat, Clear Sheet Glass.
- .11 CAN/CGSB-12.3-M91 Flat, Clear Float Glass.
- .12 CAN/CGSB-12.4-M91 Heat Absorbing Glass.
- .13 CAN/CGSB-12.5-M86 Mirrors, Silvered.
- .14 CAN/CGSB-12.8-M97 Insulating Glass Units.
- .15 CAN/CGSB-12.10-M76 Glass, Light and Heat Reflecting.
- .16 CAN/CGSB-12.11-M90 Wired Safety Glass.
- .17 CAN/CGSB-12.12-M90 Plastic Safety Glazing.

.18 Flat Glass Manufacturers Association (FGMA) Glazing Manual.

.19 Laminators Safety Glass Association Standards Manual.

1.2 Performance Requirements

.1 Provide continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:

.1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.

.2 Size glass to withstand wind loads, dead loads and positive and negative live loads acting normal to plane of glass to a design pressure applicable to locale as measured in accordance with ASTM E 330-02.

.3 Limit glass deflection to lesser of 1/200 or flexural limit of glass with full recovery of glazing materials.

.4 Provide fire rated labelled glass in accordance with tested assemblies recognized by authorities having jurisdiction to achieve specified fire resistance ratings for intended application.

1.3 Samples

.1 Submit samples in accordance with Section 01300.

.2 Submit duplicate 12" size samples of mullions and sealant material.

1.4 Closeout Submittals

.1 Provide maintenance data including cleaning instructions for incorporation into manual specified in Section 01730.

1.5 Quality Assurance

.1 Perform work in accordance with FGMA Glazing Manual IGMAC and Laminators

Safety Glass Association - Standards Manual for glazing installation methods.

- .2 Maintain one copy of each standard document on site.
- .3 Provide testing and analysis of glass under provisions of Section 01450.
- .4 Provide shop inspection and testing for glass.

1.6 Environmental Requirements

- .1 Install glazing when ambient temperature is 10°C minimum. Maintain ventilated environment for 24 hours after application.
- .2 Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

PART 2 - PRODUCTS

2.1 Glass Materials

- .1 Tempered safety glass to CAN/CGSB-12.1-M90, Type 2, Class A of thickness indicated.
- .2 Laminated safety glass to CAN/CGSB-12.1-M90, Type 1, Class A minimum 6mm or thickness as indicated.
- .3 Float glass: to CAN/CGSB-12.3-M91, glazing quality.
- .4 Mirrors silvered, glass: to CAN/CGSB-12.5-M86, silvered, Type 1A 6 mm thick, ground and polished edges framed with stainless steel edging and supported with concealed tamperproof fasteners and adhesive of sizes indicated.
- .5 Insulating glass units:
 - .1 CAN/CGSB-12.8-M97, with outer pane of 6 mm thick clear laminated glass with 25 mm total thickness, Low E coating on #2 surface and inner pane of 6 mm thick tempered safety glass.
 - .1 Outerboard Lite: Guardian CrystalGray Glass or equal. a) Coating on Surface No.2: SN 68 #2 Clear 1" IGU.
 - .2 Air Space: 12 mm (1/2 inch) wide, hermetically sealed,

dehydrated air space.

- .3 Inboard Lite: Guardian Clear Glass or equal.
- .4 Glass Unit Performance Characteristics: a) Visible Light Transmittance: 68 percent b) Visible Light Reflectance Outdoors: 11 percent c) Ultraviolet Transmittance: 30 percent d) Winter U-Value Nighttime: 0.245 e) Summer U-Value Daytime: 0.22 f) Solar Heat Gain Coefficient: 0.34 g) Light to Solar Gain: 1.82
- .5 Edge Seals: ASTM E 2188, with aluminum spacers, dual-sealed with a primary seal of polyisobutylene and a secondary seal of silicone sealant for glass-to-spacer seals.
- .6 Sealant: Approved by glass manufacturer.

.6 Wired glass: to CAN/CGSB-12.11-M90, type 1 clear Georgian Polished Plate, wire mesh style 3, 6 mm thick.

.7 Obscure patterned glass: to CAN/CGSB-12.13-M91, 6mm thick, inside pane of insulating glass units where shown. Submit samples to Consultant for approval.

.8 Fire rated glass: glass material labelled by accredited testing organization recognized by authorities having jurisdiction. Firelite Plus 8mm non-wired ceramic glazing or equal as approved by Consultant.

.9 At all glass in exterior doors and exterior sidelights, CAN/CGSB-12.8-M97, with outer pane of 6mm thick laminated safety glass and inner pane of 6mm thick laminated safety glass with 25mm total thickness, capillary tubes. Match Tint and Low E to window glass.

2.2 Glazing and Sealing Compound Materials

- .1 Glazing compound:
 - .1 Oil base, to CAN/CGSB-19.6-M87, Type 1, black colour.
 - .2 Non-hardening, modified oil type to CAN/CGSB-19.2-M87, black colour.
- .2 Sealant compound: one component acrylic base, to CGSB 19-GP-5M, gun grade, black colour.
- .3 Sealant compound: one component compound, to CAN/CGSB-19.13-M87, Class A, gun grade, black colour.
- .4 Sealant compound: one component, silicone base, solvent curing to CAN/CGSB-19.18-M87, black colour.
- .5 Sealant compound: multi-component, chemical curing to CAN/CGSB-19.24-M90, type 2, class A, black colour.

.6 Sealing and Bedding Compound, Acoustical: to CAN/CGSB-19.21-M87.

.7 Putty Linseed Oil: to CAN/CGSB-19.1-M87.

2.3 Accessories

.1 Glazing tape: pre-shimmed preformed butyl tape, 10-15 durometer hardness, paper release, black colour, to suit.

.2 Setting blocks: neoprene, Shore "A" durometer hardness Shore "A" 80-90, 100 mm long x 6 mm high x width to suit glass thickness.

.3 Spacer shims: neoprene, Shore "A" durometer hardness 80, 75 mm long x 2.4 mm thick x 9 mm high.

.4 Glazing splines: neoprene manufacturer's standard dry glazing splines to suit aluminum extrusions, grey colour.

.5 Glazing points and wire spring clips: corrosion resistant, manufacturer's standard.

.6 Lock-strip gaskets: black neoprene to ASTM C 542-94(1999), H type U type for cavities spline type for recessed reglets type. Provide internal drainage channel with drainage holes in sill section. Injection mould one-piece corner sections and heat-seal to main gasket.

.7 Primer-sealers and cleaners: to glass manufacturer's standard.

.8 Breather tubes: to manufacturer's standard.

.9 Mirror attachment accessories:

.1 Stainless steel clips.

.2 Plastic rosettes.

.3 Mirror adhesive, chemically compatible with mirror coating and wall substrate.

.4 Mirror frames: Stainless steel.

PART 3 - EXECUTION

3.1 Examination

- .1 Verify that openings for glazing are correctly sized and within tolerance.
- .2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.2 Preparation

- .1 Clean contact surfaces with solvent and wipe dry.
- .2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .3 Prime surfaces scheduled to receive sealant.

3.3 Workmanship

- .1 Remove protective coatings and clean contact surfaces with solvent and wipe dry.
- .2 Apply primer-sealer to contact surfaces.
- .3 Place setting blocks as per manufacturer's instructions.
- .4 Install glass, rest on setting blocks, ensure full contact and adhesion at perimeter.
- .5 Install removable stops, without displacing tape or sealant.
- .6 Provide edge clearance of 3 mm minimum.
- .7 Insert spacer shims to center glass in space. Place shims at 600 mm oc and keep 6 mm below sight line.
- .8 Apply cap bead of sealant at exterior void.
- .9 Apply sealant to uniform and level line, flush with sightline and tooled or wiped with solvent to smooth appearance.
- .10 Do not cut or abrade tempered, heat treated, or coated glass.

3.4 Exterior Glazing

- .1 Dry method - tape/tape and sealant:
 - .1 Cut glazing tape to proper length and set against permanent stops 5 mm below sightline. Install horizontal strips first, extend over entire width of opening before applying vertical strips. Weld corners together by butting tape and dabbing with sealant.
 - .2 Place glazing tape on glass in manner described above.
- .2 Combination method - tape/sealant:
 - .1 Cut glazing tape to proper length and set against permanent stops, 5 mm below sightline. Install horizontal strips first, extend over entire width of opening before applying vertical strips. Weld corners together by butting tape and dabbing with sealant.
 - .2 Fill gap between glass and applied stop with sealant to depth equal to bite of frame on glass but not more than 10 mm below sightline.
- .3 Wet method - sealant/sealant:
 - .1 Apply sealant to back and bottom of rabbet.
 - .2 Bed glass in position with sealant.
 - .3 Fill gap between glass and stops with sealant to depth equal to bite of frame on glass but not more than 10 mm below sightline.
- .4 Lock strip gasket method:
 - .1 Unpack and lay out gaskets on flat warm area to permit recovery of shape.
 - .2 Install gaskets under compression from corners inward.
 - .3 Drain infiltrated moisture to exterior through drain holes in sill.
 - .4 Install locking strip and gasket assembly to manufacturer's instructions.

3.5 Interior Glazing

- .1 Dry method - tape/tape:
 - .1 Cut glazing tape to length and install against permanent stop, project 1.5 mm above sightline.
 - .2 Place glazing tape on free perimeter of glass in same manner described above.
- .2 Combination method - tape/sealant:
 - .1 Cut glazing tape to proper length and install against permanent stop, projecting 1.5 mm above sightline.
 - .2 Fill gap between glass and applied stop with sealant to depth equal to bite of frame on glass to uniform and level line.

.3 Trim off excess tape to sightline.

.3 Wet method - compound/compound:

.1 Apply sealant to back and bottom of rabbet.

.2 Bed glass in position with sealant.

.3 Locate and secure glass using glaziers' clips.

.4 Fill gaps between glass and stops with compound until flush with sightline and tool to smooth straight line.

.4 Gasket method:

.1 Install gasket to permanent stop and install glass.

.2 Apply removable stops. Install gaskets in frame channels.

3.6 Fire Rated Glass

.1 Install fire rated glass in accordance with manufacturer's specifications.

3.7 Mirror Installation

.1 Install mirrors where indicated using full adhesive bed and clips.

3.8 Cleaning

.1 Remove glazing materials from finish surfaces.

.2 Remove labels after work is complete.

.3 Clean glass and mirrors.

3.9 Protection of Finished Work

.1 After installation, mark light with an "X" by using removable plastic tape or paste. Do not mark heat absorbing or reflective glass units.

PART 1 - GENERAL

1.1 References

- .1 ASTM C 635-00 Specifications for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
- .2 ASTM C 636-96 Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

1.2 Design Criteria

- .1 Maximum deflection: 1/360th of span to ASTM C 635-00 deflection test.

1.3 Samples

- .1 Submit samples in accordance with Section 01300 - Submittals.
- .2 Submit one representative model of each type ceiling suspension system.
- .3 Ceiling system to show basic construction and assembly, treatment at walls, recessed fixtures, splicing, interlocking, finishes, acoustical unit installation.

PART 2 - PRODUCTS

2.1 Materials

- .1 Intermediate duty system to ASTM C 635-00.

- .2 Basic materials for suspension system: commercial quality cold rolled steel zinc coated or aluminum sheet mill finished.
- .3 Exposed tee bar grid components: shop painted satin sheen white colour . Components die cut. Main tee with double web, rectangular bulb and 25 mm rolled cap on exposed face. Cross tee with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection.
- .4 Hanger wire: galvanized soft annealed steel wire.
 - .1 3.6 mm diameter for access tile ceilings.
 - .2 to ULC design requirements for fire rated assemblies.
 - .3 2.6 mm diameter for other ceilings.
- .5 Hanger inserts: purpose made.
- .6 Carrying channels: 38 x 19 mm channel, of 1.2 mm thick galvanized steel.
- .7 Accessories: splices, clips, wire ties, retainers and wall moulding flush, to complement suspension system components, as recommended by system manufacturer.
- .8 Secondary Support System: Unistrut or equal complete with purpose made clamps and fastening systems as required, spanning between structural members. Submit shop drawings signed and sealed by member of Professional Engineers of Ontario (P.E.O.).

2.1 Separate Price No. 1 – Seismic Restraint Bracing System

- .1 The contractor shall supply and install seismic restraint bracing for the suspended ceiling system in accordance with the applicable requirements of the Ontario Building Code and all applicable standards referenced therein.
- .2 Seismic restraints shall be designed, supplied, and installed to meet the seismic design criteria applicable to the City of Oshawa. Bracing shall be provided for all suspended ceiling systems as required by code, including but not limited to main runners, cross tees, perimeter details, hangers, light fixtures, diffusers, and other ceiling-mounted components.
- .3 The contractor shall:
 - .1 Coordinate seismic bracing requirements with architectural, structural, and mechanical drawings.
 - .2 Submit signed and sealed shop drawings prepared by a professional engineer licensed in the Province of Ontario.
 - .3 Ensure all anchors, hangers, and attachments to the structure are designed for the applicable seismic loads.

- .4 Provide all required hardware, bracing members, supports, and accessories necessary for a complete and code-compliant installation.
- .4 All costs associated with seismic bracing for the suspended ceiling system shall be included in the separate Price No. 1.
- .5 Product:
 - .1 Provide Seismic RX Suspension System, ICC-ESR-1308, or equal.

PART 3 - EXECUTION

3.1 Installation

- .1 Installation: in accordance with ASTM C 636-96 except where specified otherwise.
- .2 Install suspension system to manufacturer's instructions and Certification Organizations tested design requirements.
- .3 Secure hangers to overhead structure using attachment methods acceptable to Consultant. DO NOT SUSPEND FROM METAL DECK. Suspend from open web steel joists, beams or channels or provide secondary support systems spanning between structural members. Where secondary support systems are utilized, submit shop drawings signed and sealed by member of Professional Engineers of Ontario (PEO).
- .4 Secure hangers to overhead structure using attachment methods acceptable to Consultant. DO NOT SUSPEND FROM METAL OR PRE-CAST CONCRETE DECK. Suspend from open web steel joists, beams or channels or provide secondary support systems spanning between structural members. Where secondary support systems are utilized, submit shop drawings signed and sealed by member of Professional Engineers of Ontario (PEO).
- .5 Lay out center line of ceiling both ways, to provide balanced borders at room perimeter with border units not less than 50% of standard unit width and according to reflected ceiling plan.
- .6 Lay out center line of ceiling both ways, to provide balanced borders at room perimeter with border units not less than 50% of standard unit width and according to reflected ceiling plan. Match location of existing suspension system wherever possible.

- .7 Install wall mould to provide correct ceiling height.
- .8 Completed suspension system to support super- imposed loads, such as lighting fixtures diffusers grilles and speakers.
- .9 Support at light fixtures and diffusers with additional ceiling suspension hangers within 150mm of each corner and at maximum 600mm around perimeter of fixture.
- .10 Interlock cross member to main runner to provide rigid assembly.
- .11 Frame at openings for light fixtures, air diffusers, speakers and at changes in ceiling heights.
- .12 Install access splines to provide 10 percent ceiling access.
- .13 Finished ceiling system to be square with adjoining walls and level within 1:1000.

3.2 Cleaning

- .1 Touch up scratches, abrasions, voids and other defects in painted surfaces.

PART 1 - GENERAL

1.1 Reference Standards

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
 - .2 CAN/CGSB-71.25-M88, Adhesive, for Bonding Drywall to Wood Framing and Metal Studs.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-M88, Building Materials and Assemblies, Standard Method of Test for Surface Burning Characteristics of.
- .3 American Society for Testing and Materials (ASTM)
 - .1 ASTM A 653/A 653M-02a, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C 36/C 36M-01, Specification for Gypsum Wallboard.
 - .3 ASTM C 79/C 79M-01, Specification for Gypsum Sheathing Board.
 - .4 ASTM C 442/C 442M-01, Specification for Gypsum Backing Board and Coreboard.
 - .5 ASTM C 475/C 475M-02, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .6 ASTM C 514-01, Specification for Nails for the Application of Gypsum Board.
 - .7 ASTM C 630/C 630M-01 630M-96a 630M-96a 630M-96a 630M-96a, Specification for Water-Resistant Gypsum Backing Board.
 - .8 ASTM C 840-02, Specification and Finishing of Gypsum Board.
 - .9 ASTM C 931/C 931M-02, Specification for Exterior Gypsum Soffit Board.
 - .10 ASTM C 954-00, Specification for Steel Drill Screws for the Application of Gypsum Board.
 - .11 ASTM C 960/C 960M-01, Specification for Predecorated Gypsum Board.
 - .12 ASTM C 1047-99, Accessories for Gypsum Wallboard and Gypsum Veneer.
 - .13 ASTM C 1280-99, Specification for Application of Gypsum Sheathing Board.
 - .14 ASTM C 1177/C 1177M-01 1178M-96 1178M-96 1178M-96 1178M-96, Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - .15 ASTM C 1178/C 1178M-01 1178M-96 1178M-96 1178M-96 1178M-96,

Specification for Glass Mat Water-Resistant Gypsum Backing Board.

1.2 Environmental Requirements

- .1 Maintain temperature minimum 10°C, maximum 21°C for 48 hours prior to and during application of gypsum boards and joint treatment, and for at least 48 hours after completion of joint treatment.
- .2 Apply board and joint treatment to dry, frost free surfaces.

1.3 Regulatory Requirements Regulatory Requirements

- .1 Fire-resistance rated ceiling assembly: ULC I517.

PART 2 - PRODUCTS

2.1 Gypsum Board

- .1 Standard board: to CAN/CSA-A82.27-M91 regular, 12 mm thick and Type X, 16 mm thick, 1200 mm wide x maximum practical length, ends square cut, edges beveled.
- .2 Exterior sheathing: to CAN/CSA-A82.27-M91 16 mm thick, 1200 mm wide x maximum practical length. Georgia Pacific Densglas Gold or equal.
- .3 Reinforced cement board: aggregated portland cement board with vinyl-coated, woven glass-fibre mesh embedded in front and back surfaces, specially formulated to resist water and steam, square cut and smooth finished edges, 900 mm wide x 1800 mm long.
- .4 Impact resistant gypsum board: to CAN/CSA-A82.27-M91, 16mm thick, 1200mm wide x maximum practical length, ends square cut, edges beveled. CGC Sheetrock Abuse Resistant or equal.

2.2 Metal Furring and Suspension Systems

- .1 Metal furring runners, hangers, tie wires, inserts, anchors: to CSA A82.30-M1980, galvanized .
- .2 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .3 Resilient drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.
- .4 At ULC Design No. I517, CGC suspension system spaced 1200mm O.C. max with 22 x 73 x 35 cross chanel s spaced 1200mm O.C. max. Complete with metal trim moulding.

2.3 Fastenings and Adhesives

- .1 Nails, screws and staples: to CAN/CSA-A82.31-M91.
- .2 Stud adhesive: to CAN/CGSB 7125 ASTM C 557-99.
- .3 Laminating compound: as recommended by manufacturer, asbestos-free.

2.4 Accessories

- .1 Casing beads, corner beads fill type: 0.5 mm base thickness commercial grade sheet steel to ASTM C 1047-99 with Z275 zinc finish to ASTM A 525-93, perforated flanges; one piece length per location.
- .2 Acoustic sealant: to CAN/CGSB-19.21-M87 and Section 07900.
- .3 Polyethylene: to CAN/CGSB-51.34-M86, Type 2.
- .4 Insulating strip: rubberized, moisture resistant, 3 mm thick closed cell neoprene strip, 12 mm wide, with self sticking permanent adhesive on one face, lengths as required.
- .5 Joint compound: to CAN/CSA-A82.31-M91, asbestos- free.

PART 3 - EXECUTION

3.1 Suspended and Furred Ceilings

- .1 Erect hangers and runner channels for suspended gypsum board ceilings in accordance with CAN/CSA-A82.31-M91 except where specified otherwise.
- .2 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .3 Install work level to tolerance of 1:1200.
- .4 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, and grilles.
- .5 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.
- .6 ULC Design No. I517, provide suspended framing member system in accordance with ULC Design and manufacturer's specifications.

3.2 Ceiling Bulkheads

- .1 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .2 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

3.3 Wall Furring

- .1 Install wall furring for gypsum board wall finishes in accordance with CAN/CSA-A82.31-M91, except where specified otherwise.
- .2 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .3 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.4 Resilient Furring

- .1 Erect drywall resilient furring transversely across studs spaced maximum 600 mm oc and not more than 150 mm from ceiling/wall juncture. Secure to each support with 38 mm common nail 25 mm drywall screw.
- .2 Install 150 mm continuous strip of 12.7 mm gypsum board along base of partitions where resilient furring installed.

3.5 Bracing

- .1 Brace suspended assemblies as required to structure at 1200mm o.c. max. Conform strictly to manufacturer's specifications and instructions. Maintain continuity of fire separations at all times. Review method of suspension with Consultant prior to commencement of Work. Failure to do so will result in immediate rejection of Work.

3.6 Gypsum Board Application

- .1 Do not apply gypsum board until bucks, anchors, blocking, electrical and mechanical work are approved.
- .2 Apply single or double layer gypsum board to metal furring or framing using screw fasteners for first layer, screw fasteners for second layer. Maximum spacing of screws 300 mm oc.
- .3 Apply single or double layer gypsum board to concrete concrete block surfaces, where indicated, using laminating adhesive.
- .4 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, and other penetrations, in partitions where perimeter sealed with acoustic sealant.

3.7 Fire Rated Assemblies

- .1 Construct fire rated assemblies where indicated in strict accordance with specified ULC Design..

3.8 Accessories

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm oc using contact adhesive for full length.
- .2 Install casing beads around perimeter of suspended ceilings.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Install shadow mould at gypsum board/ceiling juncture as indicated. Minimize joints; use corner pieces and splicers.

3.9 Control Joints

- .1 Construct control joints of preformed units or two back-to-back casing beads set in gypsum board facing and supported independently on both sides of joint.
- .2 Provide continuous polyethylene dust barrier behind and across control joints.
- .3 Locate control joints at changes in substrate construction at approximate 10 m spacing on long corridor runs at approximate 15 m spacing on ceilings.
- .4 Install control joints straight and true.

3.10 Expansion Joints

- .1 Construct expansion joints as detailed, at building expansion and construction joints. Provide continuous dust barrier.
- .2 Install expansion joint straight and true.

3.11 Access Doors

- .1 Install access doors to electrical and mechanical fixtures specified in respective Sections.
- .2 Rigidly secure frames to furring or framing systems.

3.12 Taping and Filling

- .1 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .2 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .3 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
- .4 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .5 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

3.13 Skim Coat

- .1 Mix joint compound slightly thinner than for joint taping.

- .2 Apply thin coat to entire surface using trowel or drywall broadknife to fill surface texture differences, variations or tool marks.
- .3 Allow skim coat to dry completely.
- .4 Remove ridges by light sanding or wiping with damp cloth.

3.14 Reinforced Cement Board

- .1 Pre-cut board to required sizes and make necessary cutouts.
- .2 Fit ends and edges closely but not forced together.
- .3 Fasten board to wood studs with 38 mm galvanized roofing nails, or blued or galvanized annular ring nails at 200 mm oc.
- .4 Fasten board to steel studs with rust proof self-drilling, self-threading case hardened screws at 200 mm oc.
- .5 Filling and reinforcing of joints between board is specified in Section 09310 - Ceramic Tile.

3.15 Impact Resistant Gypsum Board

- .1 Provide impact resistant gypsum board at all exterior soffits.
- .2 Provide in accordance with manufacturer's specifications including recommended accessories and materials.

PART 1 - GENERAL

1.1 References

- .1 American Standards for Testing and Material (ASTM)
 - .1 ASTM C 241-90(1997)e1, Standard Test Method for Abrasion Resistance of Stone Subject to Foot Traffic.
 - .2 ASTM D 2370-98(2002), Test Method for Tensile Properties of Organic Coatings.
- .2 Canadian Environmental Protection Act (CEPA).
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .4 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A5/A8/A362- 93 , Portland Cement/Masonry Cement/Blended Hydraulic Cement.
 - .2 CAN/CSA-A23.1-00 94 , Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
 - .3 CSA G30.5-M1983 (R1998), Welded Steel Wire Fabric for Concrete Reinforcement.
 - .4 CAN/CSA-ISO 14040-97, Environmental Management-Life Cycle Assessment-Principles and Framework.
 - .5 CSA Z760-94 94 , Life Cycle Assessment.
- .5 Fisheries Act.
- .6 Terrazzo, Tile and Marble Association of Canada (TTMAC) standards and specification studies.

1.2 Submittals

- .1 Submit proof of manufacturer's CCMC Listing and listing number to Consultant .

- .2 Submit proof of manufacturer's ISO 9000 registration and compliance to Consultant .
- .3 Submit proof of manufacturer's ISO 14000 registration and compliance to Consultant .
- .4 Submit proof of manufacturer's participation certificate for Environmental Choice Program to Consultant .
- .5 Manufacturer's instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01300.
- .2 Indicate layout of divider strips, and expansion joints .

1.4 Samples

- .1 Submit samples to match existing terrazzo in accordance with Section 01300.
- .2 Submit duplicate 300 x 300 x 20 mm thick samples of each colour terrazzo.

1.5 Closeout Submittals

- .1 Provide maintenance data as set out in TTMAC publication for terrazzo work for incorporation into manual specified in Section 01780 - Closeout Submittals.

1.6 Delivery, Storage and Handling

- .1 Deliver materials to job site just prior to installation.
- .2 Store materials inside, in dry location, away from heavy traffic areas.
- .3 Deliver and store materials in manner to prevent damage.
- .4 Ensure materials remain in original wrapping and containers until used.

1.7 Waste Management and Disposal

- .1 Separate and recycle waste materials.
- .2 Close and seal tightly all partly used sealant containers and store protected in well ventilated, fire-safe area at moderate temperature.
- .3 Ensure emptied containers are sealed, labeled and stored safely for disposal away from children.
- .4 Place used sealant tubes and other containers in areas designated for hazardous materials.
- .5 Place materials defined as hazardous or toxic waste in designated, labeled containers.
- .6 Use trigger-operated spray nozzles for water hoses.
- .7 Fold up metal banding, flatten, and place in designated area for recycling.
- .8 Collect wood packing shims and pallets, and place in designated area for recycling and reuse.
- .9 Dispose of all waste in accordance with applicable local, provincial and national regulations.
- .10 Give preference to suppliers who will take back packaging materials.

1.8 Environmental Requirements

- .1 Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of materials.
- .2 Ventilation.
 - .1 Provide continuously during and after installation. Run system 24 hours per day during installation; provide continuous ventilation for 7 days after completion of installation.
- .3 Temperature.
 - .1 Maintain air temperature and structural base temperature at terrazzo installation area above 12 °C for 24 hours prior to, during, and for 24 hours following installation.
- .4 Manufacturing Process.
 - .1 To Life Cycle Assessment Standards as per CAN/CSA-ISO 14040-97 CSA Z760-94 .

PART 2 - PRODUCTS

2.1 Materials

- .1 Cement
 - .1 To CAN/CSA-A5-93.
 - .2 Type 10 , grey for underbed.
 - .3 White for topping.
 - .4 6 % air-entrainment.
- .2 Sand, fine and coarse aggregates:
 - .1 To CAN/CSA-A23.1-00.
 - .2 Clean, washed, locally available.
 - .3 Oval aggregate.
- .3 Water: potable.

- .4 Marble chips:
 - .1 Graded in accordance with TTMAC standard.
 - .2 Abrasion resistance to ASTM C 241-90 (1997)e1.
 - .3 No deleterious or foreign matter.
 - .4 Match colour of marble chips to range and size of existing.
- .5 Pigments:
 - .1 Compatible with portland cement.
 - .2 Alkali-resistant, colour-stable.
 - .3 Lime-proof mineral.
- .6 Epoxy bonding agent: two components, epoxy resin and epoxy hardener conforming to following performance properties after cure schedule of 28 days at 25°C.
 - .1 Viscosity: mixed viscosity not less than 0.04 Pa.s or more than 0.5 Pa.s.
 - .2 Gel time: not less than half hour at 20°C.
 - .3 Flexibility: Gardiner flexibility test, passes bending over 12 mm mandrel, without cracking.
 - .4 Elongation: ASTM D 2370-98 (2002), minimum 10%.
 - .5 Bond strength: 2 MPa, with 100% concrete failure at minimum coverage, test concrete specimen minimum compressive strength 20 MPa.
 - .6 Coverage: 0.3 L/m² minimum, dry film thickness not less than 0.2 mm.
- .7 Divider strips: to match existing.
- .8 Accessories: base caps and base divider strips, separator strips, purpose made and of same material to match divider strips.
- .9 Reinforcing steel: billet steel, grade 300 plain bars.
- .10 Welded steel wire fabric: to CSA G30.5-M1983 (R1998), 50 x 50 x 1.6 x 1.6 mm wire, galvanized, in flat sheets only.
- .11 Slip sheet: polyethylene sheet to CAN/CGSB-51.34-M86, Type 2, 0.05 mm thick.
- .12 Non-slip aggregate: aluminum oxide of size and colour to match marble chips.
- .13 Curing compound: to manufacturers standard.
- .14 Cleaning compound: to TTMAC standard 1004.

- .15 Sealants:
 - .1 To TTMAC 2002 .
 - .2 Sealants, solvents, cleaners, and other fluids: water-based , water clean-up , non-flammable , biodegradable , low Volatile Organic Compound (VOC) content , manufactured without compounds which contribute to ozone depletion in the upper atmosphere , manufactured without compounds which contribute to smog in the lower atmosphere , do not contain methylene chloride , do not contain chlorinated hydrocarbons , do not contain toxic metal pigments.
 - .3 Water-borne surface coatings:
 - .1 Meet or exceed all applicable governmental and/or industrial safety and performance standards.
 - .2 Manufactured and transported, including disposal of waste products, to meet all requirements of applicable acts, by-laws and regulations including, for facilities located in Canada, Fisheries Act and Canadian Environmental Protection Act (CEPA).
 - .3 Formulated or manufactured without aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
 - .4 Water-borne surface coatings and recycled water-borne surface coatings:
 - .1 Flash point of 61.0 °C or greater.
 - .2 Made by process that does not release:
 - .1 Matter in undiluted production plant effluent generating Biochemical Oxygen Demand (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment, or
 - .2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
 - .3 Proper disposal method information contained in packaging.
 - .5 Recycled water-borne surface coatings:
 - .1 50 % post-consumer material by volume.
 - .2 Lead levels below 600.0 ppm weight/weight total solids.
 - .3 Mercury levels below 50.0 ppm weight/weight total product.
 - .4 Cadmium levels below 1.0 ppm weight/weight total product.
 - .5 Hexavalent chromium levels below 3.0 ppm weight/weight total product.
 - .6 Organochlorine or polychlorinated biphenyl (PCB) levels below 1.0 ppm weight/weight total product.
- .16 Finishing compound: to TTMAC standard 3001.

2.2 Mixes

- .1 Slurry coat: cement and water mixed to creamy paste.
- .2 Underbed: 1 part cement to 4 parts sand by volume.
- .3 Terrazzo topping: to match existing colours, texture and pattern, field colour and coved base.

PART 3 - EXECUTION

3.1 Workmanship

- .1 Do terrazzo work in accordance with CSC Architectural Specification Study on Terrazzo (Portland Cement), produced in cooperation with Terrazzo, Tile and Marble Association of Canada (TTMAC), except where specified otherwise.

3.2 Inspection

- .1 Examine area to receive terrazzo for defects in existing work which may affect proper execution of terrazzo work.
- .2 Ensure tolerances of concrete slab work do not deviate from tolerance set for finished terrazzo floor.
- .3 Terrazzo contractor to start work only when all defects are corrected.

3.3 Installation

- .1 Install terrazzo after concrete slabs have cured 28 days.
- .2 Install divider strips true and level to detailed pattern.
- .3 Install control joints above control joints in subfloor.
- .4 Slope finished terrazzo floors to drains.
- .5 Produce terrazzo finished surfaces to match existing.
- .6 Floors
 - .1 to match existing and applicable TTMAC detail.
- .7 Bases
 - .1 Terrazzo bases: to match existing. .
- .8 Clean, seal and finish terrazzo surfaces to TTMAC recommendations.

3.4 Refinishing and Renovated Terrazzo (Reno. Terr.)

- .1 Strip existing terrazzo floors and coved base to be refinished.
- .2 Sawcut existing cracks minimum 20mm x 35mm deep in existing terrazzo floor and coved base in areas to be refinished. Leave metal dividing strips intact and undamaged.
- .3 At damaged and deteriorated existing terrazzo, sawcut to stable finish. Leave metal dividing strips intact and undamaged.
- .4 Fill sawcut cracks and damaged and deteriorated existing terrazzo with terrazzo to match existing colour and aggregate size and chip density.
- .5 Grind, polish and seal terrazzo floor and base as indicated to be refinished to TTMAC specifications and recommendations.

PART 1 - GENERAL

1.1 References

- .1 Canadian Standards Association (CSA)
 - .1 CSA B111-1974, Wire Nails, Spikes and Staples.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.
 - .2 CAN/CGSB-92.1-M89, Sound Absorptive Prefabricated Acoustical Units.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-M88, Surface Burning Characteristics of Building Materials.

1.2 Environmental Conditions

- .1 Permit wet work to dry before commencement of installation.
- .2 Maintain uniform minimum temperature of 15°C and humidity of 20 - 40% before and during installation.
- .3 Store materials in work area 48 hours prior to installation.

1.3 Maintenance Materials

- .1 Provide maintenance materials in accordance with Section 01001.
- .2 Provide acoustical units amounting to 2% of gross ceiling area for each pattern and type required for project.

- .3 Materials to be same production run as installed materials.

PART 2 - PRODUCTS

2.1 Materials

- .1 Acoustic units for suspended ceiling system as manufactured by Armstrong World Industries Canada Ltd.: to CAN/CGSB-92.1-M89.
- .1 Type Minaboard/Fireguard or approved equal.
 - .2 Pattern Cortega.
 - .3 Flame spread rating of 25 or less.
 - .4 Noise reduction coefficient (NRC) designation of -.65.
 - .5 Light reflectance range of min.75.
 - .6 Edge type square.
 - .7 Colour white.
 - .8 Size 610 x 1220 x 16 mm thick.
 - .9 Shape flat.
- .2 Adhesive: type recommended by acoustic unit manufacturer.
- .3 Staples, nails and screws: to CSA B111-1974 non-corrosive finish as recommended by acoustic unit manufacturer.
- .4 Polyethylene: to CAN/CGSB-51.33-M89, Type 2, 0.15 mm thick.
- .5 Hold down clips: purpose made clips to secure tile to suspension system, approved for use in fire-rated systems.
- .6 Light fixture protection boxes: five sided, trapezoidal of same material as lay-in acoustic tiles as specified in ULC design.

PART 3 - EXECUTION

3.1 Installation

- .1 Do not install acoustical panels and tiles until work above ceiling has been inspected by Consultant.
- .2 Co-ordinate ceiling work to accommodate components of other sections, such as light fixtures, diffusers, speakers, sprinkler heads, to be built into acoustical ceiling components.
- .3 Provide light fixture protection boxes in accordance with applicable ULC Design.

3.2 Suspension System

- .1 Install acoustical panels and tiles in ceiling suspension system.

3.3 Interface With Other Work

- .1 Co-ordinate ceiling work to accommodate components of other sections, such as light fixtures, diffusers, speakers, sprinkler heads, to be built into acoustical ceiling components.

PART 1 - GENERAL INFORMATION

1.01 SUMMARY

- A. This section deals with resilient flooring found in the drawings and schedules of the contract that meet the requirements of this section.

1.02 RELATED SECTIONS

- A. Section 3 - Cement: not covered in this section.
- B. Section 6 - Wood and plastic: not covered in this section.
- C. Section 7 - Thermal and humidity protection: not covered in this section.
- D. Section 9 - Other sections containing information related to floor finishes: not covered in this section.

1.03 REFERENCES (INDUSTRY STANDARDS)

- A. ASTM F710: « Practice for preparing concrete floors to receive resilient flooring ».
- B. ASTM E648: « Test method for critical radiant flux of floor covering systems using a radiant heat energy source ».
- C. ASTM E662: « Test method for specific optical density of smoke generated by solid materials ».
- D. ASTM F1869: « Standard test method for measuring moisture vapor emission rate of concrete subfloor using anhydrous calcium chloride ».
- E. ASTM F2170: « Determining relative humidity in concrete floor slabs using in situ probes ».
- F. ASTM F1344: « Standard specification for rubber tile floor covering without backing ».
- G. ASTM E989: « Classification for determination of impact insulation class (IIC) ».
- H. ASTM E492: « Standard test method for laboratory measurement of impact Sound transmission through floor-ceiling assemblies using tapping machine ».
- I. ASTM F970: « Standard test method for measuring static load limit ».
- J. ASTM F1515: « Test method for measuring light stability of resilient flooring by color change ».
- K. ASTM G21: « Standard method of determining resistance of synthetic polymeric materials to fungi ».

1.04 ITEMS TO DELIVER

- A. Provide the product's Technical Specifications data sheet as well as all Installation and Maintenance Instructions.
- B. When required, supply floor drawings and installation plans.
- C. Supply a set of samples measuring at least 12 cm (5 in) by 12 cm (5 in) of the complete range of colors and finishes chosen for the project.
- D. When required, provide American Biltrite's attestation, certified by an independent laboratory, confirming that the flooring complies with the fire standards of the following tests:
 - 1. ASTM E648; Critical Radiant Flux: 0.45 watts/cm² or more;
 - 2. ASTM E662; Smoke Density: 450 or less.
- E. Provide American Biltrite's Warranty Certificate.
- F. Provide technical data sheet showing contributions to LEED:
 - 1. For LEED V4 MR BPDO, the product must have a third party certified Environmental Product Declaration (EPD Type III).
 - 2. For LEED V4 MR BPDO, the product must be certified Declare Red List Free.
 - 3. For LEED v4 EQ Credits, the product must be certified FloorsScore® and supply the certificate number.

1.05 QUALITY ASSURANCE

- A. Have American Biltrite flooring installed by a qualified installer of this type of flooring.
- B. In accordance with the technical instructions in the Installation Instructions, use all the accessories recommended by American Biltrite when installing its flooring.
- C. Follow the instructions specified in the most recent version of American Biltrite's Installation Instructions.
- D. Manufactured in a factory that has ISO 9001 and ISO 14001 certifications.

1.06 DELIVERY, HANDLING, STORAGE

- A. Deliver the flooring to the installation site in American Biltrite's original packaging. Indicate the project name and handling instructions on the outside of the boxes.
- B. Advise the carrier of any damaged material and indicate it on the packing slip.
- C. Store the flooring inside, sheltered from extreme hot or cold temperatures. Place the material on a smooth level floor or where there is uniform solid support in a clean, dry well-ventilated area. Unstack the palettes.

The long-term storage temperature must be maintained between 18°C (65°F) and 29°C (85°F). Protect adhesive and flooring material from freezing, extreme heat and direct sun exposure.

- D. Acclimatize the subfloor, all flooring material and adhesive for 48 hours before, during and after the installation by maintaining the room temperature between 18°C (65°F) and 29°C (85°F). The palettes should be unstacked 24 hours prior to use.
- E. Afterwards, maintain the room temperature between 13°C (55°F) and 38°C (100°F). Protect the material from direct sources of heat such as air vents and other types of heaters.
- F. Install the flooring after all other finishing work, including painting, have been completed.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. American Biltrite
200 Bank Street
Sherbrooke, QC, Canada, J1H 4K3
Telephone: 819-829-3300
Toll free: 1-800-437-8743
Internet: www.american-biltrite.com

2.02 RESILIENT FLOORING DESCRIPTION AND MINIMUM PERFORMANCE CRITERIA

- A. **Basis of Specification:** ABPURE® tile flooring with patented Nfuse® technology
 - 1. Description: ABPURE Nfuse Tile product line is a collection of homogeneous rubber flooring in tile format featuring pure colors that last and passing the color stability norm ASTM F1515, as well as not requiring any waxing for the lifetime of the flooring. The collection is available in solid colors, or with a colored chip pattern (Imagine) available in multiple profiles.
 - 2. Meets homogeneous rubber tile ASTM F 1344, Class I, A or B.
 - 3. Nominal thickness: 2.0 mm (ABT only) or 3.0 mm (0.080 in (ABT only) or 0.118 in).
 - 4. Sizes: 36 inch x 36 inch or 18 inch x 18 inch.
 - 5. Featuring the patented Nfuse technology
 - 6. Should have an IIC of 59 dB or higher (when measured according to ASTM E989 / E492 with suspended ceiling).
 - 7. Passes the ASTM F1515 UV light color stability and offers a 10-year color stability guarantee.

8. Passes the ASTM F970 norm for static load limit and needs to meet the norm with a modified static load limit up to 1,000 psi.
9. Passes antimicrobial ASTM G21 norm.
10. Needs to be FloorScore certified.
11. Needs to be certified Declare Red List Free.
12. Needs to have a third party certified environmental product declaration EPD type III.
13. Product line and Colors selected:

Code	Description	Profile	Thickness	Size	Color Code and Color Name
ABT	ABPure Imagine (chip design)	Smooth	3mm (0.118")	900mm x 900mm (35 ½" x 35 ½")	Selected by Consultants at later date.

A. Substitutions: No Substitution

2.03 ADHESIVES

- A. Use American Biltrite's AD-590 adhesive. AD-590 covers 18.6 sq. m/3.8 litres (200 sq. ft./gallon) when applied with the recommended notched trowel.

2.04 OTHER MATERIAL

- A. Subfloor repairs: use a good-quality Portland cement-based compound that has a minimal resistance to compression of 246 kg/cm² (3,500 lb/sq. in) to fill, smooth or level subfloor imperfections.
- B. Self-levelling underlayment: use a Portland cement-based self-levelling underlayment that has a minimal resistance to compression of 246 kg/cm² (3,500 lb/sq. in).

PART 3 - EXECUTION

3.01 SITE INSPECTION

- A. Examine the subfloor before installation to ensure that the surface is clean, dry, smooth, structurally sound, and free from foreign substances that may adversely affect adhesion or cause discoloration. Furthermore, ensure that the subfloor is free of paint, varnish, adhesive, oil, grease,

solvent and other foreign substances, including treatment compounds, sealers and curing compounds that may adversely affect adhesion or alter the appearance or durability of the rubber flooring.

- B. Verify the surface to ensure there is no powder, scaling or mold. If there is, remove it with a mechanical sander and level with a good-quality cement-based Portland primer.
- C. Do not install without a remediation system if the concrete slab has been treated with a curing or sealing agent, added to the surface, or embedded in the concrete.
- D. Do not install on cement slabs that have been subjected to adhesive chemical abatement unless an approved remediation system was used afterwards.
- E. Report and rectify all unsatisfactory conditions. Do not start flooring installation until all rectifications have been completed.

3.02 SUBFLOOR PREPARATION

- A. Level all rough surfaces and fill cracks and marks with a Portland cement-based patching compound.
- B. Mechanically remove all surface contaminants such as paint, oil, grease, varnish, adhesive as well as various other products such as treatment compounds. Do not use solvent-based stripper.
- C. Measure the humidity and pH levels in the cement in compliance with the following standards before installation:
 - 1. ASTM F1869, Anhydrous Calcium Chloride test for Moisture levels. The maximum allowable reading is:
 - 10 lb/1,000 sq. ft./24 hours (4.54 kg/92.9 sq. m/24 hours) for AD-590 adhesive;
 - 2. ASTM F2170, Relative Humidity (RH) test using in situ probes. The maximum allowable reading is 90% RH for AD-590.
 - 3. ASTM F710, pH levels (test procedure 5.3.1). The readings should be between 8 and 11;
 - 4. The ASTM test frequency recommendation is 3 measures for the first 1,000 sq. ft. (92.9 sq. m) and one measure for each additional 1,000 sq. ft. (92.9 sq. m).
- D. Ensure Moisture, Relative Humidity and pH tests have all been conducted and measurements meet manufacturer's recommendations.
- E. In case of doubt, test the adhesion on the cement subfloor or other surface that will be covered by the flooring. Do the test using the specified flooring and recommended adhesive.

3.03 RESILIENT FLOORING INSTALLATION

- A. Install the flooring according to the latest version of American Biltrite's Installation Instructions. Use the tools, adhesives, trowel types and procedures recommended in the instructions.
- B. Acclimatize the subfloor, all flooring material and adhesive for 48 hours before, during and after the installation by maintaining the room temperature between 18°C (65°F) and 29°C (85°F). Afterwards, maintain the temperature between 13°C (55°F) and 38°C (100°F).

3.04 CLEANING AND PROTECTION

- A. Remove all excess adhesive immediately after installation as recommended in American Biltrite's Installation Instructions.
- B. Before allowing traffic after installation, consult and follow the recommendations in American Biltrite's Installation Instructions.
- C. Following installation and cleanup, if the work of all other trades has not yet been completed, protect the flooring by laying sheets of non-staining brown Kraft paper, and then a layer of plywood sheets (rolls of non-staining heavy cardboard material could also be used for protection).
- D. Follow the instructions in American Biltrite's Maintenance Instructions when performing initial and regular maintenance procedures.

PART 1 - GENERAL

1.1 References

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D 3960-02 93 , Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.36-M97 97 , General Purpose Interior Varnish.
 - .2 CAN/CGSB-1.38-2000 M91 , Interior Enamel Undercoater.
 - .3 CGSB 1-GP-48M 78 , Primer, Marine, for Steel.
 - .4 CAN/CGSB-1.57-96 96 , Alkyd, Interior, Semigloss, Enamel.
 - .5 CAN/CGSB-1.60-97 97 , Interior Alkyd Gloss Enamel.
 - .6 CAN/CGSB-1.68-M91 M91 , Solvent Type Primer-Sealer for Interior Walls.
 - .7 CAN/CGSB-1.73-97 97 , Exterior and Interior Enamel for Floors.
 - .8 CAN/CGSB-1.100-99 95 , Interior Latex Type, Flat Paint.
 - .9 CAN/CGSB-1.102-M89 M89 , Clear Alkyd Type Sealer.
 - .10 CAN/CGSB-1.118-95 95 , Interior Alkyd, Flat Finish.
 - .11 CAN/CGSB-1.119-2000 95 , Primer-Sealer, Wall, Interior Latex Type.
 - .12 CAN/CGSB-1.121-93 93 , Vinyl Pretreatment Coating for Metals (Vinyl Wash Primer).
 - .13 CAN/CGSB-1.126-M91 M91 , Vinyl Sealer for Wood.
 - .14 CAN/CGSB-1.143-98 M90 , Heat Resistant Aluminum Enamel, Silicone Alkyd.
 - .15 CAN/CGSB-1.145-97 97 , Solvent-Based Pigmented Stain.
 - .16 CAN/CGSB-1.146-99 92 , Cold Curing, Gloss Epoxy Coating.
 - .17 CAN/CGSB-1.150-M91 M91 , Clear Lacquer for Wood Furniture.
 - .18 CAN/CGSB-1.153-2000 M90 , High Build, Gloss, Epoxy Coating.
 - .19 CAN/CGSB-1.165-M89 M89 , Cold Curing Epoxy Primer.
 - .20 CAN/CGSB-1.175-97 97 , Polyurethane Interior Coating, Oil Modified, Clear, Gloss and Satin.
 - .21 CGSB 1-GP-180Ma 96 , Coating, Polyurethane, Two-Package, General Purpose.
 - .22 CAN/CGSB-1.188-96 96 , Emulsion Type Filler Masonry Block.
 - .23 CGSB 1-GP-193Ma 83 , Coating, High-Build Epoxy, Marine.
 - .24 CAN/CGSB-1.195-99 95 , Interior Semigloss Latex Paint.
 - .25 CAN/CGSB-1.198-2001 95 , Cementitious Primer (for Galvanized Surfaces).
 - .26 CAN/CGSB-1.202-96 96 , Interior Low Gloss Alkyd Enamel.
 - .27 CAN/CGSB-1.209-93 93 , Low Sheen Latex Interior Paint.
 - .28 CGSB 85-GP-1M 78 , Painting (New) Exterior Wooden Surfaces.
 - .29 CGSB 85-GP-2M 78 , Painting (Maintenance) of Exterior Painted Wooden Surfaces.
 - .30 CGSB 85-GP-10M 79 , Shop Painting Structural Steel.

- .31 CGSB 85-GP-11M 80 , Painting Steel for Protection Against Continuous Wetting.
- .32 CGSB 85-GP-13M 80 , Painting Structural Steel for Protection Against Heavy Industrial Atmospheres.
- .33 CGSB 85-GP-14M 78 , Painting Steel Surfaces Exposed to Normally Dry Weather.
- .34 CGSB 85-GP-15M 78 , Painting, Maintenance, Exterior Steel Exposed to Normally Dry Weather.
- .35 CGSB 85-GP-16M 79 , Painting Galvanized Steel.
- .36 CGSB 85-GP-18M 80 , Painting, Maintenance, Exterior, Steel, for Protection Against Continuous Wetting.
- .37 CGSB 85-GP-20M 79 , Painting copper and Copper Alloys.
- .38 CGSB 85-GP-31M 79 , Painting Stucco, Masonry and Brick Surfaces.
- .39 CGSB 85-GP-32M 79 , Painting Concrete Floors.
- .40 CGSB 85-GP-33M 79 , Painting Interior Plaster and Wallboard.
- .41 CAN/CGSB-85.100-93 93 , Painting.
- .3 Canadian Painting Contractors' Association (CPCA).
 - .1 Painting Specifications Manual 1993 .
- .4 Canadian Standards Association (CSA)
 - .1 CSA Z760-94 94 , Life Cycle Assessment.
- .5 Environmental Choice Program (ECP)
 - .1 ECP-67- 95 , Recycled Water-Borne Surface Coatings.
 - .2 ECP-76- 98 , Surface Coatings.
- .6 Environmental Protection Agency (EPA)
 - .1 EPA-SW-846, Test Methods for Evaluating Solid Wastes.
- .7 International Organization for Standardization (ISO)
 - .1 ISO 14040/14041- 1997 , Environmental Management - Life Cycle Assessment.
- .8 National Fire Code of Canada 1995 .
- .9 Steel Structures Painting Council (SSPC).
 - .1 Systems and Specifications Manual 1989
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1.2 Product Data

- .1 Submit product data in accordance with Section 01340.
- .2 Submit full records of all products used. List each product in relation to finish formula and include the following:
 - .1 Finish formula designation.
 - .2 Product type and use.
 - .3 CGSB number.

- .4 Manufacturer's product number.
 - .5 Colour number s .
 - .6 Manufacturer's Material Safety Data Sheets (MSDS).
 - .7 Maximum VOC classification.
 - .8 Eco-Logo certification.
- .3 Submit manufacturer's installation and application instructions for each product specified.

1.3 Samples

- .1 Submit samples in accordance with Section 01340.
- .2 Submit duplicate 300 x 200 mm sample panels of each paint.
- .3 Submit full range of available colours where colour availability is restricted.
- .4 Use 3 mm plate steel for finishes over metal surfaces. Use 12.5 mm birchplywood for finishes over wood surfaces. Use 50 mm concrete block for finishes over concrete or concrete masonry surfaces. Use 12.5 mm gypsum board for finishes over gypsum board and other smooth surfaces.

1.4 Submittals

- .1 Within a period of 30 days after award of Contract, and before any paint materials are delivered to the job site, submit to the Owner a complete list of all materials proposed to be furnished and installed under this portion of the work including a letter as to the name of the paint manufacturer proposed for the work.
 - .2 This shall in no way be construed as permitting substitution of materials for those specified or approved for this work by the Consultant.
 - .3 Accompanying the materials' list, submit to the Consultant two copies of the full range of colours available in each of the proposed products.
 - .4 After the award of Contract, the Consultant will prepare and issue a Colour Schedule. This Schedule is guidance for the painter in the preparation of samples of colour and finish. The Painter shall not purchase materials on the basis of the Colour Schedule.
 - .5 Upon receipt of the Colour Schedule, provide materials and prepare samples indicating colours and degree of gloss. The samples shall be submitted on gypsum board, 600 mm square for those areas where the paint is to be applied to a smooth
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finished surface and on Celotex board, 600 mm square where paint is to be applied on finished masonry.

- . 6 Meet with the Consultant to consider the samples which will be inspected under the conditions and in the areas to which the colours and finishes are to be applied. Modify the colours as often as may be required for the Consultant's final approval. Upon final approval, the Painter will be authorized to proceed with the purchase of the materials.
- . 7 The samples shall be clearly identified and will be maintained clean and in good condition at the site. Upon receipt of such factory pre-mixed paints as purchased by the Painter, he will satisfy himself that the materials in sealed containers matches precisely the samples which have been approved before applying same to the appropriate surfaces.
- . 8 Upon commencement of the Work, sample rooms shall be prepared with base and finish coats as specified. This Work shall be executed in the presence of the paint manufacturer's representative to ensure that the materials are applied at the proper coverages. It shall be the responsibility of this trade contractor to advise the paint manufacturer and the Consultant in writing as to time and date which this work will be performed. Sample rooms and finishes when approved shall be a standard for comparison for the remainder of the work. Work subsequently executed which in the Consultant's or paint manufacturer's opinion does not equal the sample finishes, shall be corrected as may be necessary by the painter without additional charge.
- . 9 Maintenance Materials: Provide 2% additional matching paint of each type and colour used on project for maintenance purposes. Turn over to General Contractor and obtain receipt.

1.5 Quality Assurance

- . 1 Use only qualified painters for the mixing and application of paint on exposed surfaces. In the acceptance or rejection painting work, no allowance will be made for lack of skill on the part of painters.
 - . 2 Retain purchase orders, invoices and other documents to prove that all materials utilized in this contract meet requirements of the specifications. Produce documents when requested by Consultant.
 - . 3 Standard of Acceptance:
 - . 1 Walls: No defects visible from a distance of 1000 mm at 90 degrees to surface.
 - . 2 Ceilings: No defects visible from floor at 45 degrees to surface when viewed using final lighting source.
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- . 3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

1.6 Delivery, Storage and Handling

- . 1 Deliver and store materials in original containers, sealed, with labels intact.
 - . 2 Indicate on containers or wrappings:
 - . 1 Manufacturer's name and address.
 - . 2 Type of paint.
 - . 3 Compliance with applicable standard.
 - . 4 Colour number in accordance with established colour schedule.
 - . 3 Remove damaged, opened and rejected materials from site.
 - . 4 Provide and maintain dry, temperature controlled, secure storage.
 - . 5 Observe manufacturer's recommendations for storage and handling.
 - . 6 Store materials and supplies away from heat generating devices. Use all means necessary to ensure the safe storage and use of paint materials and the prompt and safe disposal of waste. Safeguards to be taken at all times to prevent fire from improperly stored rags, thinners and paints.
 - . 7 Use all means necessary to protect materials before, during and after application to protect the installed work and materials of all other trades.
 - . 8 Store materials and equipment in a well ventilated area with temperature range 7 to 30 °C.
 - . 9 Store temperature sensitive products above minimum temperature as recommended by manufacturer.
 - . 10 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Consultant. After completion of operations, return areas to clean condition to approval of Consultant.
 - . 11 Store only the approved materials at the job site, and store only in a suitable and designated area restricted to the storage of paint materials and related equipment. Provide adequate protection to walls and floors. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.
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- .12 Provide minimum one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.
- .13 Remove only in quantities required for same day use.
- .14 Fire Safety Requirements:
 - .1 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
 - .2 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

1.7 Environmental Requirements

- .1 Ventilation:
 - .1 Provide continuous ventilation during and after application of paint. Run ventilation system 24 hours per day during installation; provide continuous ventilation for 7 days after completion of application of paint.
- .2 Apply paint finishes only when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.
- .3 Substrate and ambient temperature must be within limits prescribed in paint standard and by manufacturer to approval of Consultant.
- .4 Maintain minimum substrate and ambient air temperature of 5°C for Alkyd and 7°C for latex paints. Maximum relative humidity 85%. Maintain supplemental heating until paint has cured sufficiently.
- .5 Moisture Content:
 - .1 Check moisture content of substrates to be painted using electronic moisture meter or other approved method. Maximum moisture content shall be:
 - .1 Concrete and Concrete Masonry: Maximum 12% for solvent coatings and as recommended by manufacturer for water based coatings.
 - .2 Gypsum Board and Plaster: Maximum 12%.
 - .3 Wood: Maximum 15%.
- .6 Provide temporary heating where permanent facilities are not available to maintain minimum recommended temperatures.
- .7 Apply paint finish only in areas where dust is no longer being generated by related construction operations such that airborne particles will not affect the quality of the finished surface.

- . 8 Apply paint only when surface to be painted is dry, properly cured and adequately prepared.
- . 9 Painting in occupied facilities to be carried out during silent hours only.
Schedule operations to approval of
Consultant such that painted surfaces will have dried and cured sufficiently before
occupants are affected.
- . 10 Provide minimum 270 lx on surfaces to be painted.

1.8 Scheduling

- . 1 Submit work schedule for various stages of painting to Consultant for approval.
Submit schedule minimum of 48 hours in advance of proposed operations.
- . 2 Obtain written authorization from Consultant for any changes in work schedule.
- . 3 Schedule painting operations to prevent disruption of occupants in and
about the building.

1.9 Extra Materials

- . 1 Submit maintenance materials.
- . 2 Submit one - four litre can of each type and colour of primer finish coating . Identify
colour and paint type in relation to established colour schedule and finish formula.
- . 3 Deliver to Owner and store where directed.

1.10 Waste Management

- . 1 Place materials defined as hazardous or toxic waste, including used sealant and
adhesive tubes and containers, in containers or areas designated for hazardous
waste.
 - . 2 Return solvent and oil soaked rags for contaminant recovery and laundering or
for proper disposal.
 - . 3 Close and seal tightly all partly used sealant and adhesive containers and store
protected in well ventilated fire-safe area at moderate temperature.
 - . 4 Do not dispose of paints or solvents by pouring on the ground.
Place in designated containers and ensure proper disposal.
 - . 5 Solvent based paints, wood preservatives, stains and finishes which cannot be
reused must be treated as hazardous waste and
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disposed of in an appropriate manner in accordance with hazardous waste regulations. Empty paint cans are to be dry prior to disposal or recycling (where available).

- . 6 Where paint recycling is available, collect all waste paint by type and provide for delivery to recycling or collection facility.
- . 7 Paints, stains, and finishes are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from the Provincial Ministries of Environment and Regional levels of Government.

PART 2 - PRODUCTS

2.1 Materials

- . 1 Qualified products: only paint materials listed on the CGSB Qualified Products List are acceptable for use on this project.
 - . 2 Top line paints, or approved equal, of each of the individual companies listed below may be used:
 - . 1 Benjamin Moore Paints
 - . 2 Para Paints
 - . 3 Crown Diamond Company
 - . 4 Pratt and Lambert Inc.
 - . 5 Sherwin-Williams Company of Canada Limited
 - . 6 Colour Your World
 - . 7 The Glidden Company (Canada)
 - . 8 PPG Canada Inc.
 - . 3 All products shall be applied to minimum thickness as recommended by the manufacturer and C.G.S.B. Where exact finish coat is not listed, consult supplier's specification sheet.
 - . 4 Paint materials for each coating formula to be products of a single manufacturer.
 - . 5 Low odour products: Whenever possible, select products exhibiting low odour characteristics. If two products are otherwise equivalent, select the product with the lowest odour.
 - . 6 Water-borne surface coatings must:
 - . 1 Meet or exceed all applicable governmental and/or industrial safety and performance standards.
 - . 2 Manufactured and transported in such a manner that all steps of the process, including the disposal of waste products arising therefrom, will meet the requirements of all applicable governmental acts, by-laws and regulations including, for
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facilities located in Canada, the Fisheries Act and the Canadian Environmental Protection Act (CEPA).

- . 7 Water-borne surface coatings must not be formulated or manufactured with: aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
- . 8 Water-borne surface coatings and recycled water-borne surface coatings must have a flash point of 61.0 °C or greater.
- . 9 Both water-borne surface coatings and recycled water-borne surface coatings must be made by a process that does not release:
 - . 1 Matter in the undiluted production plant effluent generating a 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.
 - . 2 Total Suspended Solids (TSS) in the undiluted production plant effluent in excess of 15 mg/L to a natural watercourse or
 - a sewage treatment facility lacking secondary treatment.
- . 10 Water-borne surface coatings and recycled water-borne surface coatings must contain information describing proper disposal methods within their packaging.
- . 11 Water-borne paints and stains and recycled water-borne surface coatings must not contain VOCs in excess of 250 g/L as determined by ASTM D 3960-02.
- . 12 Water-borne varnishes must not contain VOCs in excess of 300 g/L.
- . 13 Recycled water-borne surface coatings must contain 50 % post-consumer material by volume.
- . 14 Recycled water-borne surface coatings must not contain:
 - . 1 Lead in excess of 600.0 ppm weight/weight total solids.
 - . 2 Mercury in excess of 50.0 ppm weight/weight total product.
 - . 3 Cadmium in excess of 1.0 ppm weight/weight total product.
 - . 4 Hexavalent chromium in excess of 3.0 ppm weight/weight total product.
 - . 5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.
- . 15 The following must be performed on each batch of consolidated post-consumer material before the surface coating is reformulated and canned. These tests must be performed at a

laboratory or facility which has been accredited by the Standards Council of Canada.

.1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.

.2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.

.3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

- .16 The manufacturing process must adhere to Lifecycle Assessment Standards as per ISO 14040/14041 , CSA Z760-94 .

2.2 Colours

- .1 Consultant will provide Colour Schedule after contract award.
- .2 Colour schedule will be based upon the selection of five base colours and three accent colours. No more than eight colours will be selected for the entire project and no more than three colours will be selected in each area.
- .3 Selection of colours will be from manufacturers full range of colours.
- .4 Where specific products are available in a restricted range of colours, selection will be based on the limited range.
- .5 Perform all colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials allowed only with Consultant's written permission.
- .6 Second coat in a three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 Paint Finishes

- .1 Exterior Metal:
- .1 Galvanized:
- .1 1 coat Galvanized Metal Primer
- .2 2 coats acrylic latex enamel
- .2 Structural Iron and Steel:
- .1 1 coat Rust Inhibitive Paint
- .2 2 coats acrylic latex enamel
- .3 Aluminum:
- .1 1 coat Rust Inhibitive Paint
- .2 2 coats acrylic Latex enamel

- .2 Interior Metal:
 - .1 Galvanized:
 - .1 1 coat Galvanized Metal Primer
 - .2 2 coats alkyd enamel
 - .2 Structural Iron and Steel:
 - .1 1 coat Rust Inhibitive Paint
 - .2 2 coats alkyd enamel
- .3 Wood:
 - .1 Paint:
 - .1 1 coat Latex Enamel Underbody
 - .2 2 coats acrylic latex enamel
 - .2 Natural - Opened Grained Woods
 - .1 1 coat Paste Wood Filler
 - .2 2 coats Urethane Satin Finish
 - .3 Natural - Close Grained Woods
 - .1 3 coats Urethane Satin Finish
 - .4 Stained - Open Grained Woods
 - .1 1 coat Paste Wood Filler Tinted with Stain
 - .2 2 coats Urethane Satin Finish
 - .5 Stained - Close Grained Woods
 - .1 1 coat Interior Stain
 - .2 2 coats Urethane Satin Finish
- .4 Interior Gypsum Board:
 - .1 Primer:
 - .1 1 coat latex primer
 - .2 Paint:
 - .1 1 coat latex primer
 - .2 2 coats acrylic latex
 - .3 Epoxy:
 - .1 1 coat latex primer
 - .2 2 coats 2-component Waterborne Acrylic Epoxy Enamel
 - .5 Interior Masonry:
 - .1 Primer:
 - .1 1 coat block Filler and primer
 - .2 Paint:
 - .1 1 coat block Filler and primer
 - .2 2 coats alkyd enamel
 - .3 Epoxy:
 - .1 2 coats Block Filler and primer
 - .2 2 coats 2-component Waterborne Acrylic Epoxy Enamel
 - .6 Interior Concrete:
 - .1 Paint (Floors):
 - .1 1 coat concrete floor enamel, thinner as recommended by manufacturer
 - .2 2 coats floor enamel

2.4 Substitution of Materials

- .1 The Consultant reserves the right to interchange finishes called for in regard to Sealer, Primer, Stain, Paint, etc. without an additional labour cost for application of the item. An extra charge for the difference in material cost would be considered.

PART 3 - EXECUTION

3.1 General

- .1 Perform all painting operations in accordance with CAN/CGSB-85.100-93 except where specified otherwise.
 - .2 Apply all paint materials in accordance with paint manufacturer's written application instructions.
 - .3 Paint or otherwise finish surfaces of building materials, building services and building accessories not otherwise protected or covered, as shown on Room Finish and Door Schedules, Drawings and as specified herein.
 - .4 In addition, and unless otherwise specified, all work which is exposed to view and which is not prefinished shall be finished by this Section.
 - .5 In areas specifically designated as "unfinished", painting is not required except for bare, primed and zinc coated metal surfaces and insulated ductwork and pipes.
 - .6 Where exposed to view paint bare metals, previously primed metals and zinc coated metals unless specified otherwise.
 - .7 Paint behind surface mounted fixtures on walls and ceilings with full coats of paint.
 - .8 Paint walls behind wall mounted heating units with full coats of paint.
 - .9 Paint inside surfaces of light coves white.
 - .10 Finish tops of doors, trim, projections and other work as specified for surrounding work whether above sight lines or not.
 - .11 Paint piping, ducts and conduit in colours matching background wall or ceiling colours, unless otherwise directed by Consultant. Ducts in mechanical rooms require only one finish coat in addition to primer. Other exposed ductwork to receive two finish coats.
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- .12 Unless specifically indicated on Drawings to be painted, all finish carpentry work shall receive transparent finish.
- .13 Paint shall be applied by means of brushes except for wall and ceiling surfaces on which the paint shall be applied by rollers. Spray painting will be permitted for ceilings only and must be done outside normal working hours.
- .14 Paint shall not be applied in rooms or areas where dust, dirt and debris are present. Cleaning is to be carried out by others to the approval of this trade before the work is commenced.
- .15 Regardless of the number of coats specified for any surface, apply sufficient paint to completely cover and hide substrate and to produce solid, uniform appearance.
- .16 Where two or more coats of the same paint are to be applied, undercoats shall be tinted in lighter shades of final coat to differentiate from final coat.
- .17 Following completion of painting in each area, promptly reinstall all items removed for painting, using only workmen skilled in the particular trade.
- .18 Previously Painted Items: When items to receive paint have been previously painted, lightly sand surface and touch up any defective areas with primer. Apply two coats of finish compatible with existing paint. Paint surfaces to be touched up 'break to break'.

3.2 Inspection

- .1 Condition of Surfaces:
 - .1 Check all surfaces with electric moisture meter and do not proceed if reading is higher than 12-15 without written permission of the Consultant.
 - .2 Proceed with work only when surfaces and conditions are satisfactory for production of a first class job.
 - .3 Remove dust, grease, rust and extraneous matter from all surfaces (except that rust occurring on items specified to be primed under other Sections shall be removed and work reprimed under those Sections).
 - .4 Fine sand all surfaces before starting work of this trade, after filler or primer is applied and between finish coats, where required, so as to eliminate all roughness.
Previously painted surfaces to be fine sanded.
 - .5 Painting shall not be undertaken at temperatures under 10 degrees C, or on surfaces where condensation has or will form due to presence of high humidity and lack of proper ventilation, or under dusty conditions.

3.3 Preparation

- .1 Remove electrical cover plates, light fixtures, surface hardware on doors, door stops, bath accessories and all other surface mounted fittings and fastenings prior to undertaking any painting operations. Store for re-installation after painting is completed.
- .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
- .3 As painting operations progress, place "WET PAINT" signs in occupied areas to approval of Consultant.
- .4 Prime all caulked areas before painting.

3.4 Protection

- .1 Provide metal pans or adequate tarpaulin to protect floors in areas assigned for the storage and mixing of paints.
 - .2 Use sufficient drop cloths and protective coverings for the full protection of floors, furnishings and work not being painted.
 - .3 Leave above areas clean and free from evidence of occupancy upon completion of painting.
 - .4 Protect paint materials from fire and freezing.
 - .5 Keep waste rags in metal drums containing water and remove from building at end of each working shift.
 - .6 Protect existing building surfaces not to be painted from paint spatters, markings and other damage. If damaged, clean and restore such surfaces as directed by Consultant.
 - .7 Cover or mask floors, windows and other ornamental hardware adjacent to areas being painted to prevent damage and to protect from paint drops and splatters. Use non-staining coverings.
 - .8 Protect items that are permanently attached such as Fire Labels on doors and frames.
 - .9 Protect factory finished products and equipment.
 - .10 Protect passing pedestrians, building occupants and the general public in and about the building.
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3.5 Existing Conditions

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Engineer all damage, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- .2 Investigate moisture content of surfaces to be painted and report findings to Engineer. Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .3 Maximum moisture content as follows:
 - .1 Plaster and wallboard: 12%.
 - .2 Masonry/Concrete: 12%.
 - .3 Concrete Block/Brick: 12%.
 - .4 Wood: 15%.

3.6 Cleaning

- .1 Clean all surfaces to be painted as follows:
 - .1 Remove all dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air .
 - .2 Wash surfaces with solution of T.S.P. bleach and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly.
 - .5 To prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
 - .6 Use trigger operated spray nozzles for water hoses.
 - .7 Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or any such organic solvents to clean up water-based paints.
 - .2 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
 - .3 Sand existing surfaces with intact, smooth, high gloss coatings to provide adequate adhesion for new finishes.
-

3.7 Surface Preparation

- .1 Prepare new wood surfaces to CGSB 85-GP-1M.
- .2 Where possible, prime all surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
- .3 Prepare previously painted wood surfaces to CGSB 85-GP-2M.
 - .1 Apply vinyl sealer to CAN/CGSB-1.126-M91 over knots, pitch, sap and resinous areas.
 - .2 Apply wood filler to nail holes and cracks.
 - .3 Tint filler to match stains for stained woodwork.
- .4 Prepare stucco, brick, concrete masonry and concrete surfaces to CGSB 85-GP-31M.
- .5 Prepare concrete floors to CGSB 85-GP-32M. Prepare new concrete floor by acid etching. Rinse with clean water and thoroughly dry.
- .6 Prepare plaster and wallboard surfaces to CGSB 85-GP-33M.

3.8 Surface Preparation -Concrete

- .1 Test surfaces for alkalinity with pink litmus paper or other recognized methods.
- .2 Where extreme alkalinity occurs, wash surfaces with 4% solution tetrapotassium pyrophosphate (5 oz. per gallon of water) where latex base paint is to be used, and with zinc sulphate solution (3 lbs. per gallon water) where other paint bases are to be used.
- .3 Etch normal concrete surfaces to receive alkyd paint with muriatic acid solution (1 part commercial 31.45% to 3 parts water).

3.9 Surface Preparation -Gypsum Board

- .1 Gypsum board shall be bone-dry and all patching complete before the first coat of paint is applied. Surfaces shall be inspected, all "hot spots" properly treated and all rough areas sanded smooth.
-

3.10 Surface Preparation - Woodwork

- .1 Sand smooth all woodwork to be finished and clean surfaces free of dust before applying first coat. With painted woodwork, fill nail holes, splits and scratches with non-shrinking filler after first coat is dry. When these blemishes occur on woodwork surface to receive transparent finish, use putty tinted to match local grain condition. Between coats, sand lightly with No. 00 sandpaper and remove dust.

3.11 Surface Preparation -Metal

- .1 Clean new metal surfaces to be painted by: removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with the following:
 - .1 Solvent cleaning: SSPC-SP-1.
 - .2 Hand tool cleaning: SSPC-SP-2.
 - .3 Power tool cleaning: SSPC-SP-3.
 - .4 Commercial blast cleaning: SSPC-SP-6.
 - .5 Brush-off blast cleaning: SSPC-SP-7.
 - .2 Clean existing metal surfaces to be repainted by: removing loose, cracked, brittle or non-adherent paint, rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with following:
 - .1 Scrape edges of old paint back to sound material. Where remaining paint is thick and sound, feather exposed edges.
 - .2 Commercial blast clean rusted and bare metal surfaces where existing paint system has failed.
 - .3 Solvent cleaning: SSPC-SP-1.
 - .4 Hand tool cleaning: SSPC-SP-2.
 - .5 Power tool cleaning: SSPC-SP-3.
 - .6 Commercial blast cleaning: SSPC-SP-6.
 - .7 Brush-off blast cleaning: SSPC-SP-7.
 - .3 Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes blowing with clean dry compressed air , or vacuum cleaning .
 - .4 Touch up shop primer to CGSB 85-GP-10M with primer as specified in applicable section. Touch-up to include cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas.
 - .5 Prepare galvanized steel and zinc coated steel surfaces to CGSB 85-GP-16M.
 - .6 Prepare copper and copper alloys surfaces to CGSB 85-GP-20M.
 - .7 Prepare new steel surfaces exposed normally to dry conditions to CGSB 85-GP-14M.
-

- .8 Prepare previously painted steel surfaces exposed normally to dry conditions to CGSB 85-GP-15M.
- .9 Prepare steel surfaces exposed to industrial environments to CGSB 85-GP-13M.
- .10 Prepare steel surfaces exposed to water or high humidity levels to CGSB 85-GP-11M CGSB 85-GP-18M .
- .11 Do not apply paint until prepared surfaces have been accepted by Consultant .

3.12 Mixing Paint

- .1 Mix ingredients in container before and during use and ensure breaking up of lumps, complete dispersion of settled pigment, and uniform composition.
- .2 Thin paint for spraying according to manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Engineer.
- .3 Do not use kerosene or any such organic solvents to thin water-based paints.

3.13 Application

- .1 Method of application to be as approved by Consultant. Apply paint by brushroller air sprayer or airless sprayer . Conform to manufacturer's application instructions unless specified otherwise.
 - .2 Brush application.
 - .1 Work paint into cracks, crevices and corners. Paint surfaces not accessible to brushes by spray, daubers or sheepskins.
 - .2 Brush out runs and sags.
 - .3 Remove runs, sags and brush marks from finished work and repaint.
 - .3 Spray application.
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
-

- .3 Apply paint in a uniform layer, with overlapping at edges of spray pattern.
- .4 Brush out immediately all runs and sags.
- .5 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access and only when specifically authorized by Engineer.
- .5 Apply each coat of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .7 Sand and dust between each coat to remove visible defects.
- .8 Finish tops of cupboards, cabinets and projecting ledges, both above and below sight lines as specified for surrounding surfaces.
- .9 Finish inside of cupboards and cabinets as specified for outside surfaces.
- .10 Finish closets and alcoves as specified for adjoining rooms.
- .11 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.14 Mechanical Electrical Equipment

- .1 In finished areas: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment. Colour and texture to match adjacent surfaces, except as noted otherwise.
 - .2 In boiler room, mechanical and electrical rooms: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.
 - .3 In other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
 - .4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
 - .5 Do not paint over nameplates.
-

- .6 Keep sprinkler heads free of paint.
- .7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- .8 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- .9 Paint all fire protection piping red .
- .10 Paint all natural gas piping yellow .
- .11 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.

3.15 Restoration

- .1 Clean and re-install all hardware items that were removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

3.16 Adjusting and Cleaning

- .1 During progress of the work, do not allow the accumulation of empty containers or other excess items except in areas specifically set aside for that purpose.
 - .2 Prevent accidental spilling of paint materials and, in event of such spill, immediately remove all spilled material and the waste of other equipment used to clean up the spill. Wash the surfaces to their original undamaged condition, all at no additional cost to the Owner.
-

- .3 Prior to takeover of the project by Owner, inspect work of this Section and touch-up or refinish damaged finishes and finishes unsatisfactory to Consultant.
- .4 Upon completion of this portion of the work, visually inspect all surfaces and removal all paint and traces of paint from surfaces not scheduled to be painted.

École élémentaire Antonine-Maillet
615 Ridgeway Ave
Oshawa, ON

New Construction Specifications
Vertical Transportation
Elevator Installation



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KJA CONSULTANTS INC
2026-02

Section 14 00 00 General	<u>1</u>
1 General	<u>1</u>
1.1 Basic Requirements	<u>1</u>
1.2 Scope	<u>1</u>
1.3 Maintenance: warranty period	<u>1</u>
1.4 Maintenance Control Program	<u>1</u>
1.5 Definitions of terms	<u>1</u>
1.6 Operation and maintenance manual	<u>2</u>
1.7 Coordination with other trades	<u>4</u>
1.8 Fixture type: vandal resistant	<u>4</u>
1.9 Progress payments	<u>5</u>
1.10 Acceleration of the Work	<u>5</u>
1.11 Acknowledgments	<u>5</u>
1.12 Assignments	<u>5</u>
1.13 Certificates of inspection	<u>6</u>
1.14 Changes in Work	<u>6</u>
1.15 Clean-downs	<u>6</u>
1.16 Claims for extra cost	<u>7</u>
1.17 Codes and ordinances	<u>7</u>
1.18 Completion schedule	<u>8</u>
1.19 Contract Documents	<u>8</u>
1.20 Defective work and non-performance	<u>8</u>
1.21 Drawing and sample submittals	<u>9</u>
1.22 Electrical diagrams	<u>10</u>
1.23 Environmental considerations	<u>10</u>
1.24 Equipment insurance	<u>10</u>
1.25 Equipment moving	<u>10</u>
1.26 Failure to perform	<u>11</u>
1.27 Generic maintenance	<u>11</u>
1.28 Hoistway protection	<u>11</u>
1.29 Inability to complete contract	<u>11</u>
1.30 Information with proposal	<u>11</u>
1.31 Inspection and acceptance	<u>12</u>
1.32 Key switches	<u>12</u>
1.33 Labour laws	<u>12</u>
1.34 Liability insurance	<u>12</u>
1.35 Liens and affidavits	<u>13</u>
1.36 Materials and workmanship	<u>13</u>
1.37 Measurements	<u>13</u>
1.38 Operation by persons with physical disabilities	<u>13</u>
1.39 Operating certificate	<u>14</u>
1.40 Operating environment	<u>14</u>
1.41 Organization chart	<u>14</u>
1.42 Overtime premium	<u>15</u>

1.43	Owner's General Terms and Conditions	<u>15</u>
1.44	Parts	<u>15</u>
1.45	Patents	<u>15</u>
1.46	Payment withheld	<u>16</u>
1.47	Personnel	<u>16</u>
1.48	Preliminary information	<u>16</u>
1.49	Protection of the Work and property	<u>17</u>
1.50	Regular hours of work	<u>17</u>
1.51	Removal of rubbish	<u>17</u>
1.52	Request for payment	<u>17</u>
1.53	Singular and plural	<u>17</u>
1.54	Special tools and access codes	<u>18</u>
1.55	Subcontractors	<u>18</u>
1.56	Submission of proposal	<u>18</u>
1.57	Taxes	<u>18</u>
1.58	Technical seminar	<u>19</u>
1.59	Trade marks	<u>19</u>
1.60	Unit inspection by the Consultant	<u>19</u>
1.61	Warranty of work	<u>19</u>
1.62	Withdrawal or rejection of proposals	<u>20</u>
1.63	Work by other trades	<u>20</u>
1.64	Work site protection	<u>20</u>
1.65	Work under division 02 (Site Preparation)	<u>20</u>
1.66	Work under division 03 (Concrete)	<u>20</u>
1.67	Work under division 04 (Masonry)	<u>21</u>
1.68	Work under division 05 (Metals)	<u>21</u>
1.69	Work under division 07 (Thermal and Moisture Protection)	<u>21</u>
1.70	Work under division 08 (Doors and Windows)	<u>21</u>
1.71	Work under division 09 (Finishes)	<u>21</u>
1.72	Work under Division 22 (Plumbing)	<u>22</u>
1.73	Work under Division 23 (Mechanical)	<u>22</u>
1.74	Work under division 26 (Electrical)	<u>22</u>
2	Separate prices	<u>25</u>
2.1	Separate price submission requirements	<u>25</u>
2.2	Maintenance: five years	<u>25</u>
2.3	Clean-downs	<u>25</u>
Section 14 01 20 Maintenance		<u>1</u>
1	General	<u>1</u>
1.1	General requirements	<u>1</u>
1.2	Scope	<u>1</u>
2	General requirements	<u>1</u>
2.1	Definition of terms	<u>1</u>

2.2	Owner's General Terms and Conditions	2
2.3	Purpose	2
2.4	Routine maintenance	2
2.5	Contract duration	2
2.6	Contract cancellation	3
2.7	Unit removed from service	3
2.8	Work included: general.	4
2.9	Work not included: general.	4
2.10	No obsolescence	5
2.11	Extra to contract work.	6
2.12	Tariffs, duties and taxes	7
2.13	Special tools and access codes	7
2.14	Minimum standard	7
2.15	Reliability	7
2.16	Reliability: action plan and reporting.	8
2.17	Suspension means replacement	8
2.18	Regular hours of work	8
2.19	Account representative.	9
2.20	Defective work and non-performance.	9
2.21	Codes and ordinances	9
2.22	Regulatory authority submissions.	10
2.23	Protection of the Work and property.	10
2.24	Liability insurance.	10
2.25	Assignments.	11
2.26	Directives	11
2.27	Deficiencies not corrected	11
2.28	Submission of proposal	11
2.29	Request for payment	11
2.30	Delay in making repairs	12
2.31	Personnel	12
2.32	Designated substances	12
2.33	Labour disruptions	13
2.34	Coordination with Owner	13
2.35	Rules of work: elevators	14
2.36	Software and firmware updates	14
3	Maintenance procedures	15
3.1	Maintenance Control Program	15
3.2	Controller: remote reset	16
3.3	Repairs.	16
3.4	Mis-adjustment.	17
3.5	Safety devices	17
3.6	Equipment defects	17
3.7	Call-back service	17
3.8	Maintenance: assistance for inspections & testing	18
3.9	Fire service testing	19

3.10	Safety inspections	<u>19</u>
3.11	Manufacturers' parts	<u>19</u>
3.12	Substitute parts	<u>19</u>
3.13	Parts stocked locally	<u>20</u>
3.14	Parts available as required	<u>20</u>
3.15	Building log	<u>20</u>
3.16	Maintenance log book	<u>21</u>
3.17	Time tickets	<u>21</u>
3.18	Accidents and claims	<u>21</u>
3.19	Electrical diagrams	<u>21</u>
3.20	Consultant's inspections	<u>22</u>
3.21	Maintenance tasks (rope replacements)	<u>22</u>
4	Performance	<u>23</u>
4.1	Performance data	<u>23</u>
4.2	Performance data measurement method	<u>23</u>
4.3	Maintenance tasks: hydraulic elevators	<u>24</u>
Section 14 26 23 Limited-Use / Limited-Application (LULA)		<u>1</u>
1	General	<u>1</u>
1.1	General requirements	<u>1</u>
1.2	Type	<u>1</u>
1.3	Data	<u>1</u>
1.4	Dimensions	<u>3</u>
2	Products	<u>3</u>
2.1	Hydraulic: pumping machine unit	<u>3</u>
2.2	Hydraulic fluid: biodegradable	<u>5</u>
2.3	Hydraulic: silencing devices	<u>6</u>
2.4	Hydraulic: main line strainer	<u>6</u>
2.5	Hydraulic: time protective device	<u>6</u>
2.6	Hydraulic motor starting	<u>7</u>
2.7	Jack unit: roped hydraulic	<u>7</u>
2.8	Governor: automatic reset	<u>8</u>
2.9	Hydraulic piping	<u>9</u>
2.10	Hydraulic pit shut-off valve	<u>9</u>
2.11	Solid-state hardware	<u>9</u>
2.12	Auxiliary slowdown devices	<u>10</u>
2.13	Position transducer	<u>10</u>
2.14	Controller	<u>11</u>
2.15	Computing devices	<u>12</u>
2.16	Power interruption restart	<u>12</u>
2.17	Control circuits grounding	<u>13</u>
2.18	Main floor elevator markings	<u>13</u>
2.19	Entrance floor markings	<u>13</u>

2.20	Floor marking: hoistway	13
2.21	Door type: two speed side opening	14
2.22	Door friction	14
2.23	Entrance: fire rating	14
2.24	Entrances	14
2.25	Entrance installation	14
2.26	Entrance finish: stainless steel	15
2.27	Entrances: door hardware	15
2.28	Car door restrictor	16
2.29	Car and hoistway door safety retainers	16
2.30	Hoistway entrance lunar key access	16
2.31	Reopening devices and detection of objects	17
2.32	Door operator (linear or harmonic)	17
2.33	Car door equipment	19
2.34	Car station	20
2.35	Signal lights	21
2.36	Automatic cab lighting and fan control	21
2.37	Floor passing and stopping tones	22
2.38	Car position indicator	22
2.39	Emergency lighting	23
2.40	Telephone: hands-free operation	24
2.41	Two-way communication system	25
2.42	Web-based monitoring service	28
2.43	Closed circuit camera security system	29
2.44	Hall call security: lockout keyswitch	30
2.45	Hall push button stations: single riser	30
2.46	Hoistway access switch	31
2.47	Cab ventilation	31
2.48	Cab: standard finishes	31
2.49	In car lanterns and gongs: applied	32
2.50	Car inspection devices	33
2.51	Sliding guides	33
2.52	Guide rails	33
2.53	Fascias	34
2.54	Car platform	35
2.55	Car frame	35
2.56	Cab installation	35
2.57	Emergency lowering	36
2.58	Car balance	37
2.59	Load weighing device	37
2.60	Pit equipment	37
2.61	Limit switch dowelling	37
2.62	Car ride	38
2.63	Painting	38
2.64	External connections	38
2.65	Travelling cable	38

2.66	Electric wiring	<u>39</u>
3	Execution	<u>40</u>
3.1	Operation: simplex	<u>40</u>
3.2	Operation: load non-stop	<u>40</u>
3.3	Operation: call response.	<u>40</u>
3.4	Operation: dispatch recovery	<u>40</u>
3.5	Operation: call initiation	<u>41</u>
3.6	Operation: high & low call return.	<u>41</u>
3.7	Operation: fault recovery	<u>41</u>
3.8	Operation: independent service	<u>42</u>
3.9	System clock	<u>42</u>
3.10	Door protective device by-pass (nudging).	<u>43</u>
3.11	Door open pause time	<u>43</u>
3.12	Operation: door protective device.	<u>44</u>
3.13	Noise level: door operation.	<u>44</u>
3.14	Noise level: cab	<u>44</u>
3.15	Cab fan: operation	<u>44</u>
3.16	Noise level: control and machine room.	<u>45</u>
3.17	Transmitted vibration	<u>45</u>
3.18	Levelling	<u>45</u>
3.19	Speed control: hydraulic	<u>46</u>
3.20	Test data form: hydraulic	<u>46</u>
3.21	Operating time	<u>47</u>
3.22	Firefighters' Emergency Operation: Phase 1 automatic recall	<u>47</u>
3.23	Seismic Requirements: elevator	<u>48</u>

Section 14 00 00 General

1 General

1.1 Basic Requirements

- .1 Comply with division 01.
- .2 Where there is a conflict between the requirements of division 01 and the general requirements of division 14, the requirements of division 01 will take precedence.

1.2 Scope

- .1 Provide labour, materials, products and services necessary for the following work at École élémentaire Antonine-Maillet, 615 Ridgeway Ave, Oshawa, ON:
 - .1 Installation of a single limited-use / limited-access (LULA), designated 1 in accordance with Section 14 26 23.

1.3 Maintenance: warranty period

- .1 Provide labour, materials, products, equipment and services necessary for the maintenance of the elevating devices in accordance with Section 14 01 20.
- .2 This maintenance to begin at Substantial Performance and end 12 months after Substantial Performance.
- .3 Costs for this maintenance are to be included in the project costs.

1.4 Maintenance Control Program

- .1 Provide to the Owner a copy of the Maintenance Control Program for each device type regardless of whether maintenance of the units is included in the project scope of work.

1.5 Definitions of terms

- .1 The term "consultant", "elevator consulting engineer", "consulting engineer" or "engineer", as used herein, refers to KJA Consultants Inc.
- .2 The term "elevator contractor" or "contractor", as used herein, refers to any person, partners, firm or corporation having a contract with the Owner to furnish labour and materials for the execution of the work herein described.
- .3 The term "sub-contractor", as used herein, refers to any person, partners, firm or corporation having a contract with the contractor to furnish labour and materials for

the execution of the work herein described.

- .4 The term "inspecting authorities", as used herein, refers to authorized agents of governments and of insurance groups which are charged with the responsibility of carrying out periodic inspections and tests on vertical transportation equipment.
- .5 The term "provide", as used herein, means to supply and install new equipment.
- .6 The term "Code", as used herein, refers to the latest edition of the CAN/CSA-B44 Safety Code for Elevators and Escalators, with updates and including Nonmandatory Appendices (which are deemed mandatory herein), as adopted by the Authority Having Jurisdiction.
- .7 All terms in the specifications that are not otherwise defined shall have the definitions as given in the Code.

1.6 Operation and maintenance manual

- .1 Supply to the Consultant and Owner prior to the Substantial Performance inspection, operation and maintenance manuals.
- .2 The project shall not be deemed to have reached Substantial Performance until the complete operation and maintenance manuals have been approved by the Consultant or Owner.
- .3 Upon acceptance by the Consultant or Owner, provide three copies of the operation and maintenance manuals per group in one of the following formats, as selected by the Owner.
 - .1 Print and bind hard copies of which two will be given to the Owner and one will be placed in the respective machine room; OR
 - .2 Print and bind one hard copy that will be placed in the respective machine room and two electronic copies in PDF format on an unprotected digital storage device (such as a USB).
- .4 The operation and maintenance manual shall incorporate, at a minimum:
 - .1 A cover page including project title, address;
 - .2 An index;
 - .3 Contact details for the respective parties;
 - .4 A warranty letter signed by a representative of the contractor having authority to bind the company;

- .5 Controller and drive manuals, including:
 - .1 A description of the controller user interface;
 - .2 The installation and user's manuals;
 - .3 A list of fault and error codes, including an explanation of meanings and corrective actions;
 - .4 Troubleshooting and diagnostic procedures, methods of use and the adjustment of programmable parameters together with their settings at the time of final adjustment.
- .6 As-built wiring diagrams;
- .7 The operation of the equipment including special features, dispatching sequences, and such items as intercom systems and security systems;
- .8 Step-by-step instructions for the operation for special features such as Firefighters' Emergency Operation, Independent service and Emergency Power service;
- .9 As-built diagrams and drawings of operating panels (e.g. car panels, central control consoles) with descriptions of the function of switches and indicators;
- .10 A copy of the final submission to the Authority Having Jurisdiction;
- .11 A copy of the final inspection report from the Authority Having Jurisdiction;
- .12 Operation and maintenance manuals for other major components where applicable, including:
 - .1 Door operator;
 - .2 Emergency brake;
 - .3 Communication system;
 - .4 Safeties & governor;
 - .5 Hoist machine & motor;
 - .6 Cylinders;
 - .7 Hydraulic pump machine and internal components;

- .8 Hall kiosks, including step-by-step instructions for re-programming;
- .9 In-car monitors, position indicators and display screens, including step-by-step instructions for re-programming;
- .10 Hall kiosk special screen features and codes (i.e. to call a specific car to a floor, to call a specific car to a floor for cleaning or other maintenance functions, etc.).
- .13 Supplier and part name for other parts (ex: travelling cable, restrictors, retainers, interlocks, car top inspection station, guide means, etc.), excluding minor or generic items such as screws, bolts, hinges, etc;
- .14 Full instructions for any special maintenance procedure, repair protocol, adjustment or test not addressed by Code (including the A17.2 and the Elevator Industry Field Employee's Safety Handbook);
- .15 Manufacturer's recommended maintenance intervals for each major component.
- .16 A copy of the Maintenance Control Program signed and sealed by a licensed Engineer in jurisdictions where required by the applicable authorities (ex. Quebec).

1.7 Coordination with other trades

- .1 Where the work joins another trade, provide drawings showing the actual dimensions and the method of joining the work to the work of the other trade and information such as anchors, templates and details for cast-ins.
- .2 Provide access and assistance as required, at no extra charge, in relation to work by other trades.

1.8 Fixture type: vandal resistant

- .1 Provide, unless otherwise indicated in the Specifications or Drawings, all signal fixtures, such as push buttons, position indicators, et cetera, of the vandal resistant type.
- .2 Provide push buttons with metal targets.
- .3 Provide push buttons having an enclosure rating of not less than IP54 (per EN 60529) or an approved equivalent upon approval by the Owner.
- .4 Provide push buttons with a positive stop on the back of the button to prevent

excessive force from transferring to the contact.

- .5 Provide push buttons compliant with EN 81-71 Class 2.
- .6 Provide a faceplate of 20 gauge stainless steel.
- .7 Provide, unless otherwise indicated in the Specifications or Drawings, signal fixtures in an illumination colour selected by the Owner.
- .8 Submit illustrations of those types available and provide at least one physical button sample of the type selected by the Owner for final approval.

1.9 Progress payments

- .1 Progress payments will be based on the percentage of the work complete as determined by the Consultant.
- .2 Ten percent of the contract value will be assigned to the provision of manuals and close-out documents and the correction of deficiencies.
- .3 A 10% holdback will apply to payments, this holdback to be released within a period as set out in the applicable legislation.

1.10 Acceleration of the Work

- .1 If the Work falls behind the schedule, take action as necessary to meet the schedule, including, but not limited to, extra personnel and overtime work.
- .2 Pay any costs associated with this action unless the delay is caused by acts of government, riot, civil commotion, war, malicious mischief, act of God or any cause beyond the control of the contractor.

1.11 Acknowledgments

- .1 The proposer acknowledges that the proposer has found no discrepancies nor any ambiguities in the specifications.

1.12 Assignments

- .1 Do not assign nor sublet the contract without the written consent of the Owner.
- .2 Do not assign any payment due or to become due as a result of this contract without the written consent of the Owner.

1.13 Certificates of inspection

- .1 Obtain and pay for certificates of approval and all other necessary permits and inspections.
- .2 Prior to Substantial Performance, arrange and pay for an acceptance inspection of the equipment by a government authority or, if that is not available, by a recognized independent private professional inspection organization.
- .3 Submit, prior to Substantial Performance, the acceptance inspection report.
- .4 Should more than one inspection for a licence or approval be required due to deficient work by others give sufficient advance notice of such deficient work to allow the Work to be completed prior to the time of the subsequent inspection.
- .5 If sufficient advance notice of such deficient work has not been given, assume the cost of the additional inspections.

1.14 Changes in Work

- .1 The Owner, without invalidating the contract, may order extra work or make changes by altering, adding to, or deducting from the Work, the contract sum being adjusted as agreed.
- .2 Execute all such work under the conditions of the original contract except that any claim for extension of time caused thereby shall be adjusted at the time of ordering such change.
- .3 The Consultant shall have authority to make minor changes in the Work, not involving extra cost and not inconsistent with the purpose of the contract.
- .4 Otherwise do no extra work nor make any change unless in pursuance of written order from the Owner.

1.15 Clean-downs

- .1 Provide clean-downs of all construction dust and debris (i.e. control/machine room, hoistway, cab, escalator interior, etc.) to occur as follows:
 - .1 Prior to turnover inspection of an individual elevating device by the Authority Having Jurisdiction.

1.16 Claims for extra cost

- .1 Provide any claims for extra cost due to instructions or otherwise, to the Owner in writing within a reasonable time after the instructions and in any event before proceeding with the work.
- .2 No such claim shall be valid unless so made and authorized in writing by the Owner.
- .3 Invoices or quotes for extra cost shall be based on the material cost +10% plus labour at the contract rates.
- .4 The Contractor shall supply invoices from manufacturers to support the material cost, otherwise the work will be deemed included in the contract.

1.17 Codes and ordinances

- .1 Supply equipment and do work in accordance with building codes, by-laws, regulations and requirements of the local, provincial and federal authorities in effect at the time of the execution of the work.
- .2 Supply equipment and do work in accordance with the Code, and any other code which may govern the requirements of the installation.
- .3 Provide labour and material, whether or not specifically mentioned in this specification, that may be necessary to provide an installation conforming to the applicable codes and regulations.
- .4 Prior to submission of the proposal and throughout the duration of work, give prompt notification in writing of any regulations or requirements known to be in process which might affect the acceptability of the work.
- .5 If changes in codes or regulations result in extra costs, those taking effect subsequent to the date of proposal submission shall be treated as an extra to the contract.
- .6 Requirements of the Authority Having Jurisdiction applicable at the time of proposal submission shall be deemed to be included in the contract, unless specifically excluded herein.
- .7 Should changes in codes, changes in legislative requirements or changes to the requirements of the Authority Having Jurisdiction be announced prior to the date of proposal submission but with a delayed adoption date, those changes shall be deemed to be included in the contract, unless specifically excluded herein.

1.18 Completion schedule

- .1 Submit with the proposal, a detailed schedule including specific dates for equipment delivery times, start of site work, completion of each unit and resolution of all noted deficiencies.
- .2 During the construction period give the following information to the Consultant:
 - .1 Revisions, if necessary, to the completion schedule;
 - .2 A progress report every month showing the progress being made and the percentage of the job completed;
 - .3 Two weeks advance notice for inspection by the Consultant.
- .3 Schedule a job site meeting every two weeks during the construction period.

1.19 Contract Documents

- .1 The Contract Documents shall consist of general conditions, instructions to bidders, the Drawings, Specifications (including alternates and addenda) and completion schedules.
- .2 Execute the work in accordance with the Owner's contract documents, any supplemental conditions and these specifications.
- .3 Where there is a conflict between the documents the Owner's contract documents will take precedence over the other documents and any supplemental conditions will take precedence over these specifications.

1.20 Defective work and non-performance

- .1 The Owner reserves the right to correct any defective work and to charge the cost to the contractor.
- .2 Should the contractor fail to execute any of the Work set out in the contract the Owner reserves the right to do the Work and to charge the cost to the contractor.
- .3 The Owner reserves the right to withhold payment in the event of non-performance or to pay only for that portion of the Work that has been executed.
- .4 The Owner will give reasonable notice in writing prior to taking such action unless the defective work or non-performance prejudice the safety of people or the installation.

1.21 Drawing and sample submittals

- .1 Drawing and sample submittals are required for exposed finishes and fixtures.
- .2 Submit for review samples of metals, glass, paint colours, plastic laminates and finishes, of 200 mm (8") by 300 mm (12") approximate size, properly identified as to project, location and material.
- .3 Submit for review, as a minimum, the following:
 - .1 General arrangements;
 - .2 Details of areas where the work joins the work of other trades;
 - .3 Machine room layouts showing the location of the equipment;
 - .4 Hoistway layouts showing the location of the equipment, car platform dimensions, cab interior dimensions and net inside cab area;
 - .5 Hoistway sections showing overhead, pit equipment, car and frame and entrances;
 - .6 Cab details including the cab shell, platform, interior panels, ceiling, entrance, lighting and finishes;
 - .7 Details of control panels such as central control consoles or fire control panels showing the layout and detailing the design of switches and indicator lights;
 - .8 Details of intercom system station types detailing the controls;
 - .9 Details of any display devices complete with examples of proposed displays, symbols and layout;
 - .10 Fixture brochures.
- .4 Show on the general arrangement or separately, details of frames, doors, sills and supports, lanterns and gongs, including views showing the relationship of hall stations, lanterns and entrances.
- .5 Provide as built information at job completion prior to Substantial Performance.
- .6 Reviews do not include the checking of measurements and do not imply approval of variations from the specifications.

1.22 Electrical diagrams

- .1 Supply wiring diagrams and data as required for the execution of the Work including schematics for speed control, dispatching system, interfaces, printed circuit boards.
- .2 Incorporate, as part of the schematic diagrams, a reference index ('road map') giving the location of electrical components and wiring interconnections for relay coils, relay contacts, field equipment, integrated circuits and other such devices, so that the position on the schematics of any of these items can be readily determined.
- .3 Supply, prior to the Substantial Performance inspection, three prints and one reproducible of the wiring and schematic diagrams revised to show changes that have been made.
- .4 If changes are subsequently made to the wiring or control, supply an additional two sets of marked-up prints of the schematics and field wiring diagrams showing the changes.

1.23 Environmental considerations

- .1 Where practicable, recycle material replaced in the course of the work.
- .2 Provide a list of materials to be removed from site and their proposed recycling or disposal location for approval prior to commencing work.
- .3 Where practicable, provide new materials manufactured by methods that do not adversely affect the environment by, for example, generating residual deposits of heavy elements and greenhouse gases.
- .4 Use materials on site, such as low VOC (Volatile Organic Compound) adhesives and paint, that will not negatively affect the in-building environment.

1.24 Equipment insurance

- .1 The Owner's insurance policy covers equipment delivered to the agreed-upon storage location and accepted by the Owner.
- .2 All other material and equipment is not included in the Owner's policy and such material and equipment is stored at the Contractor's own risk.

1.25 Equipment moving

- .1 Provide floor protection and bracing so that equipment moving causes no damage to the building.

1.26 Failure to perform

- .1 If the contractor shall neglect to prosecute the work properly or fail to perform any provision of the contract, the Owner after ten days written notice to the contractor may, without prejudice to any other remedy the Owner may have, make good such deficiencies and may deduct the cost therefrom from payment due to the contractor.

1.27 Generic maintenance

- .1 Arrange that the equipment can be maintained and adjusted by any competent elevator company without the use of proprietary tools, information or equipment or, if such tools, information or equipment are required, provide them (these shall become the property of the Owner).
- .2 Do not incorporate any running time, cycle counters or trip counters that would cause the equipment to shut down or alter its operation in any way.

1.28 Hoistway protection

- .1 Provide, maintain and, after the Work is complete, remove any partitions required in the hoistway.

1.29 Inability to complete contract

- .1 Should there be a reasonable doubt that the work will be completed within the scheduled time because of labour disputes or any other cause, the Owner reserves the right, at the Owner's option, to cancel the contract.
- .2 In the event this option is exercised, the payments for the work shall be made on a pro rata basis for materials and labour supplied to the time of cancellation and such material and work performed shall become the property of the Owner.
- .3 Prior to exercising this option, the Owner shall give two weeks notice in writing of intention to cancel.

1.30 Information with proposal

- .1 Provide the following information, where relevant, with the proposal:
 - .1 The model and manufacturer of such items as solid state drives, fixtures, control systems, door operators and other purchased material (with the exception of miscellaneous minor items);
 - .2 Brochures, descriptions and manuals (where applicable) for the major items;
 - .3 Detailed completion schedule for the work;

- .4 A copy of your health and safety policy as issued to your employees;
- .5 Mechanic and team regular and overtime hourly rates.

1.31 Inspection and acceptance

- .1 Furnish a team of competent personnel to assist the Consultant with an inspection of each elevating device prior to Substantial Performance to verify that the work is in compliance with the Specifications.
- .2 If the results of these inspections do not meet the requirements of the Specifications, make the appropriate corrections, and provide, as set out above, for another inspection.

1.32 Key switches

- .1 Where possible supply switches and keys compatible with the vertical transportation equipment portfolio of the Owner, unless otherwise noted herein.
- .2 Engrave or mechanically fasten collar rings to clearly mark key-switch functions, positions and key required.
- .3 Prior to placing any units into service for the public, provide to the Owner six copies of each key-switch key type defined in the Code as being Security Group 2, 3 and 4.
- .4 Engrave the key number on each key provided to the Owner and group the keys by Security Group and key type.

1.33 Labour laws

- .1 Comply with applicable provisions of federal, provincial and local labour laws and with applicable union regulations.

1.34 Liability insurance

- .1 Provide, during the period this contract is in force, premises liability, including public liability insurance and property damage insurance in the amount of \$5,000,000 inclusive, to be covered against any claims for damage to property or for personal injury, including death, which may arise from operation under this contract, whether such operation is by yourself or by any sub-contractor or anyone directly or indirectly employed by you.
- .2 Upon completion of the contract, have in force a completed operations and products liability insurance, in the amount of \$5,000,000 inclusive, to be covered against any

claims for damages to property or for personal injury, including death, which may arise after the premises liability is terminated.

- .3 Maintain the insurance in force for a minimum period of two years after completion of the contract.
- .4 List the Owner as an additional insured.
- .5 The certificates shall state that the insurance will not become ineffective without sufficient written notice to the Owner.
- .6 Submit certificates of such insurance with the Owner before work is begun.

1.35 Liens and affidavits

- .1 The final payment and any part of the retained percentage shall not become due until a complete release of liens arising out of this contract or receipts in full in lieu thereof have been delivered to the Owner.
- .2 Furnish an affidavit to the Owner that the release or receipts include labour and materials for which a lien could be filed.
- .3 If any lien remains unsatisfied after all payments are made, refund to the Owner monies that the Owner may be compelled to pay in discharging such a lien, including costs and reasonable legal fees.

1.36 Materials and workmanship

- .1 Provide all new materials and equipment.
- .2 Install equipment in a neat, accurate, workmanlike manner.

1.37 Measurements

- .1 In the execution of the work, verify all dimensions with the actual conditions in order to do a perfect job.

1.38 Operation by persons with physical disabilities

- .1 Ensure that controls and fixtures comply with Appendix E of the Code.

1.39 Operating certificate

- .1 Where permitted by the Authority Having Jurisdiction, locate licences or operating certificates in the control room, and submit and pay for any such applications as may be necessary.
- .2 Where licences or operating certificates in the cab are required by the Authority Having Jurisdiction, coordinate with the Owner a location to install licences with permanent licence holders with steel or aluminum borders and plastic or glass covers.

1.40 Operating environment

- .1 Provide material and equipment to function normally within the requirements of the specifications when the ambient temperature is between 5.0 and 32.0 degrees Celsius (41 and 90 degrees Fahrenheit).
- .2 Provide material and equipment to function normally and within the requirements of the specifications when the ambient relative humidity is between 25% and 95% non-condensing.
- .3 Provide material and equipment to function normally and within the requirements of the specifications when the supply voltage is within minus 10% and plus 10% of the nominal voltage and the frequency is within 5% of the nominal frequency.
- .4 Provide equipment needed to meet the specified voltage operating parameters (e.g. filters, isolation transformers, transient voltage surge suppression, etc.).
- .5 Arrange that the equipment meet the seismic requirements.
- .6 Perform necessary equipment adjustments related to building compression up to and including building compression of 2mm (0.08 in.) over a 4,000 mm (157.5 in.) floor-to-floor height.

1.41 Organization chart

- .1 Provide to the Owner an organization chart from the local supervisory level up.
- .2 Provide to the Owner the names, positions and experience of the field and supervisory personnel associated with this project.
- .3 During the course of the work when organization changes are made, provide the Owner with updated information.

1.42 Overtime premium

- .1 In the event that the Owner, for whatever reason, pays for overtime worked to complete the work as set out in the Specifications, the Owner will pay the added cost of the overtime.
- .2 The added cost shall be the difference between the overtime cost and straight time cost at contract rates.
- .3 Obtain from the Owner prior written authorization for overtime to be worked and chargeable, as described above, to the Owner, this authorization to be for specific amounts and for specific times.
- .4 Submit time sheets for such overtime worked for approval to the Owner or the designated representative of the Owner within 48 hours of the time that such overtime is worked.
- .5 If the procedures as set out above are not followed, assume the costs of the time worked.

1.43 Owner's General Terms and Conditions

- .1 Abide by the Owner's General Terms and Conditions.
- .2 Where there is a conflict between the Owner's General Terms and Conditions and these specifications the Owner's Terms and Conditions take precedence.

1.44 Parts

- .1 Supply parts on request for a period of fifteen years subsequent to Substantial Performance of the project, at then prevailing prices.
- .2 Where purchased components are used, ensure that the original manufacturer's name and component designation are clearly marked on the part or in the parts catalogue.

1.45 Patents

- .1 Hold and save the Owner and its officers, agents, servants and employees harmless from liability due to patent or copyright infringement arising from the use of, in the performance of the work or in the completed installation, any invention, process, article, or appliance.

1.46 Payment withheld

- .1 Approval for payment may be withheld to such extent as may be necessary on account of:
 - .1 Defective work not remedied;
 - .2 Claims filed or reasonable evidence indicating probable filing of claims;
 - .3 Failure of contractor to make payments properly to sub-contractors or for material and labour;
 - .4 Failure to work to schedule;
 - .5 A reasonable doubt that the contract can be completed for the balance then unpaid;
 - .6 Damage to the building or another contractor by the elevator contractor or one of their subcontractors.
- .2 When the above grounds are removed, payment will be made for amount withheld.

1.47 Personnel

- .1 Supervise personnel so that they present a neat appearance and their movement in the building is within the requirements of their work.
- .2 Provide uniforms and photo identification for personnel.
- .3 The Owner reserves the right to reject or refuse access to personnel or contractors at its sole discretion.
- .4 Assign and maintain a dedicated service representative to the work, this representative to be responsible for liaison with the Owner and the Consultant.
- .5 Assign and maintain a dedicated service supervisor to the work, this supervisor to be responsible for technical communications with the Owner and the Consultant.

1.48 Preliminary information

- .1 Submit, within 30 working days after awarding of contract, the information and details, including reactions, power requirements, ventilation requirements, cutouts, access requirements, light and outlet locations, quantity, location and size of external wires required to inter-connect the equipment, and all other information required to complete the work to be performed by others in conjunction with the installation of the equipment.

1.49 Protection of the Work and property

- .1 Maintain protection of the Work and protect the Owner's property from injury or loss arising out of the execution of this contract.
- .2 Make good any injury or loss caused by the Contractor's agents or employees.
- .3 Take all necessary precautions to ensure that the Work is done in a manner that does not endanger any person.

1.50 Regular hours of work

- .1 Regular hours of work are from 08:00 to 17:00 Monday to Friday, excluding holidays.
- .2 For residential buildings and hotels complete noisy and disruptive work during regular hours.
- .3 For all other buildings, unless otherwise noted, complete noisy and disruptive work outside of regular hours.

1.51 Removal of rubbish

- .1 Remove rubbish, keep the building and premises clean during the progress of the work, and leave the premises at completion in perfect condition as far as the work under the specifications is concerned.

1.52 Request for payment

- .1 Submit applications for payment with the necessary data, information, waivers and affidavits including certificates of compliance and appropriate statutory declaration.

1.53 Singular and plural

- .1 In all cases singular and plural shall be interchangeable and shall be applied as required to meet the sense and intent of the Specifications.
- .2 Where the singular is employed it shall be interpreted as necessary, unless otherwise indicated, to apply to all equipment and devices required to produce a complete installation.

1.54 Special tools and access codes

- .1 If any special tools (i.e. tools that are not readily purchased from a hardware supplier) are used to maintain or adjust the equipment or are required for any aspect of the work on the equipment, list these tools with details on the proposal form and provide such tools to the Owner prior to Substantial Performance.
- .2 If any access codes are used to maintain or adjust the equipment or are required for any aspect of the work on the equipment (including the reading and resetting of error codes and logs) list these access codes with details on the proposal form and provide such access codes to the Owner prior to Substantial Performance.
- .3 Do not change the access codes without the written consent of the Owner and, when changed, provide to the Owner the new access codes.

1.55 Subcontractors

- .1 Bind subcontractors to all applicable portions of the Specifications.
- .2 The contractor shall be responsible for all actions and all work performed by its subcontractors to the same extent as the contractor is itself responsible under the Specifications.

1.56 Submission of proposal

- .1 Submission of a proposal will be considered presumptive evidence that the proposer is conversant with local facilities and conditions, requirements of the Contract Documents and of pertinent provincial and local codes, state of labour and material markets, and in the proposal has made due allowance for all contingencies.

1.57 Taxes

- .1 Include applicable local, provincial and federal taxes or assessments in effect at the time of the signing of the contract.
- .2 Show on the proposal form the amount of each tax included.
- .3 The Contractor is liable for the above mentioned taxes or assessments whether or not specifically mentioned in his proposal or in the final contract document.
- .4 In the event new taxes or assessments, to become due on completion of the contract, are imposed after the signing of the contract these are to be paid, in addition to the original contract amount, by the Owner to the Contractor, who in turn is to pay them to the proper authorities.
- .5 In the event taxes or assessments in effect at the signing of the contract should be

revoked before consummation of the contract rebate to the Owner the amount of such taxes and assessments included in the original contract.

1.58 Technical seminar

- .1 Before the time of Substantial Performance, arrange with the Owner to provide a seminar for the Owner's staff.
- .2 Include in the seminar a complete review of the documentation, operation of the equipment and demonstration of any special features including programming of any display devices.

1.59 Trade marks

- .1 Do not apply trade marks visible to the general public on any piece of equipment.

1.60 Unit inspection by the Consultant

- .1 Advise the Consultant in writing two weeks prior to the completion of a unit so as to arrange an inspection by the Consultant at a mutually convenient time.
- .2 Assist the Consultant in the performance of this inspection to verify that performance figures, workmanship and equipment furnished are in compliance with the Specifications.
- .3 Provide the necessary test weights to carry out full load tests and a team of competent persons to assist the Consultant in making the necessary tests and inspections.

1.61 Warranty of work

- .1 Warrant that the materials, performance and workmanship are in accordance with the industry standard in every respect.
- .2 Make good defects not due to improper use which may develop within one year from the date of Substantial Performance of the project.
- .3 Warrant that the equipment performs to the standards set out herein.
- .4 Neither the final payment nor any provision of the Contract Documents diminishes the responsibility for negligence or faulty materials or workmanship within the extent and period provided by law.
- .5 Upon written notice remedy defects and pay expenses for damage to others resulting from defects.

1.62 Withdrawal or rejection of proposals

- .1 The Owner reserves the right to reject any or all proposals or to waive any conditions.
- .2 Proposals may not be withdrawn until sixty days after the scheduled date for the receipt of the proposals.

1.63 Work by other trades

- .1 In the event that work by other trades is required and work by others as set out herein is in conflict with or inadequate for your equipment or design, so state on the proposal form with all necessary details.
- .2 If no exceptions are noted on the proposal form, pay the costs of all modifications necessary to suit your equipment and design.

1.64 Work site protection

- .1 Provide, maintain and, after the work is complete, remove protective hoarding around the work site.
- .2 Arrange the protective hoarding so as to prevent public access to the work site.

1.65 Work under division 02 (Site Preparation)

- .1 A lockable storage space during the installation period.

1.66 Work under division 03 (Concrete)

- .1 Properly framed hoistways with a variation from nominal well dimensions of not more than ± 25 mm (1").
- .2 A structure designed for the following estimated reactions (including a provision for impact) generated by each device:

Reactions at (per unit):	car buffer		on pit floor under jack (1 jack)		car guide rail safety forces (per rail, in down direction)	
	kN	lb	kN	lb	kN	lb
LULA	35	7,900	40	9,000	15	3,400

- .3 Gross openings for hoistway entrances exceeding the clear door dimensions by 250 mm (10") on each side and above.

-
- .4 Blocking in of entrance frames following installation.
 - .5 Supports for the sill support angles, flush with the inside hoistway wall, a minimum of 150 mm (6") in depth, capable of sustaining a minimum unit load equivalent to the capacity of the elevator.
 - .6 Adequate support for the guide rail fastenings and installation of guide rail bracket inserts where required.
 - .7 Sleeves and coring for electric ducts and oil lines in the hoistway, machine space and control space as required.
 - .8 Pockets, as required, to permit fastening of rail brackets to building structure. Pockets to be filled after brackets installed.
 - .9 Fire-resistant control/machine room with a concrete floor and access door.

1.67 Work under division 04 (Masonry)

- .1 Grouting under hoistway sills.

1.68 Work under division 05 (Metals)

- .1 Supports for the guide-rails at each floor and in the overhead.
- .2 For hoistway walls not made of concrete, intermediate supports for the guide-rails where guide-rail reinforcement cannot be installed by the elevator contractor and where floor heights exceed 4300 mm (14' 0").

1.69 Work under division 07 (Thermal and Moisture Protection)

- .1 Means to limit the presence of water, gases and odours in the pit.
- .2 Waterproofing of the pit.

1.70 Work under division 08 (Doors and Windows)

- .1 For the elevator control/machine room, a full height self-locking and self-closing access door.

1.71 Work under division 09 (Finishes)

- .1 Initial painting of the machine room floors.
- .2 Sealing of the hoistway and machine room ceilings and walls to reduce dust.

- .3 Painting of the hoistway entrances, where required.
- .4 Flooring for the elevator cab.

1.72 Work under Division 22 (Plumbing)

- .1 A pit drain with connection to the building drainage system, drains to have a capacity of 11.3 m³/h (3,000 gal/h) per elevator hoistway having a positive means to prevent water, gases and odours from entering the hoistway. Note: a pit drain is recommended but is not a Code requirement.
- .2 A cover for the pit drains secured to and level with the pit floor.
- .3 A pit drain grease interceptor.
- .4 Any sprinkler systems employing water if installed in the machine rooms, control rooms or hoistway to be arranged to operate at a higher temperature (approximately 20% higher) than the fire alarm sensors.
- .5 If required by the applicable regulations, means to limit the presence of smoke in the hoistway of the designated firefighters' elevator.

1.73 Work under Division 23 (Mechanical)

- .1 Heating and cooling in order to maintain continuously (i.e. 24 hours a day) a temperature of greater than 13 degrees Celsius and less than 29 degrees Celsius based on the estimated heat generated by the elevator equipment as follows:

Heat generated (per elevator):	control/machine room	
	kW	BTU/h
LULA	1.1	3,600

- .2 Do not locate HVAC equipment directly above elevator equipment and ensure air conditioning exhaust ducts do not direct conditioned air directly onto elevator wire ropes.

1.74 Work under division 26 (Electrical)

- .1 A grounded power supply sufficient to start and run each unit at rated speed and capacity, and including the following:
 - .1 A disconnect means located in view of the elevator controller near the access to the control/machine room.

- .2 Wiring between the disconnect and the elevator power input point (elevator transformer or controller).
- .2 A power supply capable of supplying for each unit the following estimated starting and running currents in amperes based on the power supply noted:

Full load up currents (per elevator)	power supply	starting current	running current
	Volts	Amps	Amps
LULA	208	30	15

- .3 In the elevator machine room one 15A 120V single phase circuit breaker or disconnect per machine/control room located in view of the elevator controller near the access to the machine/control room, to power the two-way communications device.
- .4 In the elevator control/machine room, one 15 A 120 V, single phase circuit breaker for each elevator, located adjacent to the lock side of the control/machine room door, to power cab ventilation, cab lighting equipment and the car top duplex GFCI receptacle. The power for this circuit to be derived from the emergency power supply if available.
- .5 An auxiliary disconnect contact with wiring to the controller, to indicate if the disconnect is on or off.
- .6 In the elevator control/machine room, protected LED lights controlled by a switch located adjacent to the lock side of the space access door, located at approximately 2500 mm (8') from floor level as required to give a minimum illumination of 200 lx at floor level and within the controller, the power for the lighting circuit being derived from the emergency power supply if available.
- .7 In the elevator control/machine room, duplex GFCI receptacles mounted on the wall and spaced at approximately 5000 mm (16') intervals.
- .8 In the elevator control/machine room, a duplex GFCI receptacle (to power intercommunication equipment) mounted on a controller and connected to the emergency power supply if available.
- .9 In the elevator pit, duplex GFCI receptacles mounted on the wall, spaced at approximately 5000 mm (16') intervals and located clear of elevator equipment.
- .10 In the elevator pit, protected LED lights, controlled by a light switch located adjacent to the pit entrance, located clear of elevator equipment to give a minimum illumination of 100 lx at pit level, the lowest lamps to be within 500 mm (20") of the pit floor. The power for the lighting circuit to be derived from the emergency power

supply if available.

- .11 Fire alarm initiating devices (FAIDs) on the recall floor.
- .12 Fire alarm initiating devices (FAIDs) on all other floors.
- .13 Fire alarm initiating devices (FAIDs) at the top of the hoistway.
- .14 Fire alarm initiating devices (FAIDs) in the pit.
- .15 Fire alarm initiating devices (FAIDs) in the control/machine space.
- .16 A connection from the fire alarm initiating devices (FAIDs) on the recall floor to the elevator controller.
- .17 A connection from the fire alarm initiating devices (FAIDs) on all other floors to the elevator controller.
- .18 A connection from the fire alarm initiating devices (FAIDs) at the top of the hoistway to the elevator controller.
- .19 A connection from the fire alarm initiating devices (FAIDs) in the pit to the elevator controller.
- .20 A connection from the fire alarm initiating devices (FAIDs) in the control/machine space to the elevator controller.
- .21 An internet connection in the machine/control room, capable of operating during a power failure for a minimum of four hours.
- .22 A closed circuit camera system for the elevator.
- .23 Conduit between the elevator hoistway, control/machine room and any remote equipment locations, terminated outside the hoistway at the basement level (or other level designated by the Owner) at a junction box (junction box to be provided by the elevator contractor).
- .24 Electric power during erection, for illumination, operations of tools and hoist, starting, testing and adjusting.

2 Separate prices

2.1 Separate price submission requirements

- .1 Submit prices to provide the following:

2.2 Maintenance: five years

- .1 Provide full maintenance of the equipment for a period of five years beginning at the end of the maintenance included in the contract.
- .2 The services agreement will continue on a month-to-month basis at the expiration of the original term unless notice in writing is provided by either party, at least 60 days in advance of the expiration date, notifying the other party of their intent to not continue with the services agreement beyond the original term mandate or any subsequent monthly mandates.
- .3 Provide this service at a flat monthly price without escalation.
- .4 Provide this service in conformity with the Maintenance Specifications.

2.3 Clean-downs

- .1 Provide a complete equipment clean-down of all construction dust and debris (i.e. control/machine room, hoistway, cab, escalator interior, etc.).

END OF SECTION

Section 14 01 20 Maintenance

1 General

1.1 General requirements

- .1 Conform to Section 14 00 00.

1.2 Scope

- .1 Provide labour, materials, products, equipment and services necessary for the full maintenance of the equipment.

2 General requirements

2.1 Definition of terms

- .1 The term "Owner", as used herein, refers to Conseil scolaire Viamonde.
- .2 The term "Consultant", "elevator consulting engineer", "consulting engineer" or "engineer", as used herein, refers to KJA Consultants Inc.
- .3 The term "elevator contractor" or "contractor", as used herein, refers to any person, partners, firm or corporation having a contract with the Owner to furnish labour and materials for the execution of the work herein described.
- .4 The term "sub-contractor", as used herein, refers to any person, partners, firm or corporation having a contract with the contractor to furnish labour and materials for the execution of the work herein described.
- .5 The term "inspecting authorities", as used herein, refers to authorized agents of governments which are charged with the responsibility of carrying out periodic inspections and tests on vertical transportation equipment.
- .6 The term "unit", as used herein, means any elevator, dumbwaiter, escalator, platform lift, lift for person with physical disabilities, moving walk or similar device mentioned in this Specification. These terms are to be interchangeable to meet the intent of the Specification.
- .7 The term "Code", as used herein, refers to the latest edition of the CAN/CSA-B44 Safety Code for Elevators and Escalators, as adopted by the Authority Having Jurisdiction.
- .8 All terms in the Specifications that are not otherwise defined shall have the definitions as given in the Code.

2.2 Owner's General Terms and Conditions

- .1 Abide by the Owner's General Terms and Conditions.
- .2 Where there is a conflict between the Owner's General Terms and Conditions and these specifications the Owner's Terms and Conditions take precedence.

2.3 Purpose

- .1 The purpose of the maintenance program is to maintain the equipment in substantially new condition, to secure the Owner's equity and to provide safe, trouble-free service.

2.4 Routine maintenance

- .1 Provide labour, materials, products, equipment and services necessary to complete maintenance testing and inspections required by the Authority Having Jurisdiction at the appropriate intervals.
- .2 Where required, perform the following:
 - .1 All Category 1 tasks at intervals not to exceed 12 months.
 - .2 All Category 3 tasks at intervals not to exceed 36 months.
 - .3 All Category 5 tasks at intervals not to exceed 60 months.
- .3 All other maintenance tasks required by Code with no prescribed frequency shall be completed at intervals not to exceed 12 months.
- .4 Perform periodic maintenance inspections once every three months, at a minimum.
- .5 In the course of the examination, should faulty parts be discovered replace them at once, and should any unusual operations or noises be found take corrective action immediately.
- .6 Schedule parts showing excessive wear for replacement on the next regular examination.

2.5 Contract duration

- .1 Provide full maintenance on the equipment to the maintenance procedures set out in the Specifications for such periods as may be defined in the Contract Documents.
- .2 The services agreement will continue on a month-to-month basis at the expiration of the original term unless notice in writing is provided by either party, at least 60

days in advance of the expiration date, notifying the other party of their intent to not continue with the services agreement beyond the original term mandate or any subsequent monthly mandates.

2.6 Contract cancellation

- .1 The Owner may elect, at its option, to cancel the contract prior to its normal termination:
 - .1 If the maintenance is not executed in accordance with the Specifications, as evidenced by the report of a recognized independent elevator consultant, and if, within four weeks of written notice, the necessary corrective action has not been completed;
 - .2 If there is a continuing failure to perform as evidenced by more than two negative reports in any twelve month period with no positive or neutral reports in the same twelve month period. (A negative report is one which defines the level of contract performance as less than 95% of the specified requirements.)
- .2 In the event of such cancellation, the Owner may, at its option, elect to use another company to restore the equipment to the Specifications standards and to charge the cost of this to the elevator contractor.
- .3 The Owner has the option to cancel the contract upon one month's written notice if there is a significant change in the circumstances of the contract (e.g. a change in ownership of the equipment, a modernization or replacement at the Owner's cost of equipment components, a change in ownership of the maintenance company); this option to be available to the Owner for a period of three months from the date on which the changed circumstances become known to the Owner.

2.7 Unit removed from service

- .1 The Owner may elect, at its option, to remove a unit from service temporarily.
 - .1 For a unit that is temporarily removed from service, each month start the unit, ensure that it operates correctly and perform regular maintenance.
 - .2 For a unit that is temporarily removed from service, invoice the maintenance at 50% of the regular monthly price.
 - .3 For a unit that is temporarily removed from service, continue to perform maintenance work mandated by the Regulatory Authorities.
- .2 The Owner may elect, at its option, to remove a unit from service permanently.

- .1 For a unit that is permanently removed from service, cease maintenance and invoicing activities.
- .3 The Owner will provide the Contractor with 30 days notice for units that are to be temporarily or permanently removed from service.

2.8 Work included: general

- .1 Maintain, repair or replace all of the elevating device equipment, except where specifically excluded, including the following, where provided:
 - .1 Elevator and lift machine, motor, drive, controller, brake, emergency brake, governor, safety, hydraulic cylinder, hydraulic fluid, pump, valve, suspension means, door operating equipment, door equipment, fixtures, remote panels, elevator communication system, fixture lighting and elevator cab lighting, fans, and all other mechanical and electrical parts required for the operation of the equipment.
 - .2 Monitoring systems where such systems are independent from base building automation systems and dedicated to the monitoring of elevating equipment.
- .2 Upon commencement of the contract, immediately assume responsibility for maintenance of the equipment and correct any pre-existing deficiencies.

2.9 Work not included: general

- .1 Do not repair or replace the following, where provided:
 - .1 Elevator and lift cab finishes, cab interior handrails (except for attachments on the exterior of the cab), flooring, hoistway enclosure, hall door and entrance (except to maintain clearances), sill and frame finish, unless damaged as a result of misalignment or incorrect maintenance;
 - .2 Buried components of hydraulic cylinders, unless damaged as a result of inadequate or incorrect maintenance (the Contractor is still required to perform the requisite maintenance for buried cylinders with corrosion protection);
 - .3 Electrical conduit/wiring outside the hoistway and machine/control room;
 - .4 Electrical disconnects.
- .2 Repairs, replacements or call-backs directly resulting from abnormal environmental conditions (such as floods, fire, lightning, and other “acts of God”) shall not be deemed included.

- .3 Repairs, replacements or call-backs directly resulting from vandalism or user negligence, apart from regular wear and tear, shall not be deemed included.
- .4 Repairs, replacements or call-backs directly resulting from failure or non-performance of non-elevator building elements (such as machine room air conditioning failure, building power failure, pit flooding) shall not be deemed included.
- .5 Any of the foregoing work not included shall be deemed included in the contract where Contractor negligence, carelessness or improper maintenance is either the cause or a significant contributing factor (ex: a pit drain blocked because of a pit not being kept clean, buried cylinders with PVC failing due to exposure to water and missed annual testing, etc.).
- .6 All claims or invoices for work not included in the contract shall be substantiated by the Contractor to the satisfaction of the Consultant; absence of a root cause of a failure or call-back that is covered by the contract shall not be deemed sufficient justification for an extra to the contract.
- .7 In the case of power failures or power disruptions (ex: brown-outs or voltage spikes) requiring repairs or call-backs, the work will be deemed not included if the Owner, acting reasonably, can correlate the event to a building issue; in absence of any known power failure or building issue the work shall be deemed included in the Contract unless the Contractor can provide evidence in the form of power supply monitoring demonstrating a fluctuation of more than $\pm 10\%$.
- .8 Invoices or quotes for work not included in the contract shall be based on the material cost $+10\%$ plus labour at the contract rates.
- .9 The Contractor shall supply invoices from manufacturers to support the material cost and time tickets to support the labour cost, otherwise the work will be deemed included in the contract.

2.10 No obsolescence

- .1 If a component or device is considered obsolete or not available from normal sources of supply, provide an equivalent replacement or re-manufacture as necessary so as to ensure that the equipment continues to operate in substantially new condition.
- .2 Supply replacement parts identical in make and model to the original parts where at all possible.
- .3 Provide substitutes of equal or better quality when identical parts are not available.

- .4 Where identical parts are not available and a substitute part is necessary, submit the substitute part for the approval of the Owner.
- .5 Modify the equipment as needed to suit substitute parts.

2.11 Extra to contract work

- .1 Give any claims for extra to contract work, due to instructions or otherwise, to the Owner in writing within a reasonable time after the work is completed.
- .2 No such claim shall be valid unless so made and authorized by the Owner.
- .3 Where extra to contract work is approved and done at the Owner's expense:
 - .1 Bill the work at hourly rates in accordance with the Contract.
 - .2 Do not charge for more than a total of forty (40) minutes of travel time per site visit.
 - .3 Do not add miscellaneous charges (e.g. mileage, parking charges, truck charges, sundry charges, fuel charges, etc.).
- .4 For extra to contract work in buildings that are more than 75 kilometers driving distance away from the city center of a city with a population of more than 50,000:
 - .1 Bill the work at hourly rates in accordance with the Contract.
 - .2 Charge travel time based on the lesser of the actual time traveled or the shortest travel time to the nearest city with a population of more than 50,000.
 - .3 Charge travel expenses based on the lesser of the actual distance traveled or the shortest travel distance to the nearest city with a population of more than 50,000.
 - .4 Do not add miscellaneous charges (e.g. hotels, parking charges, truck charges, sundry charges, etc.).
 - .5 Charge mileage at a rate that does not exceed the prevailing tax deduction rate established by federal tax authorities.

2.12 Tariffs, duties and taxes

- .1 The maintenance fees shall include all taxes, duties and tariffs, except for Value Added Taxes.
- .2 There shall be no increases to the maintenance fees during the contract as a result of changes in taxes, tariffs, duties or other levies, or changes in labour rates or labour agreements, unless explicitly permitted by these specifications or the contract.

2.13 Special tools and access codes

- .1 For those elevators or components that have access codes or access tools used for commissioning, programming, or other purposes, keep all access tools on site with a hard copy listing of access codes.
- .2 If the contract is cancelled, provide to the Owner, for those elevators or components that have access codes or access tools for commissioning, programming or other purposes, the access tools and a hard copy listing of the access codes.
- .3 If the Owner provides access codes or access tools, preserve these codes and tools confidential for use only on the particular equipment for which the Owner has provided them and keep these access codes or access tools on site.
- .4 Change access codes only when authorized in writing by the Owner.

2.14 Minimum standard

- .1 As a minimum standard, perform to the Specifications and to the Code.
- .2 Maintain the equipment at all times in the same or better condition as at the commencement of the maintenance work.

2.15 Reliability

- .1 Ensure that the average number of callbacks does not exceed 6.0 per elevator per year.
- .2 Ensure that the average number of entrapments does not exceed 1.5 per elevator per year.
- .3 Ensure that the average number of callbacks does not exceed 3.0 per escalator per year.

2.16 Reliability: action plan and reporting

- .1 Provide a summary report detailing root cause analysis and a plan for corrective action where a building exceeds the reliability benchmark by more than 25% over an average of 6 months.
- .2 Provide a summary report detailing root cause analysis and a plan for corrective action where an individual elevator exceeds the reliability benchmark by more than 50% over an average of 12 months.
- .3 Continue to provide such summary reports every three months until such a time as the building or elevator reliability meets the reliability benchmark for a period of 6 months in a row.

2.17 Suspension means replacement

- .1 In groups of elevators, the elevator(s) adjacent to an elevator undergoing a suspension means replacement shall not be removed from service during regular hours if removing such elevators from service would reduce the number of elevators available in the group to less than 65%.
- .2 Where the suspension means replacement requires a reduction in the number of elevators available in a group to less than 65%, all such work shall be completed outside of regular hours (inclusive of preparatory work such as the installation of netting/hoarding, if applicable).
- .3 The foregoing requirements apply only to groups of elevators and not simplex elevators.
- .4 The foregoing requirements also apply to the replacement of governor ropes or compensating means.

2.18 Regular hours of work

- .1 Regular hours of work are from 08:00 to 17:00 Monday to Friday, excluding holidays.
- .2 For residential buildings and hotels complete noisy and disruptive work during regular hours.
- .3 For all other buildings, unless otherwise noted, complete noisy and disruptive work outside of regular hours.

2.19 Account representative

- .1 Assign and maintain a company representative for the contract to coordinate activities and to be responsible for communications with the Owner's representative.
- .2 Assign a person acceptable to the Owner for this position.

2.20 Defective work and non-performance

- .1 The Owner reserves the right to correct defective work and to charge the cost to the Contractor.
- .2 Should the contractor fail to execute any of the Work set out in the contract the Owner reserves the right to do the Work and to charge the cost to the Contractor.
- .3 The Owner reserves the right to withhold payment in the event of non-performance or to pay only for that portion of the Work that has been executed.
- .4 The Owner will provide 30 days notice in writing prior to taking such action, except where the defective work or non-performance prejudice the safety of people or the installation, in which case the Owner need only provide 5 days notice in writing.
- .5 The Contractor may correct the defective work within the notice period but shall provide confirmation in writing to the Owner prior to the end of the notice period, or the Contractor shall still bear direct charges incurred by the Owner to correct the defective work.

2.21 Codes and ordinances

- .1 Supply equipment and do work in accordance with building codes, by-laws, regulations and requirements of the local, provincial and federal authorities in effect at the time of the execution of the work.
- .2 Supply equipment and do work in accordance with the Code, and any other code which may govern the requirements of the installation.
- .3 Provide labour and material, whether or not specifically mentioned in this specification, that may be necessary to provide an installation conforming to the applicable codes and regulations.
- .4 Prior to submission of the proposal and throughout the duration of work, give prompt notification in writing of any regulations or requirements known to be in process which might affect the acceptability of the work.
- .5 If changes in codes or regulations result in extra costs, those taking effect subsequent to the date of proposal submission shall be treated as an extra to the

contract.

- .6 Requirements of the Authority Having Jurisdiction applicable at the time of proposal submission shall be deemed to be included in the contract, unless specifically excluded herein.
- .7 Should changes in codes, changes in legislative requirements or changes to the requirements of the Authority Having Jurisdiction be announced prior to the date of proposal submission but with a delayed adoption date, those changes shall be deemed to be included in the contract, unless specifically excluded herein.

2.22 Regulatory authority submissions

- .1 Complete any submissions to the regulating authorities that may be necessary for the continuing use and operation of the equipment.

2.23 Protection of the Work and property

- .1 Maintain protection of the Work and protect the Owner's property from injury or loss arising out of the execution of this contract.
- .2 Make good any injury or loss caused by the Contractor's agents or employees.
- .3 Take all necessary precautions to ensure that the Work is done in a manner that does not endanger any person.

2.24 Liability insurance

- .1 Provide, during the period this contract is in force, premises liability, including public liability insurance and property damage insurance in the amount of \$5,000,000 inclusive, to be covered against any claims for damage to property or for personal injury, including death, which may arise from operation under this contract, whether such operation is by yourself or by any sub-contractor or anyone directly or indirectly employed by you.
- .2 Upon completion of the contract, have in force a completed operations and products liability insurance, in the amount of \$5,000,000 inclusive, to be covered against any claims for damages to property or for personal injury, including death, which may arise after the premises liability is terminated.
- .3 Maintain the insurance in force for a minimum period of two years after completion of the contract.
- .4 List the Owner as an additional insured.
- .5 The certificates shall state that the insurance will not become ineffective without

sufficient written notice to the Owner.

- .6 Submit certificates of such insurance with the Owner before work is begun.

2.25 Assignments

- .1 Do not assign nor sublet the contract without the written consent of the Owner.
- .2 Do not assign any payment due or to become due as a result of this contract without the written consent of the Owner.

2.26 Directives

- .1 Advise the Owner of directives received from the Inspecting Authorities and from the Regulatory Authorities.
- .2 Carry out directives from the Inspecting Authorities and from the Regulatory Authorities within the period of time set out on the directives, working in overtime if necessary to meet the required date, except for those items that are:
 - .1 The responsibility of the Owner;
 - .2 Directives resulting from changes to the existing regulations.

2.27 Deficiencies not corrected

- .1 If there is a failure to carry out instructions of the inspecting authorities (except for those items that are the responsibility of the Owner and directives resulting from changes to the existing codes) within the period of time allowed by the authorities issue a credit to the Owner for any costs, including the cost of the inspecting authority reinspection, incurred by the Owner as a result of this failure.

2.28 Submission of proposal

- .1 Submission of a proposal will be considered presumptive evidence that the proposer is conversant with local facilities and conditions, requirements of the Contract Documents and of pertinent provincial and local codes, state of labour and material markets, and in the proposal has made due allowance for all contingencies.

2.29 Request for payment

- .1 Submit monthly applications for payment for work done at the end of each month together with the necessary data, information, waivers and affidavits.

2.30 Delay in making repairs

- .1 Execute promptly the necessary repairs to return non-functioning units to service.
- .2 Return units to service when answering service calls unless return visits are necessary for additional troubleshooting or to source replacement parts.
- .3 Where return visits are necessary, promptly return to the site on the next business day upon availability of the necessary replacement parts.

2.31 Personnel

- .1 Supervise personnel so that they present a neat appearance and their movement in the building is within the requirements of their work.
- .2 Provide uniforms and photo identification for personnel.
- .3 The Owner reserves the right to reject or refuse access to personnel or contractors at its sole discretion.
- .4 Assign and maintain a dedicated service representative to the work, this representative to be responsible for liaison with the Owner and the Consultant.
- .5 Assign and maintain a dedicated service supervisor to the work, this supervisor to be responsible for technical communications with the Owner and the Consultant.

2.32 Designated substances

- .1 The Contractor is responsible to adhere to the designated substances and/or hazardous substances management programs in place at the site including, but not limited to, the presence of asbestos.
- .2 In the event that designated substances or hazardous substances are discovered by the Contractor's personnel and not previously identified by the Owner, report such substances to the Owner.
- .3 The Contractor shall not be responsible for abatement of designated substances or hazardous substances.
- .4 The Contractor acknowledges that small amounts of designated substances or hazardous substances may be present in elevator components (such as asbestos in brake pads and mechanical gaskets, lead in paints and soldering, silica in concrete and masonry, mercury in fluorescent light tubes, PCBs in transformers, etc.), and the Contractor shall ensure proper maintenance procedures are followed to safely complete maintenance, repair and replacement of such components.

- .5 The Contractor shall provide personal protective equipment as necessary to comply with the management program for work in such environments including, but not limited to, disposable protective clothing (gloves, boot covers, coveralls) and fit-tested respirators.

2.33 Labour disruptions

- .1 In the event of a labour disruption of the Contractor's technicians (e.g. strike, lockout, etc.) provide alternative qualified personnel to:
 - .1 Respond to regular call-backs on non-critical units during regular working hours;
 - .2 Respond to regular call-backs on critical units 24 hours per day, seven days per week;
 - .3 Respond to emergency call-backs 24 hours per day, seven days per week;
 - .4 Complete regular maintenance activities required by the Authority Having Jurisdiction.
- .2 For units that remain operational throughout the duration of the labour dispute, but where regular maintenance activities required by the Authority Having Jurisdiction are not performed, provide a credit of 50% towards the regular monthly maintenance fees for the duration of the labour dispute.
- .3 For units that were shut down and remained out of service during the labour dispute provide a credit of 100% towards the regular monthly maintenance fees for the duration of the time that the elevator was shut down.

2.34 Coordination with Owner

- .1 Before each routine maintenance visit contact a representative specified by the Owner.
- .2 Discuss the operation of the equipment with the Owner's representative and take immediate action on problems.
- .3 Should a problem be of a nature that cannot be satisfactorily resolved during the inspection or trouble call, report back to the Owner's representative to explain why it was not possible to correct the problem and when the problem will be resolved.

2.35 Rules of work: elevators

- .1 Check with and obtain approval from the site building management prior to taking an elevator out of service.
- .2 Keep the site building management informed of work activity including, but not limited to, the following:
 - .1 When an elevator is taken out of service;
 - .2 When an elevator is placed back in service;
 - .3 When starting work each day;
 - .4 When finishing work each day.
- .3 Perform work on an elevator at a floor selected by the site building management.
- .4 Where possible restrict activities to inside the hoistway with the hall doors closed.
- .5 Do not leave materials or tools in the elevator lobbies or other public areas.
- .6 Do not leave an elevator out of service with the hall and car doors open except as approved by site building management.
- .7 When taking an elevator out of service, station someone at the entrance or erect barricades so as to ensure that a passenger does not enter and is not trapped in the cab.
- .8 When finished working on the elevator, ensure that the elevator is in proper working order.

2.36 Software and firmware updates

- .1 Check each January for equipment software and firmware updates and advise the Owner of the status of these updates.
- .2 Obtain and install updates.

3 Maintenance procedures

3.1 Maintenance Control Program

- .1 Provide to the Owner and the Consultant a copy of the Maintenance Control Program for each device type.
- .2 Ensure that the Maintenance Control Program is prepared and sealed by a licensed Engineer in jurisdictions where required by the applicable authorities (ex.: Quebec).
- .3 During the course of the maintenance contract update the Maintenance Control Program as necessary and forward to the Owner and the Consultant a copy of the updated Maintenance Control Program.
- .4 The Maintenance Control Program is the property of the Owner.
- .5 Store the Maintenance Control Program on site in accordance with the requirements of the Authority Having Jurisdiction.
- .6 Do not use electronic Maintenance Control Programs without explicit permission of the Owner.
- .7 Execute the maintenance in accordance with these specifications and the Maintenance Control Program.
- .8 As a minimum, perform tasks as required by the Authority Having Jurisdiction at the appropriate intervals.
- .9 Where maintenance and testing frequencies in the Maintenance Control Program are less frequent than the intervals defined in these specifications, these specifications shall take precedence and such frequencies shall be reflected in each device-specific Maintenance Control Program.
- .10 The Owner may approve changes to these specifications provided that the minimum requirements of the Authority Having Jurisdiction are respected.
- .11 In advance of performing Category 5 testing, submit to the Owner and Consultant a written plan outlining:
 - .1 Step-by-step instructions of how the testing will be performed;
 - .2 Names and qualifications of personnel selected to perform the testing;
 - .3 Incremental testing procedures;
 - .4 Alternative testing means, if applicable and accepted by the Authority

Having Jurisdiction;

.5 Schedule of the work.

.12 As part of the Category 5 testing:

- .1 Perform pre-testing of the safeties prior to full load testing by testing application of the safeties at inspection speed with no load in the cab.
- .2 Perform alternative testing and provide the results to the Owner in an acceptable electronic format (e.g. PDF), and provide a hard copy printout in the Maintenance Control Program, for record keeping and to establish a baseline for future testing.
- .3 Take reasonable steps to protect the cab finishes from damage (i.e. laying down plywood or using rubberized weights).
- .4 If completion of the test on an elevator requires that adjacent elevators in the same group be removed from service, perform the testing outside of regular hours at a time approved by the Owner.
- .5 If testing is performed prior to submitting an adequate plan and receiving approval from the Owner, or testing deviates from the requirements herein, the Contractor is responsible for correcting any and all damage that may result from the testing (i.e. including building damage).
- .6 The contractor is responsible to repair or replace any elevator components that may be damaged or fail as a result of testing.

3.2 Controller: remote reset

- .1 Do not permit remote resetting of the controller under any condition.

3.3 Repairs

- .1 For scheduled repair work, outside of the regular maintenance procedure, give the Owner at least two weeks prior notice.
- .2 For unscheduled repair work, outside of the regular maintenance procedure, give the Owner immediate notice.
- .3 Communicate, in writing, the status of repairs to the Owner at the beginning and close of the normal working day.
- .4 Where possible indicate the time required for completion of repairs.

3.4 Mis-adjustment

- .1 Do not change any of the adjustments in such a way as to lead to a deterioration of the equipment performance.
- .2 Do not, in the course of routine maintenance or trouble shooting, re-adjust any of those settings which affect either the performance or the safety of the equipment.
- .3 Should it appear that some setting has changed or some problem has arisen such as to alter the performance of the equipment, arrange that a qualified adjuster with the appropriate tools, manuals and training make the necessary re-adjustments in an organized, systematic way.
- .4 Do not allow ad hoc adjustments to the equipment.

3.5 Safety devices

- .1 At no time permit the equipment to operate while any of the safety devices, mechanical or electrical are in-operative.

3.6 Equipment defects

- .1 Should a defect in the equipment or the design of the equipment become apparent based on experience with this installation or similar installations elsewhere, advise the Owner immediately in writing setting out the steps to be taken to correct the problem.
- .2 Forward to the Owner copies of any memoranda, internal or external, published or unpublished, dealing with actual or potential flaws in the equipment and design.

3.7 Call-back service

- .1 Include, as part of the maintenance program, regular and emergency call-back service.
- .2 Provide regular and emergency call-back service 24 hours per day, seven days per week.
- .3 An emergency is a situation such as:
 - .1 An entrapment;
 - .2 An incident;
 - .3 An accident;

- .4 A shut down of more than one elevator in a group;
- .5 The absence of elevator service to a floor.
- .4 At the time the call is placed the Owner may choose to indicate that the call can be handled during regular hours; otherwise, answer the call immediately whether it be in overtime or regular time.
- .5 Respond only to calls placed by the Owner except in the case of emergency calls.
- .6 Provide an answering service staffed twenty-four hours per day.
- .7 Provide, where applicable, an answering service inclusive of two-way non-verbal communication and the means to monitor video.
- .8 Ensure that calls received by the answering service are transmitted immediately to a responsible person for action.
- .9 Provide regular call-back response within a maximum of two hours from the time a call is placed until the arrival of a maintenance person at the site.
- .10 Provide emergency call-back response within a maximum of 45 minutes from the time a call is placed until the arrival of a maintenance person at the site.

3.8 Maintenance: assistance for inspections & testing

- .1 Provide all necessary co-operation and assistance to allow inspections of the equipment by the Consultant and by the Inspecting Authorities.
- .2 Provide all necessary co-operation and assistance, either in regular time or overtime, to allow testing of those systems associated with the equipment such as smoke detectors, fire detectors, heat detectors, emergency power, firefighters emergency operation, communication systems, security systems and other systems ancillary to the equipment.
- .3 In the event that this requires the supply of one crew for more than an average of three hours per unit per year, submit a request to the Owner for an extra to contract payment.
- .4 Should the tests fail because of problems with the elevator or escalator equipment provide any necessary additional assistance at no extra charge.

3.9 Fire service testing

- .1 Perform annual testing of the Firefighters' Emergency Operation for buildings that are not designated as High Buildings.
- .2 Perform quarterly testing of the Firefighters' Emergency Operation for buildings designated as High Buildings.
- .3 Execute the tests, at the option of the Owner, either in regular hours of work or outside of regular hours of work at no extra cost to the Owner.
- .4 Carry out the testing as required by the regulatory authorities.
- .5 Record the results of the testing and forward to the Owner a copy of the record.

3.10 Safety inspections

- .1 Carry out instructions of the inspecting authorities within the period of time allowed by the authorities or, if no period is designated, 30 days of notice of deficiency except for those items that are the responsibility of the Owner and directives resulting from changes to the existing codes.

3.11 Manufacturers' parts

- .1 Supply replacement parts identical in make and model to the original parts where at all possible.
- .2 Where identical parts are not available or a better substitute is available submit the alternative part for the approval of the Owner.

3.12 Substitute parts

- .1 Where items visible to the general public, in particular exposed finishes and fixtures, are to be replaced, submit drawings, photographs or samples, as required, in ample time for consideration and review.
- .2 Submit samples of metals, plastic laminates and finishes properly identified as to project, location and material.
- .3 Supply materials in accordance with the reviewed samples.
- .4 The review does not include the checking of measurements nor the approval of variations from the Specifications or the Contract Documents.

3.13 Parts stocked locally

- .1 Arrange that the following spare parts are available on site, in a service vehicle or from the local maintenance office and allow the Owner, at their request, to inspect these parts:
 - .1 Buttons: four button heads;
 - .2 Car door equipment: two car door sheaves and one set of door gibs;
 - .3 Hall door equipment: one complete hoistway door closer assembly, two interlocks, four hall door sheaves, and two sets of door gibs;
 - .4 Fuses: three fuses of each size used in the controller and in the main line disconnect;
 - .5 Relays: three complete relays of each type with spare contacts and coils;
 - .6 An adequate supply of cleaning solvent, wipers, general purpose oil and door operator oil.
 - .7 At least one spare for each part used in quantity on the equipment in the ratio of one spare for every 100 such parts.

3.14 Parts available as required

- .1 Arrange that spare parts not stocked locally, but for which like-for-like replacements are readily available from manufacturers, are provided within 72 hours to the site.
- .2 The Contractor shall arrange and pay for expedited shipping where necessary to meet this requirement.
- .3 For parts that are not stocked locally and not readily available from manufacturers, such as parts that require off-site repair or parts that are manufactured to suit the installation, the Contractor shall provide to the Owner an estimate for the time to manufacture or repair the part.

3.15 Building log

- .1 Complete required entries for building log systems.

3.16 Maintenance log book

- .1 Provide a maintenance log in a permanently bound journal having pre-numbered pages.
- .2 Indicate in the journal the following information: date, time, name of maintenance technician, regular maintenance, regular time callback, over time callback, action taken, work completed, and further repairs required.
- .3 The journal is the property of the Owner.
- .4 Maintain the journal current, on the premises, and available for inspection by the Owner at any time.
- .5 Make entries in ink, legibly, consecutively and without blanks.

3.17 Time tickets

- .1 Indicate the section of the normal maintenance schedule on each time ticket with details of the portion of the section completed.
- .2 Submit time tickets for each call-back detailing the cause of the call-back and the action taken.
- .3 If electronic time tickets are used, make these tickets accessible to the owner through internet at all times.

3.18 Accidents and claims

- .1 In the event of an accident causing death, personal injury or property damage, arising out of or in connection with the equipment or the performance of the Work whether on or adjacent to the site, advise the Owner immediately giving a verbal report and submit to the Owner within 24 hours of the accident signed written reports from each of the maintenance personnel involved.
- .2 In the event of an injury to anyone working on or using the equipment, take whatever immediate action is necessary to aid the injured person and to prevent further injury to others.

3.19 Electrical diagrams

- .1 Maintain any existing electrical diagrams in good condition and do not remove electrical diagrams from the site.
- .2 Where existing electrical diagrams are not bound or laminated to protect the diagrams from damage, either bind or laminate the drawings for longevity as part

of the maintenance.

- .3 If, in the course of the maintenance contract, changes are made to the wiring or control, supply to the Owner marked-up prints of the altered schematics and field wiring diagrams showing the changes.

3.20 Consultant's inspections

- .1 From time to time the Consultant will carry out inspections to verify that the Work is being carried out in accordance with the specifications and with industry standards.
- .2 The Consultant will prepare a report listing deficiencies.
- .3 Carry out such maintenance, repair and replacement to correct the deficiencies listed on the Consultant's Report within 30 days or, if it is anticipated that the corrective measures will require more time, advise the Consultant of this and obtain their approval of the extension.

3.21 Maintenance tasks (rope replacements)

- .1 In addition to the tasks required in the Maintenance Task Intervals, perform maintenance in accordance with the following requirements.
- .2 When replacing the elevator suspension means:
 - .1 Ensure that the number of wire rope rotations does not exceed:
 - .1 1.5 rotations per 30.5 m (100 ft.) for a 1:1 roping arrangement;
 - .2 3 rotations per 30.5 m (100 ft.) for a 2:1 roping arrangement.
 - .2 Use wedge type cable clamps for suspension means;
 - .3 Within six to eight weeks, inspect the suspension means and shorten as necessary.

4 Performance

4.1 Performance data

- .1 Maintain the elevators so that at all times they comply with the following performance parameters.

	LULA
Operating time	< 45.0 s
Levelling accuracy	+/- 9 mm
Speed accuracy	+/- 5 %
Door noise level	< 60 dB
Cab noise level	< 58 dB
M/R noise level	< 80 dB

4.2 Performance data measurement method

- .1 The horizontal vibration, front to rear or side to side, is measured in the elevator cab with the elevator travelling with a load of less than 10 per cent of capacity from top to bottom and bottom to top (measured between two consecutive points of opposite value).
- .2 The door noise level is measured using an ANSI type 2 sound level meter on the "A" scale with an "F" response within the cab during a full door open, door close and door reversal cycle.
- .3 The cab noise level is measured using an ANSI type 2 sound level meter on the "A" scale with an "F" response within the elevator cab with the elevator travelling from one end of the hoistway to the other with the cab fan on.
- .4 The machine room noise level is measured with the elevator running by a meter positioned in the centre of the machine room.
- .5 The operating time is measured for a typical floor run (less than 4000 mm [13']) from the time when the fully opened doors begin to close until the car is stopped level with the next floor and the car and hall doors are 800 mm (32") open. For door types other than centre-opening or slow rated speed, the specified operating time is adjusted as follows:
- .1 For elevators with side-opening doors and a door width under 1100 mm (43"), add 2.0 seconds to the specified operating time.
- .2 For elevators with wider entrances and centre-opening doors, add 0.25

seconds per additional 150 mm (6") of door width to the specified operating time.

- .3 For elevators with wider entrances and side-opening doors add 0.5 seconds per additional 150 mm (6") of door width to the specified operating time.
- .4 For electric elevators with a contract speed under 1.78 metres per second (350 fpm), add 1.5 seconds to the specified operating time.
- .5 For hydraulic elevators with a contract speed under 0.76 metres per second (150 fpm), add 1.5 seconds to the specified operating time.

4.3 Maintenance tasks: hydraulic elevators

- .1 Check the following elements during each periodic maintenance visit:

- .1 Car ride and general operation;
- .2 Levelling;
- .3 Hall and car operation;
- .4 Alarm bell;
- .5 Communication system;
- .6 Door open button;
- .7 Door force (maximum of 135 Newtons [30 lb]);
- .8 Door re-opening device;
- .9 Position indicators;
- .10 Car operating panel devices;
- .11 Check the hydraulic fluid level;
- .12 Check the piston gland packing;
- .13 Check oil recovery system.

- .2 Perform the following duties at least once every six months:

- .1 Clean pit;

- .2 Clean tops of car;
- .3 Clean the machine removing any oil from the gland packing drip tray;
- .4 Check and lubricate the governor tension sheave;
- .5 Check and lubricate the governor;
- .6 For oil buffers, check the buffers and the buffer oil;
- .7 For group operation, check the door open pause times to ensure that they are consistent from one car to another in a group;
- .8 Check the door open pause time cancellation (i.e. monitor) circuit;
- .9 Check the load weighing devices;
- .10 Check the suspension means.
- .3 Perform the following duties at least once every year:
 - .1 Check the hydraulic machine and motor;
 - .2 Check the operation of the overspeed valve;
 - .3 Carry out a safety test of the plunger gripper;
 - .4 Check the hydraulic pressure relief valve;
 - .5 Remove the covers of the car operating panels and check the internal components and connections;
 - .6 Lubricate and clean car door tracks;
 - .7 Clean control room and control room floor;
 - .8 Check the car door contacts;
 - .9 Check the hoistway door interlocks.
 - .10 Check the car door rollers and eccentrics;
 - .11 Check the car door clutch assembly;
 - .12 Check door operator, clean and lubricate pivot points;

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- .13 Clean guide rails and guide rail fastenings;
 - .14 Vacuum hoistway from top to bottom;
 - .15 Replace the filters on the controller air inlets;
 - .16 Check the terminal slowdown device;
 - .17 For oil buffers, check the buffer oil levels, check for water in the oil and test the buffers;
 - .18 Check travelling cables for wear;
 - .19 Check hangers and junction box connections;
 - .20 Check guide rail fastenings;
 - .21 Check the speed, acceleration and jerk profiles and if necessary adjust the drive parameters;
 - .22 Measure performance parameters (noise levels, vibration, operating times) and re-adjust if required;
 - .23 Check components and fastenings that under failure might create a dangerous situation (e.g. sheave bolts and welds, gear bolts, car slings et cetera);
 - .24 As required, clean and paint machine room and pit floor (perform not less than once every five years);
 - .25 Submit a report to the Owner confirming that the annual checks have been carried out, listing the items checked and the measured performance parameters.
 - .26 Check the emergency power or battery lowering device operation.
 - .27 Check the emergency fire recall operation.
 - .28 Check the functioning of the Firefighters' Emergency Operation.
- .4 For elevators with roped hydraulic cylinders, perform the following duties at least once every year:
- .1 Check rope hitches;
 - .2 Inspect ropes for wear in accordance with standards for elevator wire rope

inspection;

- .3 Lubricate the hoist ropes in accordance with the rope manufacturer's recommendations;
- .4 Check rope tension and adjust if necessary;
- .5 Check rope stretch and remove buffer blocks or shorten ropes if required;
- .6 Clean and check safety mechanism;
- .7 Perform a test of the safeties;
- .8 Check sheaves and shafts for soundness and wear.

END OF SECTION

Section 14 26 23 Limited-Use / Limited-Application (LULA)

1 General

1.1 General requirements

.1 Conform to Section 14 00 00.

1.2 Type

.1 Installation of a single limited-use / limited-access (LULA), designated 1.

1.3 Data

LULA		
Item		
number of units	1	
designation	1	
application	passenger	
rated speed (m/s, fpm)	0.15	30
capacity (kg, lb)	635	1400
motor power (kW, HP)	3.7	5
operation	automatic	
motor location	submerged	
pump		
pump machine unit location	submerged	
jack type	roped hydraulic	
valve assembly		
drive type	wye-delta	
emergency brake	none	
governor	provide	
hoist ropes	provide	
heat exchanger	none	
tank heater	none	
scavenger pump	none	
overspeed valve	none	
pit shut-off valve	provide	
control system	provide, microprocessor	
controller location	control room	
front entrances	G,2	
rear entrances	None	

door type	two-speed side-opening	
hoistway door fire resistance	1.5 hours	
lobby sill material	aluminum	
car sill material	aluminum	
entrance width (mm, “)	914	36
entrance height (mm, “)	2083	82
entrance markings	provide	
cab width (mm, “)	1181	46.5
cab depth (mm, “)	1524	60
cab height (mm, “)	2083	82
car door restrictor	provide	
door safety retainers	provide	
entrance protection	3D	
door operator	linear or harmonic	
interlocks	yes	
main car station	provide applied	
auxiliary car station	none	
verbal annunciation	floor passing tones	
car position indicator	provide in COP	
cab emergency lighting	provide	
cab communication	provide	
telephone system with video communication	provide	
in-cab video display system	none	
car closed circuit camera	future provisions	
car call security	none	
hall call security	keyswitch	
hall stations (typical)	1	
hall stations (main floor)	1	
hoistway access switches	none	
cab ventilation	provide	
cab finishes	standard	
hall door finish (typical)	stainless	
hall door finish (main floor)	stainless	
car door finish	stainless	
hall lanterns	none	
in-car lanterns	provide	
hall position indicator	none	
lobby panel	none	

CACF panel	none
central control monitor	none
car top inspection station	provide
car guiding	sliding guides
load weighing device	provide
guide rails	T rails
emergency recall (phase I)	provide, automatic
firefighter's operation (phase II)	none
emergency power	battery lowering
car top railings	none
equipment guarding	provide
flood detection	none
seismic	none
operating time	35s
acceleration rate	0.6 m/s/s

1.4 Dimensions

- .1 Provide equipment to suit the machine room, hoistway, pit and overhead dimensions.

2 Products

2.1 Hydraulic: pumping machine unit

- .1 Provide a pumping machine unit compactly and neatly designed with all the components as follows in a self-contained unit: drip pan, floating inner base for mounting motor pump assembly, oil reservoir with tight fitting tank cover, filter in suction line, oil hydraulic pump, electric motor, oil control unit.
- .2 Provide an oil level gauge that can be read without removing the tank cover.
- .3 Provide, to measure the oil temperature, a thermometer that can be read without removing the tank cover.
- .4 Provide a pump especially designed and manufactured for oil hydraulic service of the rotary positive displacement type inherently designed for steady discharge with minimum pulsations to give smooth and quiet operation.

- .5 Provide a motor designed for oil hydraulic service.
- .6 Provide a motor rated for not less than 120 starts/hour at 40°C.
- .7 Provide equipment which will deliver its rated output continuously with a temperature rise not to exceed 50°C (90 F).
- .8 Provide an oil control unit consisting of the following components: relief valve, safety check valve, levelling valve, manual lowering valve, tank shut-off valve.
- .9 Design the equipment so that all adjustments are accessible and can be made without removing the assembly from the oil line.
- .10 Provide variable flow bypass valves to give controlled high and levelling speed operation.
- .11 Provide valves with individual adjustments, such that changing one adjustment does not affect other adjustments.
- .12 Provide an externally adjustable relief valve capable of by-passing the total oil flow without increasing the back pressure more than 10% above that required to barely open the valve.
- .13 Provide a 50 mm (2") pressure gauge, complete with isolating shut-off valve, for measuring the setting of the relief valve.
- .14 Design the safety check valve to close quietly without permitting any reverse flow and to support the elevator on a positive locked column of oil when the car is at rest.
- .15 Provide an externally adjustable up start valve to by-pass oil flow during initial start of the motor pump assembly, and to close slowly, gradually diverting oil to the jack unit, insuring smooth up starts, so as to relieve load on the motor during starting.
- .16 Provide an externally adjustable lowering valve and levelling valve for drop away speed, lowering speed, levelling speed and stopping speed to insure smooth down starts and stops.
- .17 Provide a manual lowering valve for manual lowering of the elevator car in the event of power failure and for use in servicing and adjusting the elevator mechanism.

- .18 Provide shut off valves in the machine room and elevator pit for isolating oil in the power tank unit to facilitate servicing and adjusting the elevator mechanism without removing the oil from the tank.
- .19 Provide strainers to prevent foreign materials from lodging in the oil system.
- .20 Provide an externally adjustable up stop valve to by-pass the oil flow for landing stops in the up direction.
- .21 Provide temperature and pressure compensation so as to minimize speed variations.
- .22 Arrange the equipment so that the car stops at the landing through controlled oil flow with the motor and pump running and so that the motor shuts off only after the car has come to rest at the landing.
- .23 Use flexible hose on the pumping machine unit where required but only within the regulations of the governing safety codes.
- .24 Provide a tank of sufficient capacity to contain, as a minimum, all of the oil in the hydraulic system (pipe lines and hydraulic cylinder) plus 10%.
- .25 Install the pumping machine unit in a dedicated machine room and not within the hoistway.

2.2 Hydraulic fluid: biodegradable

- .1 Provide hydraulic fluid of the non-toxic and inherently or readily biodegradable type.
- .2 Provide hydraulic fluid having a minimum viscosity index of 95.
- .3 Do not use vegetable-based hydraulic fluid.
- .4 Provide signage on the tank identifying the type of oil used in the system.

2.3 Hydraulic: silencing devices

- .1 If the motor and pump are not submersible:
 - .1 Enclose the power unit on all four sides with sheet steel panels combined with 20 mm (3/4") suitable sound-deadening material;
 - .2 Form the panels with approximately 20 mm (3/4") returns, returning to, but separated from, the main power unit frame with suitable rubber mouldings.
- .2 To reduce hydraulic pulsations through the oil, provide a blow-out proof double-faced hydraulic muffling device in the oil line adjacent to the power unit, downstream to the valve assembly.
- .3 To reduce any vibration transmitted through the oil line itself, provide two approved blow-out proof sound isolating couplings in the oil line, located between the check valve and the hydraulic jack.
- .4 Design each sound-isolating coupling to completely eliminate any solid metal to metal contact from the pipe on one side of the coupling to the pipe on the other side.
- .5 Mount the motor and pump on a resilient rubber base to isolate them from the oil reservoir, controller and building structure.

2.4 Hydraulic: main line strainer

- .1 Provide a main line strainer and shut off cock assembly of the self cleaning type, equipped with a 60 minimum mesh element, and a magnetic drain plug, in the oil line.
- .2 Design the unit for a minimum 2800 kilopascals (400 psi) working pressure and provide easy access for cleaning.

2.5 Hydraulic: time protective device

- .1 Provide a time protective device.
- .2 If the pump motor should run continuously for 20 seconds longer than the period of time necessary to move the elevator (in inspection operation) from the bottom floor

to the top floor, the time protective device will cause:

- .1 Up direction relays and contactors to be de-energized.
- .2 Automatic registration of a bottom floor call to bring the car to the lowest landing where it will remain with its doors open.
- .3 No response to any further hall calls or car calls until the main line switch has been opened and closed again.

2.6 Hydraulic motor starting

- .1 Start the hydraulic pump motor after the doors start to close so that the motor is running at full speed before the doors are fully closed.
- .2 Stop the hydraulic pump motor if the door closing operation is interrupted.
- .3 Provide solid state control of the starting operation so as to limit the motor starting current to not more than two times the full load running current.
- .4 Energize the hydraulic machine up start valve, subject to the standard safety circuits, after the doors are closed and a signal is received from the solid state starter indicating that the motor is up to operating speed.

2.7 Jack unit: roped hydraulic

- .1 Provide a jack unit of sufficient size to lift the gross load the height specified.
- .2 Factory test the jack unit to ensure adequate strength and freedom from leakage.
- .3 Do not use brittle material, such as gray cast iron or semi steel, in the jack construction.
- .4 Provide a jack unit consisting of the following parts: a plunger of heavy seamless steel tubing accurately turned and polished, a stop ring electrically welded to the plunger to positively prevent the plunger leaving its casing, an internal babbit-lined or bronze guide bearing, packing of suitable design and quality, a drip ring around the casing top, an outer casing made of steel tubing provided with a pipe connection with an air bleeder.

- .5 Locate the jack unit within the hoistway at either the side or rear of the elevator car or, if twin jacks are used, locate the jack units within the hoistway at either side of the elevator car.
- .6 Weld brackets to the jack casing for supporting the elevator on pit channels.
- .7 Use packing of the single sealing edge type of teflon, roulon or similar material to reduce wear and friction.
- .8 Provide a deflector sheave at the top of the piston.
- .9 Attach the piston to the deflector sheave bearing shaft using welded brackets.
- .10 Provide ropes running from a dead-end hitch, over the sheave and thence to an attachment on the elevator car.
- .11 Provide ropes of sufficient number, size and characteristics such that the addition of 50 per cent of the rated load to the car cab will cause no more than a 0.04 per cent elongation in the rope.
- .12 Where ropes are used in parallel to share a load, ensure that the ropes are all from one manufacturing run.
- .13 Ensure that the number of rope rotations does not exceed 3 rotations per 30.5 m (100 ft.).
- .14 Provide means during and after installation to prevent the ropes turning; do not use swivel connections.
- .15 Use wedge type cable clamps.

2.8 Governor: automatic reset

- .1 Provide an automatic reset governor located so that it can be maintained from the top of the elevator car and tested without special access arrangements.
- .2 Arrange that the governor, once tripped, will be reset when the car is moved up off the car safeties.

2.9 Hydraulic piping

- .1 Provide pipes and fittings to connect the power unit to the jack unit.
- .2 Seal connections adequately to prevent any leakage or seepage of oil.
- .3 Provide pipe of minimum 50 mm (2") nominal size to reduce oil velocity, noise and vibration.
- .4 Run the oil lines above ground and suspend the oil lines with isolating hangers to reduce sound transmission.

2.10 Hydraulic pit shut-off valve

- .1 Provide a pit shut-off valve for the hydraulic jack.

2.11 Solid-state hardware

- .1 Mount solid-state devices, except for high power silicon controlled rectifiers, on removable printed circuit boards.
- .2 Gold plate the contact points of edge connectors.
- .3 Use G10 glass epoxy with minimum equivalent 57 gram (2 ounce) copper.
- .4 Coat the circuits with tin-lead.
- .5 Provide a solder resist screen.
- .6 Provide plated through holes for double sided boards.
- .7 Make all connections to the printed circuits on the printed circuit boards by means of properly dimensioned pads.
- .8 Do not provide "patched" connections.
- .9 Design solid-state devices for a high level of noise immunity.
- .10 Incorporate electrical noise suppression devices in the power supplies and the inputs and outputs associated with the solid-state circuits.

- .11 Provide filters and circuits to limit the generated electromagnetic noise level at any frequency to not more than 0.1 db above the ambient electromagnetic noise level, as measured in the centre of the machine room using a calibrated radio frequency receiver designed in accordance with CSA Standard C108.1.1 together with a calibrated rod or loop antenna.
- .12 Provide filters and circuits to limit the generated electromagnetic noise level at 10 KHz to not more than 0.01 db above the ambient electromagnetic noise level, as measured in the centre of the machine room using a calibrated radio frequency receiver designed in accordance with CSA Standard C108.1.1 together with a calibrated rod or loop antenna.

2.12 Auxiliary slowdown devices

- .1 Provide auxiliary slowdown devices compatible with the solid state speed control and so arranged that, if the normal slowdown devices fail to operate correctly, the elevator will be brought to a controlled stop at the terminal landing with an acceleration not exceeding 0.3 g.
- .2 Arrange the control circuits so that, if the auxiliary slowdown devices were required to act to stop the elevator, the elevator parks at the terminal landing until the system is checked by a maintenance technician.

2.13 Position transducer

- .1 Provide a position transducer device to transmit to the control system the position of the elevator.
- .2 Arrange that the device transmit a minimum of 10 counts per 25 mm (1") of travel.
- .3 Provide a device having an overall precision within ± 1.0 mm (± 0.04 ").
- .4 Arrange the elevator controls so that the output from this device is read at least every 5 ms.
- .5 Transmit the signal from this device either in serial format using a standard protocol (e.g, CAN) or in parallel format using low impedance (less than 10 kilohms) inputs.
- .6 If the transducer is a relative (pulse counter) type rather than an absolute encoder

type:

- .1 Provide gray encoding so as to indicate the direction of movement of the car and to offset 'false' counts caused by vibration;
- .2 In the event of a counter error reset the position with an accuracy within ± 2.5 mm (± 0.1 ") by returning the car at low speed to a fixed point in the hoistway.

2.14 Controller

- .1 Provide a micro-processor based controller designed to give the required operation as herein specified.
- .2 Mount panels securely on substantial, self supporting steel frames designed for floor or wall mounting.
- .3 Provide completely enclosed controllers with covers.
- .4 Do not mount equipment on the covers unless:
 - .1 Its wiring is designed to support bending caused by opening and closing the cover;
 - .2 Its wiring is protected against damage;
 - .3 If damage happens to the equipment mounted on the cover or the wiring of this equipment, the unit will continue to operate normally.
- .5 Where relays are used, provide those having a design electrical life and mechanical life equivalent to thirty years operation in the given application, with their contacts designed for maximum conductivity and wiping action.
- .6 Install wiring on the controller, whether control or field wiring, in a neat workmanlike order and make connections to studs and terminals by means of solder or solderless lugs, or similar connecting devices.
- .7 Mark relays, contactors, fuses, printed circuit boards and other components clearly and permanently with designations as shown on the schematics.
- .8 Mount the designations for plug in components on the controller adjacent to the

component; do not mount the designation on the plug in component.

- .9 Provide a written guarantee from the control manufacturer that software and firmware updates will be provided for not less than 20 years at no charge to the Owner.
- .10 Install the controller in a dedicated control room and not within the hoistway.

2.15 Computing devices

- .1 Where computing devices are used, such as micro-processors or mini-computers, along with associated devices, design to the following requirements:
 - .1 Isolate the inputs from external devices (such as push-buttons) and isolate the outputs to external devices (such as indicators) by means of relays or optical devices;
 - .2 Provide the control program on read-only-memory with spare capacity to allow for future programming modifications and extensions;
 - .3 Provide crystal regulation of frequency;
 - .4 Provide for separate regulated power supplies to serve each micro-processor system.

2.16 Power interruption restart

- .1 Provide means so that the elevator system will restart automatically in the event of power interruption.
- .2 Where volatile memories are provided for position and other data necessary to the continuing operation of the elevators, provide means of preserving this data on power failure or fading ('brownout') for a minimum of four hours and means of automatic recovery upon restoration of normal power.

2.17 Control circuits grounding

- .1 Arrange the control circuits so that one side of the control power supply for external circuits is grounded to facilitate testing and trouble shooting.
- .2 An external circuit is defined as one wired outside micro-processors or solid-state devices, as for example, buttons, relays, lights, display screens, position indicators, lanterns, kiosks, limits, locks and such similar devices.
- .3 Arrange that accidental grounding in the control system will not defeat the safety circuits.

2.18 Main floor elevator markings

- .1 Provide at the main floor, for each elevator designated as a Firefighter's Elevator, a suitable symbol such as a Firefighter's Hat.
- .2 At locations required by Code, provide for each elevator alphanumeric symbols on a metal plate indicating the designation of the elevator.
- .3 Provide markings as selected by the Owner.
- .4 Provide samples for review.

2.19 Entrance floor markings

- .1 Provide, on each hall entrance jamb, raised tactile and braille metallic markings on a metal plate to designate the floor.
- .2 Provide markings as selected by the Owner.
- .3 Provide samples for review.

2.20 Floor marking: hoistway

- .1 Identify each landing by means of markings on the inside of the hoistway.
- .2 Use a stencil to ensure that the floor markings are neat and uniform in appearance.
- .3 Provide numerals and letters approximately 100 mm (4") high and of a clearly

contrasting colour to the colour of the doors and fascias.

2.21 Door type: two speed side opening

- .1 Provide car and hoistway doors of the two-speed side opening, horizontal sliding type.

2.22 Door friction

- .1 Adjust the doors so that with the door closing device disconnected, the doors can be started into motion, from any position, with a force of less than 25 newtons (six pounds) per door panel applied horizontally at the mid-point of the door in line with the direction of movement of the door.

2.23 Entrance: fire rating

- .1 Provide entrances bearing a 1.5 hours fire rating approved by authorities having jurisdiction.
- .2 Provide a closure, including interlock mechanism and associated wiring, capable of operating for a period of at least one hour when the assembly is subjected to the standard fire exposure tests.

2.24 Entrances

- .1 Provide entrances consisting of frames, jambs, sills, sill support angles and brackets, struts, headers, fascias, toe guards, and sight guards and doors of approved design and size complete with guides and bumpers and all other items necessary to provide a completed installation.
- .2 Construct the doors of sheet steel a minimum of 1.3 mm (18 gauge) thick.

2.25 Entrance installation

- .1 Assume undivided responsibility for the entire installation of the entrances.
- .2 Handle, store, protect, install the entrances and associated equipment.
- .3 Set door frames in perfect alignment with the elevator car platform.

- .4 Fasten frames and headers to structural supports.
- .5 Set frames and sills in place prior to building walls.
- .6 Install frames within 1 mm (0.04") of plumb and sills within 2 mm (0.08") of level over the entrance width.
- .7 Fasten frames securely at the sill and header.
- .8 Fasten sills securely to the building structure by means of a support angle or substantial brackets.
- .9 Install struts, fascias, toe guards and other associated equipment required to complete the installation of the entrances.

2.26 Entrance finish: stainless steel

- .1 Provide stainless steel entrances finished so that spot welds or other surface defects will not show under reflected light.

2.27 Entrances: door hardware

- .1 Supply hoistway door hardware consisting of door hangers and tracks, interlocks, door closers, relating mechanism, operating linkages, gibbs, and all other hardware necessary for the installation and operation of the hoistway doors.
- .2 Provide heavy duty constant force door closers at the main floor to minimize stack-effect from impacting elevator door operation and provide heavy duty constant force door closers at any other high stack-effect elevator lobbies.
- .3 Supply, for each sliding panel, sheave type, two point suspension hangers.
- .4 Supply sheaves not less than 75 mm (3") in diameter with ball bearings, properly sealed to retain grease lubrication, and mounted on stands arranged for direct attachment to the panels.
- .5 Equip hangers with adjustable ball bearing rollers to take the up-thrust of the doors.
- .6 Arrange the tracks and sheaves so that there is no metal to metal contact, and so that the doors operate properly without any regular lubrication.

- .7 Design all door hardware for a minimum of noise.

2.28 Car door restrictor

- .1 Provide a car door restrictor to mechanically prevent the opening of the car door from inside the cab unless the elevator is in the door unlocking zone.
- .2 Provide a device that does not require electrical or electronic components to function.

2.29 Car and hoistway door safety retainers

- .1 Provide safety retainers at the top and bottom of horizontally sliding doors to retain the closed door panel in position if the primary guiding means fail.
- .2 Provide retainers that will prevent the displacement of the door panel top and bottom by more than 20 mm (0.8") when the door panel is subjected to a force of 5 000 N (1130 lbf) applied towards the hoistway at right angles to the panel over an area of 300 mm by 300 mm (12" by 12") at the centre of the panel.
- .3 Provide retainers that will withstand, without detachment or permanent deformation, a force of 1 000 N (225 lbf) applied upward at any point along the width of the door panel together with an additional concurrent force of 1 100 N (250 lbf) applied at right angles to the door at the centre of the panel over an area of 300 mm by 300 mm (12" by 12").
- .4 Arrange that the retaining means are not involved in the guiding of the panel and are not subjected to wear or stress during normal door operation.

2.30 Hoistway entrance lunar key access

- .1 Provide lunar key access for each hoistway entrance.
- .2 Provide a protective metal sleeve for each circular lunar key hole (where applicable).

2.31 Reopening devices and detection of objects

- .1 Provide a reopening device and entrance protection capable of detecting objects in the door path and objects approaching the doors.
 - .1 In jurisdictions that have adopted B44-19 or earlier, provide equipment in accordance with B44-19 Section 2.13.5.
 - .2 In jurisdictions that have adopted B44-22, provide equipment in accordance with B44-22 Section 2.13.5.
- .2 Arrange the doors to reopen (or remain open) when an object is detected.
- .3 To prevent accidental damage, position detection receivers and emitters, when installed on the door, as far from the leading edge of the doors as allowable by manufacturer's installation guidelines.
- .4 Provide a signal on the unit or in the machine room to indicate that a failure has occurred.
- .5 Supply a device, reliable and consistent in operation, not affected by dust or temperature changes, and having inherent long term reliability with minimum maintenance.
- .6 Arrange that the operation of the devices will not be affected by adjacent reflective, shiny or glass surfaces.
- .7 For a transom-mounted reopening device, if new cab interiors are being provided, install the device recessed into the transom substantially flush with the surface (i.e. do not surface mount).

2.32 Door operator (linear or harmonic)

- .1 Provide a heavy duty door operator to open and close the car and hoistway doors simultaneously.
- .2 If providing a harmonic door operator:
 - .1 Provide either:

- .1 An alternating current motor, either standard or linear induction type, with associated variable voltage and variable frequency solid state drive to control the speed and torque of the door operator, or;
 - .2 A direct current motor with associated solid state drive to control the speed and torque of the door operator.
 - .3 Provide as a minimum a 375 W (0.5 HP) motor.
- .3 If providing a linear door operator:
- .1 Provide either one or two permanent magnet synchronous AC drive motors rated at a total of 250 W (1/3 HP) minimum.
 - .2 Arrange that the operator functions on a single phase 110 or 220 VAC supply.
 - .3 Provide a solid state motion control system using a DC link (single phase AC to DC to three phase variable frequency AC).
- .4 Provide event logging with non-volatile memory so as to retain the event log under power-off conditions.
 - .5 Directly connect the operator motor or motors to a circulating flat belt with integral teeth (power timing belt).
 - .6 Connect the belt to the door panels so as to move the door panels as the operator motor turns.
 - .7 Provide a solid state door operator control incorporating negative feedback circuits for position, acceleration, velocity and torque.
 - .8 Provide fully automatic installation algorithm profiles that self-adjust the motion profile for the relevant parameters.
 - .9 Provide an output from the door control for a pre-start command to the elevator speed control system.
 - .10 Provide optical isolation for input and output signals.

- .11 Provide signal line short circuit protection.
- .12 Provide a serial input to the door control to allow adjustment of speed, acceleration, torque and pre-start point using a notebook computer or keypad.
- .13 Provide the keypad or software for a standard notebook computer.
- .14 Arrange that the settings for the door operator can be uploaded to the keypad or notebook computer and then downloaded to another identical operator.
- .15 Provide an average door closing speed of 300 mm (12") per second, respecting the parameters for door force and door inertia as set out in the elevator code.
- .16 Provide an average door opening speed of 400 mm (16") per second.
- .17 Provide, either in the door operator control or in the main elevator control, means to automatically recycle the doors in the event that they stall during the opening or closing operations.
- .18 Design the door operator and associated components for a minimum of noise.**2.33**

Car door equipment

- .1 Provide car door header, hangers and tracks, door electrical contacts, master door operators, and all incidental devices necessary for the correct operation of the doors.
- .2 Provide, for each sliding car door panel, sheave type, two point suspension hangers.
- .3 Provide sheaves not less than 80 mm (3.25") in diameter with ball bearings, properly sealed to retain grease lubrication, and mounted on stands directly attached to the panels.
- .4 Equip hangers with adjustable ball bearing rollers to take the up-thrust of the doors.
- .5 Arrange the tracks and sheaves so that there is no metal to metal contact, and so that the doors operate properly without any regular lubrication.
- .6 Design all door equipment and associated components for a minimum of noise.

2.34 Car station

- .1 Provide one main car operating panel.
- .2 Provide in the panel the devices required for normal automatic operation, including the following:
 - .1 Floor push buttons;
 - .2 Door open button;
 - .3 Door close button;
 - .4 Alarm button;
 - .5 Emergency communication button.
- .3 Number the car call buttons to correspond to the floor served.
- .4 Provide in conjunction with the car buttons a call registered light for each button to be lighted when the button is pressed and extinguished when the car stops at the selected floor.
- .5 Secure tactile markings using hidden fasteners.
- .6 Provide Code-required keyswitches on the car operating panel.
- .7 Provide, only when required by the prevailing codes, a stop switch located in the service cabinet, arranged to stop the elevator and to duplicate the functions of the alarm button.
- .8 Engrave the car station with markings and signage such as car capacity, elevator number and other markings required by the prevailing codes and local regulations including remote location of device licenses where available.
- .9 Ensure that engravings and button designations are easily read when viewed at an angle from any normal standing position in the elevator cab within arms reach of the car station.
- .10 Hinge the car station faceplate so that it can be swung open towards the adjacent

cab side wall to allow access for servicing of the inner components of the car station.

- .11 Provide a hinge capable of supporting without distortion a test weight of minimum 11 kg resting on the panel non-hinged edge with the panel swung open.
- .12 Secure the car station in the closed position using countersunk spanner head fasteners or approved equivalent.
- .13 Arrange the car station so that it can be swung open without interference from the cab flooring, cab wall, cab handrails or other cab appurtenances.

2.35 Signal lights

- .1 Provide LED position indicators and call registered lights having a minimum contrast ratio of 8:1 throughout a life expectancy greater than 100,000 hours.
- .2 The contrast ratio is to be determined by subtracting the brightness of the indicator background from the brightness of the marking and then dividing the result by the brightness of the background.
- .3 Arrange that the variation in intensity and contrast ratio between position indicators does not exceed 5 percent.
- .4 Arrange that the variation in intensity and contrast ratio between call registered lights does not exceed 5 percent.
- .5 All measurements are to be made in ambient lighting conditions meeting Code requirements.

2.36 Automatic cab lighting and fan control

- .1 Arrange that the cab lights and fan are turned off in not more than five minutes when:
 - .1 The elevator is level at a floor;
 - .2 The elevator doors are closed;
 - .3 The elevator has not been selected to answer a call;

- .4 The elevator is on automatic operation;
- .5 The elevator safety circuit (including interlocks) is intact.
- .2 Ensure cab lighting has an efficacy of not less than 35 lumens per Watt.
- .3 Should any of the above conditions no longer obtain or when emergency communication devices are initiated, turn the car lights and fan on within 0.5 seconds.

2.37 Floor passing and stopping tones

- .1 Provide an audible tone, arranged to sound midway between floors, having an adjustable volume level of between 55 and 70 decibels, as measured from within the elevator cab, to indicate to the passengers in the elevator that the elevator is passing from one floor to another.
- .2 Provide an audible tone of a different nature, having an adjustable volume level of between 55 and 70 decibels, as measured from within the elevator cab, arranged to sound when the elevator is levelling into the floor, to indicate to the passengers in the elevator that the elevator is stopping at the floor.
- .3 Arrange that the operation of these tones is field-selectable and does not require software changes to enable or disable their functioning.

2.38 Car position indicator

- .1 Provide a digital car position indicator mounted in each car operating panel.
- .2 Arrange the indicator to display a number or symbol at least 50 mm (2") high.
- .3 Indicate the position of the car at all times, corresponding to the landing through which the car is passing or at which it is stopped.
- .4 Provide an LCD position indicator screen, a segmented display using LEDs with a minimum of 16 segments per character, or a dot-matrix display using LEDs with a minimum of 35 dots per character.
- .5 If there is an auxiliary car station, provide identical position indicators in both

stations.

- .6 Arrange the circuits so as to provide continuous indication of car position.

2.39 Emergency lighting

- .1 Provide a back-up battery power system for alarm bell operation and emergency cab lighting.
- .2 Install the emergency lighting lamp at the top or upper reaches of the car station unless otherwise required by the site Architectural cab design.
- .3 Provide a lighting level of at least 11 lux of illumination at the car operating panels for a minimum period of four hours, using at least four LED lamps of equal rating.
- .4 Cause the lamps to be immediately energized in the event of a power failure or electrical fault de-energizing the normal elevator lighting circuit.
- .5 Provide for the automatic disconnection of the lamps and the automatic recharging of the lighting unit when normal power is restored to the elevator lighting circuit.
- .6 Provide a rechargeable battery of the hermetically sealed type, or of a type which provides a reserve of electrolyte, capable of operating unattended and requiring no addition of water or electrolyte for a period of not less than ten years, with provision for visual checking of the electrolyte level without opening the battery or removing caps or fittings.
- .7 Arrange the battery charging to operate automatically upon restoration of normal power to the unit, to remain in operation until the battery is fully recharged and to maintain the battery at full rated capacity at all times when the unit is not in operation.
- .8 Provide a pilot lamp to indicate that the normal power supply to the unit and battery charging is in operation.
- .9 Arrange that the unit can be conveniently tested and operated manually.
- .10 Install the unit as part of the car so that it is not readily removed.
- .11 Do not provide portable equipment.

- .12 Install the lamp fixture above the car station.
- .13 Provide an emergency lighting test switch in the car service cabinet or behind the car swing return.

2.40 Telephone: hands-free operation

- .1 Provide a hands-free telephone with automatic dialer capable of initiating and receiving calls.
- .2 Integrate the telephone into the car station.
- .3 Provide a push button to initiate the telephone connection.
- .4 Arrange that the telephone connection can be initiated by an external call.
- .5 Provide an indicator light to confirm that communication has been established.
- .6 Pierce the car station for the push button and indicator light with the indicator light mounted flush with the panel.
- .7 Provide a speaker/microphone for communication.
- .8 Pierce the car station in front of the speaker with multiple holes 3 mm (1/8") in diameter to allow passage of sound to and from the speaker.
- .9 Identify the telephone and the button with a raised symbol and Braille.
- .10 Provide instructions and button identification text adjacent to the button (i.e. do not place text directly on button).
- .11 Provide wiring for the telephone from the cab to the machine room.
- .12 Provide a communication station in the machine room.
- .13 Connect the wiring on the car to a terminal block mounted in or adjacent to the telephone box.
- .14 Terminate the wiring in the machine room at a separate enclosed external terminal

block mounted on the controller.

- .15 Provide the terminal block and its enclosure and locate it so that personnel other than elevator mechanics can easily run their conduit and wiring to these terminals without interfering with or touching the elevator wiring or controls.
- .16 Where more than one controller is in a common machine room bring wiring to one common terminal block.
- .17 Clearly mark the terminal block.
- .18 Provide wiring of the twin conductor shielded type with grounded shields.
- .19 Provide equipment and wiring compatible with and acceptable to the telephone company providing service to the project.
- .20 Provide material and labour as necessary so as to ensure that the communication system meets the requirements of the Code.

2.41 Two-way communication system

- .1 Provide a two-way emergency communication system that permits verbal and non-verbal communication.
- .2 Provide a VoIP system (Voice over Internet Protocol) or approved alternative.
- .3 Provide line monitoring.
- .4 Integrate the system into the car station.
- .5 For verbal communication:
 - .1 Provide a speaker/microphone for communication.
 - .1 Utilization of the hands-free telephone system, including speaker/microphone, is acceptable provided it is compatible and all requirements are met.
- .6 For non-verbal communication:

- .1 Provide a camera inside the elevator cab to permit authorized persons to observe the entire surface area of the elevator cab floor.
- .2 Provide the video coverage required to meet the Code via a streaming service.
- .3 Ensure that the video streaming service is only initiated by the operator and that streaming is stopped once terminated by the operator.
- .4 Ensure that video recordings are not stored off-site (including “cloud”-based servers).
- .5 If buffering of the video (or any other temporary storage for streaming purposes) is required, ensure that the video is immediately deleted at the end of the video streaming session.
- .6 Install the camera in the elevator ceiling or in the car station and protect it from damage caused by impact.
 - .1 Utilization of existing closed circuit camera systems installed inside the elevator is acceptable provided it is compatible and all requirements are met.
- .7 Provide a LCD display screen in the car station.
 - .1 Utilization of the car position indicator for the LCD screen is acceptable provided it is compatible and capable of displaying the car position during communication.
- .8 Arrange the display screen to display the elevator cab floor surface area, text messages transmitted by authorized personnel and text messages transmitted by passengers inside the elevator.
- .9 Provide means for the passengers inside the elevator to communicate non-verbally with authorized personnel by:
 - .1 A QWERTY style button input on the car station; or
 - .2 YES or NO buttons on the car station.

- .7 Provide instructions and button identification text adjacent to the button (i.e. do not place text directly on button).
- .8 Provide a back-up battery power system for the communication system capable of operating the system for 4 hours in the event of a power failure.
- .9 Provide a communication station in each machine room.
- .10 Initiate the emergency communication system when the push-button on the car station for two-way emergency communication is pressed.
- .11 Arrange that the emergency communication system connection can be initiated by an external call.
- .12 Provide an indicator light to confirm that communication has been established.
- .13 Arrange the emergency communication system to dial to a location within the building staffed by authorized personnel when activated and, if not answered within 45 seconds, automatically forward the call to an off-site location staffed 24 hours per day by authorized personnel.
- .14 Provide, to authorized personnel, information that identifies where the call is coming when an emergency communication call is made.
- .15 Provide audible and visual communication failure signals within the same housing as the emergency recall switches and indicators and provide a key-switch in this housing to allow authorized personnel to temporarily deactivate the audible signal.
- .16 Supply wiring as necessary to connect the system to the elevator system.
- .17 Connect the wiring on the car to a terminal block mounted in or adjacent to the telephone box.
- .18 Terminate the wiring in the machine room at a separate enclosed external terminal block mounted on the controller.
- .19 Provide the terminal block and its enclosure and locate it so that personnel other than elevator mechanics can easily run their conduit and wiring to these terminals without interfering with or touching the elevator wiring or controls.

- .20 Where more than one controller is in a common machine room bring wiring to one common terminal block.
- .21 Clearly mark the terminal block.
- .22 Provide wiring of the twin conductor shielded type with grounded shields.
- .23 Provide equipment and wiring compatible with and acceptable to the telephone/IT company providing service to the project.
- .24 Provide material and labour as necessary so as to ensure that the communication system meets the requirements of the Code.
- .25 Provide any incidental elevator material and elevator work necessary to obtain a complete functioning communication system.
- .26 Do not ground the system to an alternating current circuit.
- .27 If the connecting wiring requires conduit external to the elevator hoistways and machine rooms coordinate with and assist as necessary the trades executing this work (these other trades are responsible for the provision of the conduit and the pulling of the wiring supplied by the elevator contractor).
- .28 Provide standard, readily available hardware components.
- .29 Submit for review brochures, details, wiring diagrams and description of the communication system.

2.42 Web-based monitoring service

- .1 Provide a web-based monitoring service to enable authorized personnel to initiate cab video monitoring or initiate non-verbal two-way communication.
- .2 Provide this monitoring service to the Owner for the maintenance period included herein (whether in the base scope or as an itemized or separate price).
- .3 If the web-based monitoring service requires fees for continued usage beyond the maintenance period included herein, such fees shall not exceed \$15 per device per month (adjusted annually from the date of substantial performance by an amount not to exceed the previous year's "all items" percentage change in the Consumer

Price Index).

- .4 Ensure that the monitoring system does not require any other special licences, services, subscription or fees to remain functional.
- .5 Ensure that the monitoring service functions with the current version of all major operating systems and browsers.
- .6 Ensure that the monitoring system does not require the installation of any proprietary software.
- .7 Make the web-based monitoring service available to any call answering service selected by the Owner (including other elevator contractors), regardless of which company maintains the elevator equipment.
- .8 Guarantee that the web-based service shall be provided and maintained for not less than 15 years.

2.43 Closed circuit camera security system

- .1 Provide necessary wiring and hardware for the future installation of a closed circuit camera in the elevator cab.
- .2 Provide wiring terminated in a junction box on the elevator car top labelled "Elevator CCTV Provisions" from the elevator to a separate junction box in the elevator machine room (location to be determined by Owner) labelled "Elevator CCTV Provisions".
- .3 Provide one RG6/U stranded centre conductor coaxial cable and one pair 18 gauge stranded conductor cable within an overall braided shield or such other interconnections as may be required by the CCTV contractor.
- .4 Provide an excess loop of 3050 mm (10') of cable at either end.
- .5 Provide a 110 vac power source labelled "Elevator CCTV Power" on the cab to power the camera.

2.44 Hall call security: lockout keyswitch

- .1 Provide a two-position removable keyswitch in the hall stations as follows:
 - .1 The keyswitch in the ON position will enable hall call functionality of the corresponding hall station;
 - .2 The keyswitch in the OFF position will disable hall call functionality of the corresponding hall station;
 - .3 Keyswitch barrel shall match that used to place the car on independent service;
 - .4 Lockout operation is to be bypassed during Firefighters' Emergency Operation as required by Code.

2.45 Hall push button stations: single riser

- .1 Provide a single riser of hall push button stations.
- .2 Provide one station for each floor.
- .3 Provide at the intermediate floors, for each station, up and down push buttons located one above the other and call registered lights.
- .4 Provide at the upper terminal and lower terminal, for each station, a single button and call registered light.
- .5 Illuminate the call registered light only when there is an elevator in service to respond to the call.
- .6 Provide emergency power and firefighters' switches, indicators and devices as necessary in the stations.
- .7 Where line monitoring is being installed, provide a communication indicator.
- .8 Secure the hall push button stations to the wall using countersunk spanner head fasteners or approved equivalent.

2.46 Hoistway access switch

- .1 Provide hoistway access switches in accordance with the Code.
- .2 Locate the switches in the entrance frame or in the sight guard in an inconspicuous place.
- .3 Locate the switches on the same side of the entrance frame as the pick-up roller assembly.

2.47 Cab ventilation

- .1 Provide an exhaust fan capable of developing 30 pascals (0.1" H₂O) static pressure differential with a minimum capacity of 165 litres per second (350 cfm).
- .2 Provide a two speed motor for the fan with the speed control located in the car operating panel.
- .3 Ensure that the cab ventilation does not consume over 0.33 W/cfm at maximum speed.

2.48 Cab: standard finishes

- .1 Provide a cab including the following items:
 - .1 A reinforced metal cab shell allowing the use of the elevator without interior finishes;
 - .2 A ceiling finished in white baked enamel;
 - .3 Returns, transom, car door jamb, lintel and door finished in stainless steel;
 - .4 Aluminum car sill;
 - .5 A 3 mm (1/8") thick aluminum plate over a wooden sub-floor;
 - .6 For non-access walls, 19 mm (3/4") thick plywood panels covered with plastic laminate chosen by the Owner among the standard products from Formica and Armstrong, with stainless steel reveals and binders;

- .7 A solid suspended ceiling made of stainless steel panels, the number and dimensions of ceiling panels to correspond with the number and width of panels on adjacent cab walls;
- .8 A LED light fixture in each suspended ceiling panel;
- .9 A 13 mm (1/2") recess for ceramic tile flooring to be installed by others, flush with the car sill;
- .10 Tubular stainless steel handrails of an exterior diameter of 38 mm (1.5") and located, extending the full length of non-access walls and with tapers at the ends.
- .2 Provide vandal-resistant finishes.
- .3 Supply any other material and labour necessary to provide a completed, installed cab including mounting strips, stay plates, base and sound-deadening material.
- .4 Provide cut-outs to accommodate the elevator equipment.
- .5 Submit for review shop drawings showing the finishes and design.

2.49 In car lanterns and gongs: applied

- .1 Provide a single in car lantern complete with electronic gongs on the cab wall near the door strike jamb side of the elevator cab entrance to indicate the future direction of the elevator.
- .2 Mount the lantern on the car entrance column.
- .3 Arrange the lantern and circuits so that as the car doors start to open in response to a call, the lantern illuminate and the gong strikes.
- .4 Sound the gong once to indicate the up direction and twice to indicate the down direction.
- .5 Maintain the lantern illuminated until the car has stopped and the door open time has elapsed.
- .6 Do not illuminate the lantern on a door re-open unless the re-open is caused by a

reversal of direction of travel of the car.

- .7 Arrange the operation of the lanterns and gongs to comply with requirements for persons with physical disabilities.
- .8 Provide LEDs for illumination.
- .9 Design the fixture so that the lamps may be readily changed. Do not mount any equipment to the covers; arrange that the covers can be removed completely without disturbing the electric wiring.

2.50 Car inspection devices

- .1 Provide, on the top of the car, a fixed lamp receptacle, with switch, outfitted with wire clamp guards, and a GFI duplex receptacle with safety ground connection.
- .2 Provide, on the top of the car, an inspection station consisting of an emergency stop button, up, down and common inspection running buttons, on-off switch for the door operator and other devices necessary for top-of-car inspection operation.

2.51 Sliding guides

- .1 Equip the car with spring-loaded sliding guides mounted at both the top and the bottom of the car frame.
- .2 Provide guide shoes of the self-aligning, self lubricating, swivel type with metal body and removable non-metallic liners to ensure smooth and quiet operation.

2.52 Guide rails

- .1 Provide standard section guide rails with tongued and grooved joints.
- .2 Provide guide rails of structural strength and rigidity sufficient to limit the horizontal deflection of the guide at any point to less than 0.6 mm (0.025") under normal conditions of operation.
- .3 Use substantial machined finished plates to form the rail joints.
- .4 Erect guide rails with a variation of not more than 1.6 mm (0.06") over any 6 m (20') section and with a maximum variation of not more than 0.8 mm (0.03") in 25 mm

(1").

- .5 Install guide rails in a strong and substantial manner using brackets affixed to the building structure.
- .6 Clamp the guides to the bracket with clips.
- .7 Arrange each clip so as to resist a vertical force of less than 4500 N (1000 pounds) and so as to allow the rail to slide if the vertical force exceeds 9000 N (2000 pounds).
- .8 Arrange the clips to prevent any horizontal movement of the rail.
- .9 Extend rails to within less than 300 mm (12") and more than 150 mm (6") of the underside of the overhead slab.
- .10 Use all standard length rails unless shorter lengths are required to avoid bracket locations or to complete the rail run at the top of the hoistway.
- .11 Install and locate the rails so that joints do not interfere with the supporting brackets and clamps.

2.53 Fascias

- .1 Provide fascias to meet, as a minimum, the requirements of the Code.
- .2 Unless a car door interlock is provided and the strength of the car door meets the applicable requirements of the Code:
 - .1 Provide fascias from the header of one entrance to the sill of the entrance above for the complete travel of the elevator including any express zone;
 - .2 Provide fascias extending below the sill of the lowest landing and above the header of the highest landing.
- .3 Provide fascia plates extending on each side at least 75 mm (3") beyond the clear openings.
- .4 Provide fascia plates of sheet steel of minimum 1.5 mm (16 gauge) thickness.

- .5 Reinforce fascia plates properly.
- .6 Provide all necessary supports required to secure fascia plates in place.

2.54 Car platform

- .1 Provide a car platform of sufficient size to accommodate the cab and to give the required inside net area assuming typical 50 mm (2") wall thickness and 180 mm (7") for doors, sill and return.
- .2 Provide a car platform with a structural steel frame filled with wood, aluminum or steel flooring having a depression to receive the finished floor.
- .3 Mount the car platform on isolating pads to prevent the transmission of noise and vibration from the car frame to the car platform.
- .4 Install the equipment in such a way that there is no direct metal connection between the car platform or the car cab and the car frame except metallic flex, where required, run in such a way as to provide vibration isolation.

2.55 Car frame

- .1 Provide a car frame of steel channels and angles securely welded, bolted or riveted and substantially reinforced and braced so as to relieve the car enclosure of all strains.

2.56 Cab installation

- .1 Assume undivided responsibility for the entire installation of the cab.
- .2 Handle, store, protect and install the cab and all associated equipment.
- .3 Install the elevator cab on the platform plumb and in alignment with the hoistway entrances.
- .4 Sound isolate the cab from the car frame.
- .5 Provide additional material and labour as required for handling, storing and installing the cab so as to provide a complete job.

2.57 Emergency lowering

- .1 Provide battery operated emergency lowering.
- .2 Provide, as a minimum, sufficient battery power to perform the following cycle of operation five times within a 30 minute period:
 - .1 Close the elevator doors;
 - .2 Run the car to the bottom floor;
 - .3 Open the doors;
 - .4 Close the doors.
- .3 Cause the emergency lowering operation to be implemented in the event of a power failure or electrical fault de-energizing the normal elevator power supply.
- .4 Under emergency lowering conditions cause the elevator to close its doors and travel down, without stopping, to the bottom floor, open its doors, and after the normal door open time has elapsed, close its doors and remain parked at the lowest floor.
- .5 On emergency lowering operation, maintain operational all of the normal safety devices including door open buttons, and door protective devices.
- .6 Provide for the automatic termination of the emergency lowering operation and the automatic recharging of the battery when normal power is restored.
- .7 Provide a rechargeable battery of the hermetically sealed type, or of a type which provides a reserve of electrolyte, capable of operating unattended and requiring no addition of water or electrolyte for a period of not less than ten years, with provision for visual checking of the electrolyte level without opening the battery or removing caps or fittings.
- .8 Arrange the battery charging means to operate automatically upon restoration of normal power, to remain in operation until the battery is fully recharged and to maintain the battery at full rated capacity at all times when emergency lowering is not in operation.

.9 Provide a pilot lamp to indicate that the normal power supply and battery charging are in operation.

.10 Provide means for convenient manual operation and testing.

2.58 Car balance

.1 Statically balance the car so that, at the centre of the travel, with the top guiding means removed, the car hangs in the centre of the rails.

.2 Arrange the equipment so that there is, in this position, with the guiding means properly adjusted, no force upon the guides.

.3 Make this test with empty car and car doors closed.

.4 Locate and adjust devices such as the compensating devices, travelling cable hangers and cab balancing weights so that the force upon any guide at any point in the travel does not exceed 110 Newtons (25 pounds) with empty car and car doors closed.

2.59 Load weighing device

.1 Provide a pressure transducer to measure the load in the car within an accuracy of $\pm 8\%$ of the elevator capacity.

2.60 Pit equipment

.1 Provide buffer extensions, support beams, work platform with ladder as necessary to accommodate the pit depth.

.2 Where there is space below the hoistway that is accessible to persons, conform to section 2.6 or 3.6 of the Code.

2.61 Limit switch dowelling

.1 After the final limit switches are adjusted and prior to the performance of safety tests and checks by the inspecting authorities, fasten, by throughbolting or dowelling, the final limit switches and final limit switch brackets so as to minimize the possibility of future incorrect adjustment.

2.62 Car ride

- .1 Arrange that the horizontal acceleration front to rear or side to side measured in the car with the elevator travelling, with a load of less than 10 per cent of capacity, from top to bottom and bottom to top does not exceed 0.15 m/s^2 (0.5 ft/s^2) measured between two consecutive points of opposite value.
- .2 Arrange that the vertical acceleration measured in the car with the elevator travelling, with a load of less than 10 per cent of capacity, from top to bottom and bottom to top at contract speed, does not exceed 0.10 m/s^2 (0.3 ft/s^2) measured between two consecutive points of opposite value.

2.63 Painting

- .1 Ensure that machine room and hoistway equipment, except for machined surfaces and non-rusting surfaces, is protected with two coats of a rust inhibiting primer of a neutral colour, each coat of 25 micron minimum thickness.
- .2 Paint the pit floor.

2.64 External connections

- .1 Provide a junction box on the external wall of the hoistway at a point to be designated later for connections for such items as telephones, CCTV, lobby panels, monitor systems, to external locations such as the CACF Room.
- .2 Locate this box as instructed and provide clearly marked terminal blocks for the wiring connections.
- .3 Supply the required wiring for the connections from this box to the external locations (provision of external conduit and pulling of wiring by others).

2.65 Travelling cable

- .1 Provide travelling cables with flame-retarding and moisture-resisting outer covers and stranded conductors.
- .2 Supply cables approved for elevator use.
- .3 Provide in the travelling cables:

- .1 14 AWG (1.5 square mm) conductors for current-carrying circuits;
- .2 18 AWG (0.75 square mm) conductors for signal circuits;
- .3 20 AWG (0.5 square mm) shielded pair conductors with shielding for telecommunications circuits and data circuits;
- .4 one RG6/U stranded centre conductor coaxial cable and one pair 18 gauge stranded conductor cable within an overall braided shield for closed-circuit television.
- .4 Provide ten percent additional minimum spare signal and current-carrying wires in each cable.
- .5 Terminate cables using terminal blocks or suitable connectors having identifying numbers to facilitate replacement and service.
- .6 Suspend light weight cables using a wire mesh sleeve to relieve strain in the individual conductors and heavier cables using a steel supporting strand if the suspended weight exceeds 35 kg (seventy-five pounds).

2.66 Electric wiring

- .1 Provide wiring required to interconnect the equipment.
- .2 Provide copper wire.
- .3 Provide insulated wiring having a flame retarding and moisture resisting outer cover.
- .4 Where flexible conduit is used, supply it in aluminium.
- .5 Provide travelling cable to connect car operating panels and other car operating devices to the controller in the machine room.
- .6 Where shielded wire is specified, provide wire of not less than 0.52 mm² area (20 gauge) having individually shielded pairs with 100% shielding.
- .7 Provide colour or number coded wires in multiwire cables.

- .8 Provide waterproof terminal labels.
- .9 Provide stranded field wire except for the individual wires in multiwire cables which may be either stranded or solid.

3 Execution

3.1 Operation: simplex

- .1 Provide a micro-processor based simplex control for the elevator.

3.2 Operation: load non-stop

- .1 Provide a load weighing device which, when the elevator has more than 35 percent of its rated load, causes it to by-pass hall calls and stop only for registered car calls.
- .2 Provide a device adjustable over the range of 30 to 60 percent of elevator capacity with a long term accuracy of plus or minus five percent.

3.3 Operation: call response

- .1 Store all hall and car calls in the control memory until answered.
- .2 Cancel a call when it is answered by a car.
- .3 Stop a running car at the first landing for which a car call is registered.
- .4 Stop a running car for a hall call registered for the same direction as the car is travelling, subject to higher priority assignments and to load in the car.

3.4 Operation: dispatch recovery

- .1 If a hall call remains registered for longer than 60 seconds and within that period the cars are not running, dispatch all cars and run without dispatch delay or assignment until all registered hall calls are cancelled.

3.5 Operation: call initiation

- .1 Control the elevator automatically by buttons in the car, marked to correspond with the respective landings served, and by the call buttons at the landing stations.
- .2 Register a call by momentary pressure of a button.

3.6 Operation: high & low call return

- .1 Cause the car to proceed to the calls until it has come to the limit of calls placed in the direction in which it is travelling, and having done this, subject to the assignment of the dispatch system, to reverse direction.
- .2 Do not stop the car, except in the case of high and low return, for hall calls in the opposite direction to the direction of the car.

3.7 Operation: fault recovery

- .1 Provide a recovery circuit arranged to take the elevator at low speed to the next floor in the event of an overspeed condition, overload trip, or other similar fault condition.
- .2 Do not implement the recovery circuit if the movement of the car would endanger the passengers in the car.
- .3 Provide a circuit separate from the normal speed control circuits, with power derived through separate controls and limited in power by resistance or fixed devices to an appropriate low level.
- .4 Do not use, in this circuit, any solid state or other device which could fail in a mode that would allow an increase in applied power.
- .5 Upon arrival of the car level at the next floor, cause the doors to open and remain open, and turn off the car lights.
- .6 Leave the elevator in this state until the fault is corrected and the car restored to service.

3.8 Operation: independent service

- .1 Provide independent service.
- .2 On independent service:
 - .1 Remove the car from the automatic supervisory control system;
 - .2 Arrange the circuits so that the car does not respond to hall calls;
 - .3 Render the hall lanterns (if provided) inoperative;
 - .4 Cause the car to park with its doors open;
 - .5 Arrange the controls so that the car responds to any car calls registered if a button is held until the doors are closed and the interlocks made-up;
 - .6 Cause the doors to reopen if the button is released at any time up to the point at which the elevator starts to move;
 - .7 Render inoperative the normal door protective devices;
 - .8 Arrange the controls so that the attendant can select direction of travel;
 - .9 Cancel all registered car calls when the direction reverses or a car call is answered.
 - .10 Arrange the independent service operation so that it does not override security features or security systems.

3.9 System clock

- .1 Where operations or functions are subject to clock control or require clock input, provide a solid state clock.
- .2 Provide, in the machine room or at the central control console, means to indicate the current clock time.
- .3 Provide, in the machine room or at the central control console, means to readily reset the clock time.

- .4 Provide crystal regulation of frequency and voltage control adequate to maintain the time within an accuracy of plus or minus five seconds per month.
- .5 Provide software to automatically adjust the time for changes from standard to daylight saving time and from daylight saving time to standard time.
- .6 Provide battery back-up to maintain for a period of at least 24 hours accurate clock time in the event of power loss.

3.10 Door protective device by-pass (nudging)

- .1 Should a door protective device be operated continuously for more than 20 seconds after the elapse of the normal door open time, cause the doors to close slowly under reduced power and operate a buzzer in the car panel as a warning to the person obstructing the door.
- .2 Cause the 20 seconds to be reduced to 6 seconds until a normal door cycle is performed.

3.11 Door open pause time

- .1 Arrange the circuits so that when the car is stopped in response to a hall call the doors remain open a predetermined length [approximately 5 seconds for an elevator whose entrances are within 3 metres (10') of the hall push button and approximately 6 seconds for an elevator whose entrances are further than 3 metres (10') from the hall push button].
- .2 Arrange that this predetermined length of time is reduced to approximately 0.7 seconds if a person moves through the entrance (as indicated by the actuation of the door protective device).
- .3 Unless otherwise specified (e.g. to allow for advance hall lantern warning), arrange the circuits so that when the car is stopped in response to a car registered call the doors remain open a predetermined length of time (approximately 3 to 4 seconds).
- .4 Make the times separately adjustable over a range from 0.25 seconds to 15 seconds.
- .5 Arrange the circuits so that the door open pause time is cancelled if a car call button

is pressed or the door close button is pressed.

3.12 Operation: door protective device

- .1 Arrange the door protective device so that, should it detect a person or any object in its path, at any point during the door closing operation, it will cause the doors to return to the open position.
- .2 Adjust both the detection device and the door operation so that an object or person in the way of the door will cause the doors to reverse without the door panel of either hall or car doors actually striking the object or person.

3.13 Noise level: door operation

- .1 Arrange the equipment so that the noise level, as measured within the cab, does not exceed 60 decibels at any time during a full door open, door close and door reversal cycle.
- .2 Initiate the door reversal by triggering the door protective device.
- .3 Measure the noise level using an ANSI type 2 sound level meter on the "A" scale with an "F" response.

3.14 Noise level: cab

- .1 Arrange that, with the elevator travelling from one end of the hoistway to the other, the noise level as measured within the elevator cab does not exceed 55 dBA for traction elevators and 58 dBA for hydraulic elevators.
- .2 Measure this noise level with an ANSI type 2 sound level meter on the "A" scale with an "F" response.

3.15 Cab fan: operation

- .1 Arrange that there is no discernible vibration in the car with the fan operating.
- .2 Arrange that the noise level developed by the fan, measured in the car with the fan running, does not exceed 55 dBA.
- .3 Measure this noise level with an ANSI type 2 sound level meter on the "A" scale with

an "F" response.

3.16 Noise level: control and machine room

- .1 Design the equipment so that the noise level with the elevator running, as measured by a meter positioned in the centre of the control and machine rooms, does not exceed 80 decibels.
- .2 Measure this noise level using an ANSI type 2 sound level meter on the "A" scale with an "F" response.

3.17 Transmitted vibration

- .1 Arrange that the dose value of the transmitted vibration generated by the machine and associated sheaves in the frequency range from 0 to 100 Hz is less than 0.2 in any single axis and that the average of the dose values of the three axes is less than 0.15.
- .2 Measure the vibration over a period of ten seconds in both directions of travel at contract speed with empty car.
- .3 Record the vibration using an accelerometer transducer mounted on the machine beam adjacent to the machine.
- .4 Process the accelerometer output through a low pass digital or analogue filter to delete frequencies above 100 Hz.
- .5 Record the accelerations from 0 Hz to a minimum 200 Hz in the vertical axis and the two horizontal axes.
- .6 Calculate the vibration dose value by integrating the fourth power of the acceleration in m/s/s over the ten second period, dividing by the number of samples, and taking the fourth root of the result.

3.18 Levelling

- .1 Cause the car to stop automatically at floor level, without overshoot, regardless of load or direction of travel so that the car sill is level, within 6 mm (1/4"), with respect to the hoistway sill.

- .2 When the elevator cab is stopped at a floor, correct for over travel or under travel or movement of the cab away from the floor, by returning the car imperceptibly to floor level.

3.19 Speed control: hydraulic

- .1 Provide a speed control system of the hydraulic-electric type in which control is accomplished by varying the oil flow to and from the hydraulic jack.
- .2 Design and adjust the equipment so that the average acceleration over the period of constant acceleration is 0.6 m/s^2 (2.0 ft/s^2) plus or minus 10%.
- .3 Design and adjust the equipment so that the average change in acceleration (jerk) is 1.8 m/s^3 (6.0 ft/s^3) plus or minus 10%.
- .4 Design and adjust the equipment so that the rated speed is maintained under any condition of loading, except the case of overload, with an accuracy of 5%.

3.20 Test data form: hydraulic

- .1 After completion of the Work, and prior to Substantial Performance, submit a test data form certifying that the unit is complete and ready for inspection.
- .2 Arrange that this form be signed by the person responsible for the performance of the Work.
- .3 Include a check list of the items in the specifications as well as other performance data such as door times, operating times, starting and running currents and voltages, operating pressures, slowdown distances, valve settings, and, in general, settings of any adjustable devices.
- .4 List on this form safety devices, together with their settings and indicate as to whether they have been checked and adjusted.
- .5 Submit a soft copy of the data form in PDF (Acrobat Reader) format.

3.21 Operating time

- .1 Adjust the equipment so that the elapsed time to travel one typical floor does not exceed the time shown in the data table.
- .2 Measure this time under the following conditions:
 - .1 A typical floor height of less than 4000 mm (13');
 - .2 Floor levelling accuracy of ± 6 mm (1/4");
 - .3 Start time when the fully opened doors begin to close;
 - .4 Stop time when the car is stopped level with the next floor and the car and hall doors are 800 mm (32") open;
 - .5 Time measured with full load in the car and in both directions of travel;
 - .6 Power door operation for the hall and car doors conforms to the elevator code requirements.
- .3 Adjust the equipment so that the operating time is compatible with dependable, consistent operation without undue wear or excessive maintenance and so that this operating time can be readily maintained over the life of the elevator installation.
- .4 Adjust the equipment so that, with the control functioning so as to give the required time, the elevator operates under smooth acceleration and retardation and provides a comfortable and agreeable ride.

3.22 Firefighters' Emergency Operation: Phase 1 automatic recall

- .1 Provide Firefighters' Emergency Operation including:
 - .1 Phase I automatic Emergency Recall Operation;
 - .2 Phase I Emergency Recall Operation to an alternate level.
- .2 Provide switches and indicators in the hall and car stations as required by Code.

3.23 Seismic Requirements: elevator

- .1 Provide equipment complying with Section 8.4 of the Code and applicable values provided by the Structural Engineer.
- .2 On the layout drawings, indicate the input seismic parameters carried in calculations required by Code.
- .3 On the layout drawings, show seismic forces for elevator equipment as required by the Building Code: Elements of Structures, Non-structural Components and Equipment.

END OF SECTION

END OF SPECIFICATION

ECOLE ELEMENTAIRE ANTONINE-MAILLET

New Elevator & Office Renovation



MECHANICAL/ELECTRICAL SPECIFICATIONS

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INDEX OF SPECIFICATIONS

01 33 23	SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
01 79 00	DEMONSTRATION AND TRAINING
02 41 00	DEMOLITION
22 05 00	COMMON WORK RESULTS FOR PLUMBING
22 05 15	PLUMBING SPECIALTIES AND ACCESSORIES
22 05 23	GENERAL-DUTY VALVES FOR PLUMBING PIPING
22 05 53	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
22 07 00	PLUMBING INSULATION
22 11 16	DOMESTIC WATER PIPING
22 13 00	FACILITY SANITARY SEWERAGE
22 42 00	COMMERCIAL PLUMBING FIXTURES
23 05 00	COMMON WORK RESULTS FOR HVAC
23 05 13	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
23 05 48	VIBRATION AND SEISMIC CONTROLS FOR HVAC
23 05 53	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 05 93	TESTING, ADJUSTING AND BALANCING FOR HVAC
23 07 00	HVAC INSULATION
23 09 00	INSTRUMENTATION AND CONTROL FOR HVAC
23 21 13	HYDRONIC PIPING
23 23 00	REFRIGERANT PIPING
23 25 13	WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEM
23 31 13	METAL DUCTS
23 33 13	DAMPERS
23 34 00	HVAC FANS
23 37 00	AIR OUTLETS AND INLETS

23 72 00	AIR TO AIR ENERGY RECOVERY EQUIPMENT
23 81 29	VARIABLE REFRIGERANT FLOW HVAC SYSTEMS
23 82 00	CONVECTION HEATING AND COOLING UNITS
26 05 00	COMMON WORK RESULTS FOR ELECTRICAL
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
26 22 00	LOW-VOLTAGE TRANSFORMERS
26 24 16	PANELBOARDS
26 28 16.02	MOULDED CASE CIRCUIT BREAKERS
26 28 23	DISCONNECT SWITCHES - FUSED AND NON-FUSED
26 51 00	INTERIOR LIGHTING

TABLE OF CONTENTS

PART 1 - GENERAL..... 2

1.1. GENERAL..... 2

1.2. DEFINITIONS 2

1.3. SUBMITTAL REGISTER..... 3

1.4. SUBMISSION PROCEDURES – SHOP DRAWINGS 4

1.5. SUBMISSION SCHEDULING 7

1.6. AS-BUILT DOCUMENTATION 7

1.7. RECORD DOCUMENTS EDIT LOG 8

1.8. AS-BUILT DRAWINGS 8

1.9. RECORD SPECIFICATIONS 9

1.10. OPERATION AND MAINTENANCE MANUALS 9

1.11. MAINTENANCE AND OPERATIONS MANUAL FORMATTING 12

1.12. WITHHOLDING OF PAYMENT 13

PART 2 - PRODUCTS (NOT APPLICABLE)..... 13

PART 3 - EXECUTION (NOT APPLICABLE)..... 13

PART 1 - GENERAL

1.1. GENERAL

- 1.1.1. This specification defines the general requirements and procedures for submittals. A submittal is information submitted for the Consultant's review to establish compliance with the contract documents.
- 1.1.2. Detailed submittal requirements are found in the technical sections of the contract specifications. The Consultant may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective technical specifications at no additional cost to the Client.
- 1.1.3. Consultant review of a submittal does not relieve the Contractor of the responsibility for compliance with the contract documents or any error which may exist. The Contractor is responsible for fully complying with all contract requirements and the satisfactory construction of all work, including the need to check, confirm, and coordinate the work of all subcontractors for the project. Non-compliant material incorporated in the work will be removed and replaced at the Contractor's expense.

1.2. DEFINITIONS

- 1.2.1. Shop Drawings: Drawings, diagrams, and schedules specifically prepared to illustrate some portion of the work. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be integrated and coordinated.
- 1.2.2. Product Data: Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions, and brochures, which describe and illustrate size, physical appearance, and other characteristics of materials, systems, or equipment for some portion of the work. Samples of warranty language when the contract requires extended product warranties.
- 1.2.3. Samples: Physical examples of materials, equipment, or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project. Field samples and mock-ups constructed to establish standards by which the ensuing work can be judged.
- 1.2.4. Design Data: Calculations, mix designs, analyses, or other data pertaining to a part of work.
- 1.2.5. Test Reports: Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work. Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

- 1.2.6. Certificates: Document required of Contractor, or of a manufacturer, supplier, installer, or subcontractor through Contractor. The purpose is to document procedures, acceptability of methods, or personnel qualifications for a portion of the work.
- 1.2.7. Manufacturer's Instructions: Pre-printed material describing installation of a product, system, or material, including special notices and MSDS concerning impedances, hazards, and safety precautions.
- 1.2.8. Manufacturer's Field Reports: Documentation of the testing and verification actions taken by manufacturer's representative at the job site on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must indicate whether the material, product, or system has passed or failed the test.
- 1.2.9. Operation and Maintenance Data: Manufacturer data that is required to operate, maintain, troubleshoot, and repair equipment, including manufacturer's help, parts list, and product line documentation. This data shall be incorporated in an operations and maintenance manual.
- 1.2.10. Closeout Submittals: Documentation necessary to properly close out a construction contract. For example, Operation and Maintenance manuals, as-built drawings. Also, submittal requirements necessary to properly close out a phase of construction on a multi-phase contract.

1.3. SUBMITTAL REGISTER

- 1.3.1. The submittal register prepared by the Contractor will list items of equipment and materials for which submittals are required by the specifications. This list may not be all inclusive and additional submittals may be required by the specifications. The Contractor is not relieved from supplying submittals required by the contract documents but which have been omitted from the submittal register.
- 1.3.2. The submittal register will serve as a scheduling document for submittals and will be used to control submittal actions throughout the contract period.
- 1.3.3. The Contractor shall provide the initial submittal register in electronic format. Thereafter, the Contractor shall track all submittals by maintaining a complete list, including completion of all data columns, including dates on which submittals are received and returned by the Consultant.
- 1.3.4. The Contractor shall update the submittal register as submittal actions occur and maintain the submittal register at the project site until final acceptance of all work by Client representative.

- 1.3.5. The Contractor shall submit formal monthly updates to the submittal register in electronic format. Each monthly update shall document actual submission and approval dates for each submittal.

1.4. SUBMISSION PROCEDURES – SHOP DRAWINGS

- 1.4.1. The Contractor shall review all shop drawings before submittal to the Consultant. This review implies that the Contractor has determined or will determine measurements and has verified or will verify on the site, the construction criteria, materials, catalog numbers and similar data, and that he has reviewed and coordinated each shop drawing with the Contractual Documents and Specifications.
- 1.4.2. Submit shop drawings to the Consultant within reasonable delays and in a logical sequence in compliance with the construction schedule.
- 1.4.3. Submit for approval, all of the items specifically mentioned under the separate sections of the specification, with information sufficient to evidence full compliance with contract requirements. Materials, fabricated articles and the like to be installed in permanent work shall equal those of approved submittals.
- 1.4.4. Submission Preparation
 - 1.4.4.1. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.
 - 1.4.4.2. Collect required data for each specific material, product, unit of work, or system into a single submittal. Prominently mark choices, options, and portions applicable to the submittal. Partial submittals will not be accepted for expedition of construction effort. Submittal will be returned without review if incomplete.
 - 1.4.4.3. All irrelevant or unnecessary data shall be removed from the submittal to facilitate accuracy and timely processing. Submittals that contain the excessive amount of irrelevant or unnecessary data will be returned with review.
 - 1.4.4.4. Forward submittals in sufficient time to permit proper consideration and approval action by the Consultant; minimum time required for Consultant's review shall be 10 business days or longer, if the submitted equipment does not match the standard of acceptance and additional time is required for the evaluation.
 - 1.4.4.5. Schedule submission to assure adequate lead time for procurement of contract required items. Delays attributable to untimely and rejected submittals will not serve as a basis for extending contract time for completion.
 - 1.4.4.6. The Consultant's review consists in reviewing the conformity of shop drawings with the contract documents for recommendation to the Client or Owner. The Consultant is not liable for any responsibility for dimensions, details nor quantities.

- 1.4.4.7. After an item has been reviewed by the Consultant no change in brand or make will be permitted unless:
 - 1.4.4.7.1. Satisfactory written evidence is presented to, and positively reviewed by the Consultant, that manufacturer cannot make scheduled delivery of approved item or;
 - 1.4.4.7.2. Item delivered has been rejected and substitution of a suitable item is an urgent necessity or;
 - 1.4.4.7.3. Other conditions become apparent which indicates approval of such substitute item to be in best interest of the Client.
- 1.4.5. If the Contractor installs equipment or material for which he has not submitted shop drawings for verification, the Consultant may, if the equipment or material is not installed in accordance with plans and specifications, require the equipment or material to be removed and replaced by a compliant product at no additional cost to the Client.
- 1.4.6. Shop drawings relating to products, special design systems or installations, custom equipment or similar to, all of which are not standard or catalogued products, will be considered engineering documents and as such, shall be authenticated by their author engineer. Authentication shall be in conformity with current Province of Ontario Laws and By-Laws. As an example, not limited to, shop drawings of a custom air-handling unit are covered by the present article and as such, constitute engineering documents that will require an authentication by their author engineer.
- 1.4.7. When shop drawings are resubmitted, indicate in writing all revisions other than those required by the Consultant.
- 1.4.8. Submit for review by the Consultant, within reasonable delays of the contract award, the complete set of shop drawings required. Faxed shop drawings are not accepted.
- 1.4.9. Shop drawings shall be submitted in electronic format. The following rules must be followed entirely:
 - 1.4.9.1. The identification form must be included;
 - 1.4.9.2. A shop drawing identification sheet hereby mentioned shall be included;
 - 1.4.9.3. A single file in PDF format for each shop drawing shall be submitted. In the case where more than one document constitutes the drawing, they must all be incorporated into a single file;
 - 1.4.9.4. Printing parameters of the drawings must be incorporated in the file to assure a scaled printing on a commercial printer;
 - 1.4.9.5. The file must be of an excellent graphical quality;
 - 1.4.9.6. Transmission of the shop drawings must follow the path of communication established for the project;
 - 1.4.9.7. A transmittal sheet shall be attached to submitted drawings.

- 1.4.10. Shop drawings not following these directives will be returned to the Contractor with a "Rejected" recommendation.
- 1.4.11. Each shop drawing shall be presented with an identification form. The shop drawing identification sheet shall include as a minimum the following information:
 - 1.4.11.1. Client's name
 - 1.4.11.2. Project's name
 - 1.4.11.3. Consultant's name
 - 1.4.11.4. Contractor's name
 - 1.4.11.5. Name of sender
 - 1.4.11.6. Sub contractor's name
 - 1.4.11.7. Supplier's name
 - 1.4.11.8. Specialty
 - 1.4.11.9. Description
 - 1.4.11.10. Specifications section number and article number
 - 1.4.11.11. Revision number
 - 1.4.11.12. Blank space for stamp of Conformity Review.
- 1.4.12. Submit all shop drawings in English, certified for construction by the manufacturer.
- 1.4.13. Drawings for non-standard articles or materials shall be produced, especially for the project.
- 1.4.14. Shop drawings shall include:
 - 1.4.14.1. Construction details, dimensions, weights and equipment or material characteristics together with supplementary information such as bulletins, illustrations and exploded views of constituting parts.
 - 1.4.14.2. Graphs, curves, capacities, efficiency and other technical data submitted by the manufacturer or requested by the Engineer concerning the operation of the equipment.
 - 1.4.14.3. Wiring diagrams, single line diagrams, principle diagrams, control diagrams, operating sequences and all interconnections with other systems when required.
 - 1.4.14.4. Flow diagrams for air, water, oil, fuel, etc. if applicable.
 - 1.4.14.5. Marketing folders or publicity brochures will not be accepted.
- 1.4.15. Shop drawings will be returned with one or two of the following mentions: "Reviewed", "Modify and resubmit", "Modify as noted", "Rejected".
- 1.4.16. Drawings stamped "Reviewed" will not be further commented. Drawings comply with contractual documents.

- 1.4.17. Drawings stamped "Rejected" shall be done over again and resubmitted for approval. Drawings do not comply with contractual documents.
- 1.4.18. Drawings stamped "Modify as noted" shall not be resubmitted. Conditionally to the corrections indicated, drawings comply with contractual documents.
- 1.4.19. Drawings stamped "Modify and resubmit" shall be resubmitted, in part or in whole, as indicated for further examination. Drawings do not comply with contractual documents.
- 1.4.20. Drawings stamped "Modify as noted" and "Modify and resubmit" shall be resubmitted in part or in whole, as indicated, for further examination. Conditionally to the corrections indicated, drawings comply with contractual documents.
- 1.4.21. The Consultant's examination of the shop drawings does not relieve the Contractor from supplying equipment conforming to current standards and bylaws and to the requirements of this specification.
- 1.4.22. Any equipment, which is manufactured without the Engineer's prior examination, may be rejected. Assume all costs inherent to such a rejection.

1.5. SUBMISSION SCHEDULING

- 1.5.1. Submittals are to be scheduled, submitted, reviewed, and returned to the Contractor prior to the acquisition of the material or equipment. All comments marked by the Consultant shall be incorporated in the item for which a submission was made. No material or equipment shall be acquisitioned if the respective submissions was reviewed and rejected by the Consultant
- 1.5.2. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow time for potential re-submittal.
- 1.5.3. No delay costs or time extensions will be allowed for time lost in late submittals or re-submittals.
- 1.5.4. All submittals are required to be reviewed prior to the start of the specified work activity.

1.6. AS-BUILT DOCUMENTATION

- 1.6.1. During progress of the Work, Contractor shall maintain a set of Record Documents and Shop Drawings at the Site. Contractor must update these documents weekly, at a minimum, with mark-ups of actual installations that vary from the Work as originally shown. Contractor shall include all Drawings issued as addenda, clarifications, or Change Orders.

- 1.6.2. Contractor shall maintain and have available for review in conjunction with project progress meetings, a current set of the marked-up Record Documents and Shop Drawings. Availability for review and acceptability of both the format and content are prerequisites for certification and acceptance of the Application for Payment by the Client and Consultant.
- 1.6.3. Contractor must protect marked-up Record Documents from deterioration and loss in a secure location.

1.7. RECORD DOCUMENTS EDIT LOG

- 1.7.1. During progress of the Work, Contractor shall update the Record Documents Edit Log each time updates or edits are made, or information is added. The Record Documents Edit Log shall be submitted to the Consultant and Client prior to submitting each monthly Application for Payment.
- 1.7.2. The Record Documents Edit Log shall include the following information as a minimum:
 - 1.7.2.1. Date Edited.
 - 1.7.2.2. Name and Company of Person Making Edit.
 - 1.7.2.3. Edit Type: RFI, Change Order/Request for Proposal, Field Change, Red Line,
 - 1.7.2.4. Supplemental Document, and Revision/ASI.
 - 1.7.2.5. Reference: name and number of the source document if applicable, such as Change Order or RFI number.
 - 1.7.2.6. Sheet(s) Edited.

1.8. AS-BUILT DRAWINGS

- 1.8.1. Contractor must mark-up Drawings that are most compatible for showing actual physical condition, fully and accurately and must reference all other appearances of this Work to the updated sheet. Contractor must include cross-references to the Change Order number on the updated Drawing sheet and all additional sheets where the Work is shown.
- 1.8.2. Contractor must mark-up with erasable colored pencil, in a legible and professional manner using separate colors where feasible, to distinguish between changes for different categories of Work at the same general location.
- 1.8.3. Contractor must mark-up important additional information, which was either shown schematically only or omitted from the Construction Documents. Contractor must give particular attention to information on concealed work that would be difficult to identify or measure and record at a later date.
- 1.8.4. The Contractor shall receive from the Consultant a set of electronic files of the project, with the engineering seal, stamp, signature and Consultant's logo removed.

- 1.8.5. The Contractor shall use the files as backgrounds on which all the changes recorded during the construction phase shall be transcribed electronically.
- 1.8.6. Once all the changes have been transcribed on the backgrounds, the drawings shall be electronically stamped "AS BUILT DRAWINGS" and shall be converted to pdf format and submitted to the Consultant for review. The Contractor remains responsible for the accuracy of the recorded information.
- 1.8.7. In association with Contractor's request for Substantial Completion inspection, Contractor must submit one (1) electronic copy of the marked-up as-built drawings to Client's representative.

1.9. RECORD SPECIFICATIONS

- 1.9.1. It is mandatory that all changes to specified materials, installation, warranty, etc. be clearly and fully marked within the applicable Specification section in a manner acceptable to the Consultant and Client. Contractor shall review with the Owner and document an acceptable procedure early in the construction phase.
- 1.9.2. Contractor must give particular attention to substitutions, selection of options, and similar information on work where the exact products used are not clearly identified or readily discernible in the original Specifications. When applicable, Contractor must cross-reference related Record Drawing information and product data.
- 1.9.3. Contractor must neatly transcribe and post all marked-up information to a "clean" copy of the Specifications, ensuring that similar types of information are annotated in like fashion throughout the Specifications. The Record Specifications shall then be converted to pdf format and submitted to the Consultant for review. The Contractor remains responsible for the accuracy of Record Specifications content.
- 1.9.4. In association with Contractor's request for Substantial Completion inspection, Contractor must submit the electronic version (pdf) of the Record Specifications to the Client representative.

1.10. OPERATION AND MAINTENANCE MANUALS

- 1.10.1. Submit operations and maintenance and operation data for all required equipment min. 15 days before application for Substantial Completion of the work. Substantial Completion status for the work will not be granted in the absence of full Operations and maintenance Information.
- 1.10.2. Contractor shall furnish the following equipment data content to be Included in Operating and Maintenance Manuals:
 - 1.10.2.1. *Description of Equipment.*

- 1.10.2.2. *Record Product Submittals.* Clearly identify all options and accessories of actual installed product and variations in the actual Work in comparison with submitted information.
- 1.10.2.3. *Parts List.* Clearly identify every part in the item of equipment with the proper manufacturer's name, part nomenclature and number, local source, and list price.
- 1.10.2.4. *Recommended Spare Parts List.* For each equipment item that Owner will likely need within a 12-month period to support and operate that item of equipment. The quantities of spare parts recommended must be based upon the quantity of like equipment items installed under the Contract Documents.
- 1.10.2.5. *Normal Operating Instructions.* Detailed information to permit a journeyman mechanic to adjust, start-up, operate, and shut down the equipment. Special start-up precautions shall be noted as well as other action items required before the equipment is put into service.
- 1.10.2.6. *Emergency Operating Procedures.* Detailed description of the sequence of action to be taken in the event of a malfunction of the unit, either to permit a short period of continued operation or emergency shutdown to prevent further damage to the unit and to the system in which it is installed.
- 1.10.2.7. *Preventive Maintenance.* Detailed information to cover routine and special inspection requirements, including but not limited to, field adjustments, inspections for wear, adjustment changes, packing wear, lubrication points, frequency and specific lubrication type required, cleaning of the unit and type solvent to use, and such other measures as are applicable to preventive maintenance program.
- 1.10.2.8. *Calibration.* Detailed data on what to calibrate, how to calibrate, when to calibrate and procedures to enable checking the equipment for reliability or indications as well as data for test equipment, special tools and the location of test points.
- 1.10.2.9. *Scale and Corrosion Control.* Detailed information covering the prevention of and removal of scale and corrosion.
- 1.10.2.10. *Trouble Shooting Procedures.* Detailed information and procedures for detecting and isolating malfunctions and detailed information concerning probable causes and applicable remedies.
- 1.10.2.11. *Removal and Installation Instructions.* Detailed information concerning the logical sequence of steps required to remove and install the item including instructions for the use of special tools and equipment.
- 1.10.2.12. *Disassembly and Assembly Instructions.* Detailed illustrations and text to show the logical procedure and provide the instructions necessary to disassemble and assemble the unit properly. The text shall include all checks and special precautions as well as the use of special tools and equipment required to perform the assembly or disassembly.

- 1.10.2.13. *Repair Instructions.* Detailed repair procedures to bring the equipment up to the required operating standard including instruction for examining equipment and parts for needed repairs and adjustments, and tests or inspections required to determine whether old parts may be reused or must be replaced.
- 1.10.2.14. *Special Tools and Test Equipment.* Detailed list of the special tools and test equipment needed to perform repair and maintenance for each equipment item. The list shall contain the special tool and test equipment part number, size, quantity, price, manufacturer's name and address, and local supplier's name and address.
- 1.10.2.15. *System Drawings.* Contractor shall furnish detailed drawings, where applicable, that clearly show wiring diagrams, utility service diagrams, control diagrams, system schematics, pneumatic and fluid flow diagrams, etc., which pertain to the unit function. System drawings must show major pieces of equipment, such as chillers, boilers, heat exchangers, pumps, air handlers, tanks, switchgear, etc., as meaningful to the Project. Fluid flow and direction and valves with their valve tag identification numbers must be clearly noted on drawings. Drawings must show modifications to another manufacturer's standard unit when it is incorporated into the assembly or package unit.

1.10.3. Warranties And Guarantees

- 1.10.3.1. Contractor shall include, within the Operating and Maintenance Manual organizational structure for each system, equipment item, or material, an executed copy of the specified warranty/guarantee with warranty effective dates covering that particular system, equipment item, or material. Contractor shall include the manufacturer's warranty as specified and the installing subcontractor's and supplier's guarantee for workmanship and system operation.

1.10.4. Requirements For Close-Out Manual

- 1.10.4.1. The Commissioning and Close-Out Manual shall include, but is not limited to, the following:
 - 1.10.4.1.1. Commissioning documentation, pre-functional and functional check lists and forms.
 - 1.10.4.1.2. Final air balance reports produced by the Test, Adjust, and Balance Firm.
 - 1.10.4.1.3. Completed Valve Schedule and Fire, Fire/Smoke and Smoke Damper Schedule.
 - 1.10.4.1.4. Owner Demonstration / Training Reports: Contractor shall furnish Training Plan and Documentation of Owner's personnel training regarding operation of systems. Contractor shall include identification of parties receiving training and date(s) of such training.
 - 1.10.4.1.5. Electrical Test Reports (including factory tests and settings).

- 1.10.4.1.6. Miscellaneous Equipment Test Reports (including factory tests and settings).
- 1.10.4.1.7. HVAC Calibration Reports (including duct testing reports).
- 1.10.4.1.8. Fire Alarm Test Reports.
- 1.10.4.1.9. Piping Test Reports.
- 1.10.4.1.10. Sewer Video Log.
- 1.10.4.1.11. Code-required Certifications as described within Technical Specifications.
- 1.10.4.1.12. Material Safety Data Sheets (MSDS) for any and all products incorporated into the Project.

1.10.5. Miscellaneous Close-out Documents.

- 1.10.5.1. Contractor shall provide categories of requirements resulting in miscellaneous work records including, but not be limited to, the following:
 - 1.10.5.1.1. Required field records on excavations, foundations, underground construction, wells and similar work.
 - 1.10.5.1.2. Accurate survey showing locations and elevations of underground lines, including invert elevations of drainage piping. Surveys establishing lines and levels of building.
 - 1.10.5.1.3. Certifications received in lieu of labels on products and similar record documentation.
 - 1.10.5.1.4. Testing and qualification of tradesmen.
 - 1.10.5.1.5. Documented qualification of installation firms.
 - 1.10.5.1.6. Materials testing reports.
 - 1.10.5.1.7. Final inspection Punch-list and deficiency corrections.
 - 1.10.5.1.8. All original, signed Project warranties and guarantees.

1.11. MAINTENANCE AND OPERATIONS MANUAL FORMATTING

- 1.11.1. Provide minimum of two (2) hard copies and one electronic copy of Mechanical Maintenance Manuals, in accordance to the following:
- 1.11.2. Manuals to be bound in a hard cover neatly labeled: "OPERATING AND MAINTENANCE INSTRUCTIONS".
- 1.11.3. The Maintenance and Operations Manuals shall be divided into sections with neatly labeled and tabbed dividers between each section. The sections to be included in the manual are:
 - 1.11.3.1. Section I - General.
 - 1.11.3.2. Section II - Piping and Pump Systems, Ductwork and Accessories.
 - 1.11.3.3. Section III - HVAC Equipment/Electrical Equipment
 - 1.11.3.4. Section IV - Automatic Controls
 - 1.11.3.5. Section V - Air and Water Balancing

1.11.4. The following information shall be contained within the sections:

- 1.11.4.1. SECTION I: A list giving name, address and telephone number of the Consultant, Engineers, General Contractor, Mechanical Trade and Controls Trade. Written warranties for the Mechanical Systems. A copy of the Valve directory giving number, valve location, normal valve position, and purpose of valve. Equipment lists and certificates shall be provided - certificates shall be signed and sealed by the appropriate suppliers.
- 1.11.4.2. SECTION II, III: A copy of all pressure tests and operational tests. A copy of Gas Operational Tests for gas fired equipment. A list giving name, address and telephone number of all suppliers. Details of chemical treatment equipment and substances. A copy of all reviewed Shop Drawings for all mechanical equipment and ancillary devices (valves, expansion tanks, pumps, strainers, plumbing, etc.). Copies of warranties.
- 1.11.4.3. SECTION IV: Complete Control Diagrams, Wiring Diagrams and description of Control system and the functioning sequence of the system.
- 1.11.4.4. SECTION V: Complete air and hydronic balancing reports.

1.12. WITHHOLDING OF PAYMENT

- 1.12.1. Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. REQUIREMENTS INCLUDED 2

1.2. INSTRUCTION OF CLIENT’S OPERATING PERSONNEL 2

1.3. DEFINITIONS 2

1.4. QUALITY ASSURANCE 2

1.5. SUBMITTALS 3

PART 2 - PRODUCTS (NOT APPLICABLE)..... 3

PART 3 - EXECUTION 3

3.1. PREPARATION FOR FINAL TESTS, DEMONSTRATIONS, AND INSTRUCTIONS 3

3.2. FINAL TESTS 3

3.3. STARTUP AND TESTING 4

3.4. DEMONSTRATIONS AND TRAINING..... 4

3.5. TIME ALLOCATED FOR DEMONSTRATIONS AND INSTRUCTIONS..... 4

PART 1 - GENERAL

1.1. REQUIREMENTS INCLUDED

- 1.1.1. Procedures for on-site demonstration and testing of equipment and systems, including temporary facilities.

1.2. INSTRUCTION OF CLIENT'S OPERATING PERSONNEL

- 1.2.1. All demonstrations, instructions and testing must be completed prior to Board acceptance for beneficial use. All safety devices must pass 100 percent before the mechanical systems can be accepted for beneficial use.
- 1.2.2. Plumbing and emergency power systems are not included.

1.3. DEFINITIONS

- 1.3.1. Start Up: Initial inspection, cleaning, lubrication, adjustment, and operation of equipment and systems by the contractor with the assistance of the representatives of the equipment manufacturers.
- 1.3.2. Pre-Tests: The final stage of the startup procedure. This occurs after all adjustments have been made except for minor fine-tuning that can be done during the pre-test. Serves as verification that the systems are ready for the final test. Witnessing of pre-test by the Consultant is not required.
- 1.3.3. Final Tests: Tests, witnessed by the Commissioning Agent or their representative, which demonstrate that all equipment and systems are in compliance with requirements.

1.4. QUALITY ASSURANCE

- 1.4.1. Experienced, trained technical service personnel who are representatives of the equipment manufacturers and system designers shall demonstrate, provide instructions, pre-test and final test, as specified, the following equipment:
 - 1.4.1.1. LULA Elevator
 - 1.4.1.2. Air Handling Equipment (ERV) and associated duct heaters
 - 1.4.1.3. Air Conditioning/Refrigeration Equipment/Outdoor Condensers
 - 1.4.1.4. VRF System (FCU-1 system) and mini split system for elevator machine room
 - 1.4.1.5. Control systems and Instrumentation.
 - 1.4.1.6. Safety valves
 - 1.4.1.7. Control valves for wall-fin convectors
 - 1.4.1.8. Wall-Fin convectors
 - 1.4.1.9. Exhaust fans
 - 1.4.1.10. Plumbing Specialties (requiring adjustment and set-up)

- 1.4.2. The person responsible for programming the BAS shall demonstrate and provide instructions on hardware, software and programming.
- 1.4.3. The Board will provide a list of personnel to receive instructions and will coordinate their attendance at agreed upon times.
- 1.4.4. All safety devices shall comply with the TSSA requirements.

1.5. SUBMITTALS

- 1.5.1. Names and qualifications of personnel performing demonstrations, instructions and tests.
- 1.5.2. Certification that pre testing is complete.
- 1.5.3. Preliminary schedule of all demonstrations, instructions and final tests two weeks prior to proposed dates.
- 1.5.4. Provide reports within three weeks after satisfactory completion of demonstrations, instructions, and tests. List date, type of work, persons participating, amount of time, test results, calculations of test results, test data.
- 1.5.5. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion,

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1. PREPARATION FOR FINAL TESTS, DEMONSTRATIONS, AND INSTRUCTIONS

- 3.1.1. Verify that equipment and systems are fully operational. Complete all start up and pre-test activities for all equipment and systems. Complete all construction and finish work.
- 3.1.2. Arrange for all test personnel for all equipment to be continuously present during one period of time so that all equipment and systems can be tested in their interrelated functions. For instance, the burner in a heating system shall be tested during the boiler testing, and instrumentation performance will be evaluated in conjunction with boiler testing.
- 3.1.3. Deliver maintenance and operating manuals four weeks prior to instruction period.
- 3.1.4. Furnish all special tools.

3.2. FINAL TESTS

- 3.2.1. Demonstrate proper operation of each equipment and system.

3.2.2. Provide tests on equipment as specified in the individual specification sections.

3.3. STARTUP AND TESTING

3.3.1. The Consultant will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Consultant. Provide a minimum of 7 days prior notice.

3.4. DEMONSTRATIONS AND TRAINING

3.4.1. Demonstrate operation and maintenance of equipment and systems to Board personnel no more than two weeks prior to scheduled Board operation of the equipment.

3.4.2. Use operation and maintenance manuals as basis of instruction. Review contents of manuals with personnel in detail to explain all aspects of operation and maintenance.

3.4.3. Demonstrate start up, operation, control, adjustment, trouble shooting, servicing, maintenance, and shut down of each item of equipment. Allow Government personnel to practice operating the equipment under supervision of instructors.

3.4.4. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

3.4.5. Submit training plans and instructor qualifications

3.5. TIME ALLOCATED FOR DEMONSTRATIONS AND INSTRUCTIONS

3.5.1. At least 16 total instructor hours to include all new building services installed under this project.

3.5.2. At least 4 total instructor hours to include BAS and computer workstation and programs.

3.5.3. Do not exceed three trainees per session, one four-hour session, per day, per trainee.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. DEFINITIONS 2

1.3. WARRANTY 2

1.4. PROTECTION 2

1.5. QUALIFICATIONS..... 4

1.6. EXAMINATION 4

1.7. SCHEDULING 4

1.8. MAINTAINING TRAFFIC..... 4

1.9. HAULING OPERATIONS 4

1.10. INTERRUPTIONS TO CLIENT'S OPERATIONS 5

1.11. SAFETY REQUIREMENTS 5

1.12. WORK INCLUDED IN THIS SECTION 5

PART 2 - PRODUCTS (NOT APPLICABLE)..... 6

PART 3 - EXECUTION 6

3.1. GENERAL 6

3.2. DUST CONTROL..... 7

3.3. DISPOSAL 7

3.4. REFRIGERANTS..... 8

3.5. DEMOLITION OF ARCHITECTURAL FINISHES 8

3.6. DEMOLITION OF CONCRETE OR ASPHALT 9

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies demolition and removal of utilities, services and equipment, as noted on the drawings and as required for the completion of the new work.

1.2. DEFINITIONS

- 1.2.1. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- 1.2.2. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse or store as noted on Drawings.
- 1.2.3. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- 1.2.4. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- 1.2.5. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.3. WARRANTY

- 1.3.1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding. Existing Warranties include the following:
 - 1.3.1.1. Roof system
 - 1.3.1.1.1. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.4. PROTECTION

- 1.4.1. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures.
- 1.4.2. Carry out all demolition work in a neat and orderly manner. Keep noise, dust, and similar nuisances to a minimum. Do not collapse walls. Do not throw or drop materials.

- 1.4.3. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations.
- 1.4.4. Where material indicated to be removed is suspected of containing asbestos, inform Client's Representative immediately. Do not disturb materials suspected of containing asbestos until asbestos content has been verified by Client.
- 1.4.5. Use extreme caution when cutting into shafts and chases. Shafts and chases may end above occupied areas within building. Take all necessary precautions to prevent debris from falling through openings between floors during demolition operations.
- 1.4.6. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.
- 1.4.7. Prevent debris from blocking drainage systems (floor drains) or affecting other mechanical and electrical systems that must remain in operation.
- 1.4.8. Protect building floors against damage from demolition work. Use ½" plywood covers over floor where lifting, moving, rolling of removed equipment is anticipated. Be responsible for repairing any damage to flooring caused by the work defined in this section. Execute repairs to the satisfaction of the Board at no cost to the Board.
- 1.4.9. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- 1.4.10. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.
- 1.4.11. Maintain at least one stairway in each structure in usable condition to highest remaining floor. Keep stairway free of obstructions and debris until that level of structure has been removed.
- 1.4.12. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
- 1.4.13. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.

1.4.14. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Client.

1.4.15. Any damaged items shall be repaired or replaced as approved by the Consultant. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required.

1.4.16. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have Resident Engineer's approval.

1.5. QUALIFICATIONS

1.5.1. Work of this section shall be executed by trades personnel having a minimum of 3 years' experience in the demolition field and capable to deploy adequate equipment as required to complete the work in an efficient and orderly manner.

1.6. EXAMINATION

1.6.1. Examine existing property. Determine the nature of materials to be removed.

1.6.2. When utilities or building services are encountered that are not indicated on the drawings, the Consultant shall be notified prior to further work in that area.

1.7. SCHEDULING

1.7.1. Coordinate the timing and duration of DCW, DHW and power shut-down with the Board representatives.

1.8. MAINTAINING TRAFFIC

1.8.1. Maintain and preserve Board's access requirements within, to and from existing building in areas where demolition and removal work is being carried out.

1.8.2. Do not close, obstruct, place or store material in the building driveways and passageways. Conduct operations with minimum interference with roads, streets, driveways, user traffic and passageways.

1.9. HAULING OPERATIONS

- 1.9.1. Maintain roadways and paving in the hauling areas clean on a daily basis and as required by Municipal Authorities.
- 1.9.2. Parking is not ample or readily available in the area where the building is located. Coordinate delivery of equipment with the Board representatives.
- 1.9.3. Contractor is responsible for all craning & lifting operations. It is the Contractor's responsibility to coordinate with the respective Municipality & pay/obtain all required permits.
- 1.9.4. Contractor is responsible for providing a craning plan for review & approval by the Client.

1.10. INTERRUPTIONS TO CLIENT'S OPERATIONS

- 1.10.1. There will be absolutely no interruptions to the building schedule during demolition work. Therefore, it is imperative that operations and machine and equipment movements, deliveries and removals are executed at time or times that will permit uninterrupted Board's operations in and around the building, including parking, receiving areas, deliveries and site and means of access and egress.
- 1.10.2. Where interruptions of domestic cold and hot water are necessary, coordinate with the School Representatives the timing and duration of such interruptions.

1.11. SAFETY REQUIREMENTS

- 1.11.1. Coordinate posting of danger signs conspicuously around property. Close doorways and thoroughfares giving access to area of demolition with barricades.
- 1.11.2. Provide a competent, experienced supervisor in charge of the Work and on Site while Work is in progress.
- 1.11.3. Should any suspect designated substance not already identified, be encountered, cease work in the immediate area and immediately report, to the Board. Board is responsible for removal of designated substances.

1.12. WORK INCLUDED IN THIS SECTION

- 1.12.1. Demolition work for this project includes but is not limited to the following:
 - 1.12.1.1. Removal of unit ventilator and wall-fin convectors in room 202, along with associated accessories and control valves as indicated in drawings.
 - 1.12.1.2. Contractor to ensure for the removed unit ventilator that the BAS network integrity is kept by reconnecting incoming and outgoing communication cables to restore daisy-chain continuity.
 - 1.12.1.3. Removal of abandoned ductwork through wall. Wall opening to be repaired and match to existing.

- 1.12.1.4. The removal of hydronic heating piping as indicated per the drawings.
 - 1.12.1.5. The removal and relocation of thermostats as indicated by the drawings.
 - 1.12.1.6. Relocation of indoor evaporator units.
 - 1.12.1.7. Removal of hot water supply and hot water return riser piping.
 - 1.12.1.8. Removal of sanitary lines, dcw, and dhw lines as indicated in the drawings,
 - 1.12.1.9. Removal of sinks, where indicated on drawings.
 - 1.12.1.10. Cutting and capping of plumbing lines for sinks that are to be demolished as indicated per drawings.
 - 1.12.1.11. Removal of existing light fixtures, switches, outlets, and electrical devices, where indicated on drawings.
 - 1.12.1.12. Relocation of PA speakers, electrical devices, junction boxes, and conduits where indicated on drawings.
 - 1.12.1.13. Removal and relocation of fire alarm devices where indicated on drawings.
 - 1.12.1.14. Removal of existing T-bar ceiling as required to complete demolition work in rooms indicated.
 - 1.12.1.15. Remove all waste from site and leave site clean for subsequent work.
 - 1.12.1.16. Removal of existing fire alarm panel and fire alarm annunciator panel as indicated per electrical drawings.
- 1.12.2. All cutting and patching associated with the removal of the wall-fin convectors, sanitary piping, DCW & DHW piping to be included.
- 1.12.3. The temporary removal of any other building services as required for the installation of the new equipment; upon completion of the work, the relocated equipment shall be relocated back to the original position or left in the new position, as warranted by the new layout.
- 1.12.4. The removal of the controls shall be done by the controls Contractor. Contractor shall identify and label all controls before demolition, to ensure that all existing equipment that is to remain will not be affected by this work and to ensure proper connection of the new equipment to the school.
- 1.12.5. All existing building services not affected by this work shall be protected and where necessary, maintained operational during and after the demolition work is complete. Any accidental damage or interruption of existing building services not required by this project will be promptly repaired at no additional cost to the Owner.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1. GENERAL

- 3.1.1. At the end of each day's work, leave site in a safe condition and erect safety barriers and lights as required. Ensure that no parts of the existing building are in danger of collapsing.
- 3.1.2. Review the requirements of new equipment to be installed. Perform all demolition work required to allow for the new equipment to be installed, whether shown on the drawings or not.
- 3.1.3. Provide any additional labour, materials and services not specifically indicated on the drawings but required to complete the demolition work.
- 3.1.4. Do not disturb adjacent structures or equipment designated to remain in place.
- 3.1.5. Confine operations and workers to those parts of the building which are defined on the drawings and exercise great care not to damage existing construction beyond that necessary for the carrying out of new work. Make good any such damage in every respect, to the satisfaction of the Client.

3.2. DUST CONTROL

- 3.2.1. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily

3.3. DISPOSAL

3.3.1. Removed Items

- 3.3.1.1. Unless otherwise instructed by the Client's representative, all materials from demolition including brick, concrete, stone, metals, insulation, wiring, tubing and similar materials shall be removed
- 3.3.1.2. Removed items become property of Contractor and shall be disposed of by him daily, off the site to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Consultant. Contractor shall dispose debris in compliance with applicable federal, provincial or local permits, rules and/or regulations.
- 3.3.1.3. Dispose of demolished materials in accordance with the requirements of Authorities Having Jurisdiction. At the end of demolition work, leave site in broom-clean condition. Clean existing surfaces specified to receive new applied finishes to ensure proper adherence.

3.3.2. Removed and Salvaged Items:

- 3.3.2.1. The Board Representative will review the Site prior to commencement of demolition and instruct the Contractor, in writing, as to the items to be Removed and Salvaged. Perform the following:

- 3.3.2.1.1. Clean salvaged items.
- 3.3.2.1.2. Pack or crate items after cleaning. Identify contents of containers.
- 3.3.2.1.3. Store items in a secure area until delivery to Owner.
- 3.3.2.1.4. Transport items to Owner's storage area location in building.
- 3.3.2.1.5. Protect items from damage during transport and storage.

3.3.3. Removed and Reinstalled Items:

- 3.3.3.1. Clean and repair items to functional condition adequate for intended reuse.
- 3.3.3.2. Pack or crate items after cleaning and repairing. Identify contents of containers.
- 3.3.3.3. Protect items from damage during transport and storage.
- 3.3.3.4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

3.3.4. Existing Items to Remain:

- 3.3.4.1. Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Owner's Representative, items may be removed to a suitable, protected storage location off-site during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.4. REFRIGERANTS

- 3.4.1. Refrigerant handling requirements are specified in Section: 23 23 00 Refrigerant Piping.

3.5. DEMOLITION OF ARCHITECTURAL FINISHES

- 3.5.1. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 3.5.1.1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - 3.5.1.2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

- 3.5.1.3. Do not use cutting torches without written permission from Client's Representative. Comply with Owner's rules and procedures.
- 3.5.1.4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loading on supporting walls, floors, or framing.
- 3.5.1.5. Dispose of demolished items and materials promptly.
- 3.5.1.6. Remove all loose material from partially demolished work leaving only sound and secure construction.
- 3.5.2. Plaster:
 - 3.5.2.1. Remove loose plaster that will be exposed in finished construction. Loose plaster is defined as plaster material of at least 2 inches by 4 inches in size that can be moved by touch or that sounds hollow when lightly tapped with a hammer.
- 3.5.3. Flooring:
 - 3.5.3.1. Where shown, scheduled or otherwise required for application or installation of new floor finishes or coverings, remove existing flooring tile, resilient sheet flooring as follows:
 - 3.5.3.1.1. Remove all traces of existing flooring materials. Remove resilient sheet and tile flooring products
 - 3.5.3.1.2. Remove adhesives, except those containing asbestos. Use chemical strippers approved by manufacturer of new flooring materials, or grind concrete floor surfaces to completely remove adhesive. Obtain Client's Representative's approval of removal method prior to beginning removal work.
 - 3.5.3.1.3. Do not remove vinyl composition tile or adhesives suspected of containing asbestos. Client will verify asbestos content of questionable materials. Removal of asbestos-containing adhesives (if any) shall be undertaken separately by the Client
 - 3.5.3.1.4. Clean floor slabs of dust and adhesive residue.

3.6. DEMOLITION OF CONCRETE OR ASPHALT

- 3.6.1. Water used during concrete and asphalt work (including sweeping and saw-cutting) must be contained and collected for proper disposal. Do not discharge water containing dust or debris from concrete or asphalt work into storm drains, catch basins or to the sanitary sewer system.

TABLE OF CONTENTS

PART 1 - GENERAL	3
1.1. DESCRIPTION	3
1.2. DEFINITIONS	3
1.3. RELATED WORK	3
1.4. APPLICABLE PUBLICATIONS	3
1.5. SUBMITTALS	4
1.6. DUTIES OF MECHANICAL CONTRACTOR.....	4
1.7. SCHEDULING OF WORK	5
1.8. INTENT	5
1.9. INTERFERENCES	6
1.10. EXAMINE SITE	7
1.11. INTERFERENCE DRAWINGS.....	7
1.12. MAINTENANCE DATA AND OPERATING INSTRUCTIONS	8
1.13. MATERIALS AND STANDARDS OF ACCEPTANCE.....	8
1.14. MATERIAL SUBSTITUTIONS.....	8
1.15. CODES, PERMITS, FEES AND CONNECTIONS	9
1.16. CONSULTANT'S INSTRUCTIONS	9
1.17. ADDITIONAL WORK AND CHANGES	9
1.18. QUALITY ASSURANCE	9
1.19. EXECUTION (INSTALLATION, CONSTRUCTION) QUALITY	11
1.20. CLEANLINESS OF PIPING AND EQUIPMENT SYSTEMS	11
1.21. DELIVERY, STORAGE AND HANDLING.....	11
1.22. AS-BUILT DOCUMENTATION	12
PART 2 - PRODUCTS	12
2.1. MATERIALS FOR VARIOUS SERVICES	12
2.2. FACTORY-ASSEMBLED PRODUCTS.....	13
2.3. COMPATIBILITY OF RELATED EQUIPMENT	13
2.4. SAFETY GUARDS.....	13
2.5. LIFTING ATTACHMENTS.....	14
2.6. ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING	14

2.7.	VARIABLE SPEED MOTOR CONTROLLERS	15
2.8.	EQUIPMENT AND MATERIALS IDENTIFICATION	15
2.9.	FIRESTOPPING	16
2.10.	GALVANIZED REPAIR COMPOUND	17
2.11.	PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS	17
2.12.	PIPE PENETRATIONS	19
2.13.	TOOLS AND LUBRICANTS.....	20
2.14.	WALL, FLOOR AND CEILING PLATES	21
PART 3 -	EXECUTION	21
3.1.	ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING.....	21
3.2.	PROTECTION AND CLEANING:	22
3.3.	WORK IN EXISTING BUILDING:	23
3.4.	TEMPORARY PIPING AND EQUIPMENT	23
3.5.	RIGGING.....	23
3.6.	THERMOMETERS AND PRESSURE GAUGES	24
3.7.	PIPE AND EQUIPMENT SUPPORTS.....	25
3.8.	LUBRICATION	26
3.9.	PLUMBING SYSTEMS DEMOLITION	26
3.10.	CLEANING AND PAINTING	27
3.11.	IDENTIFICATION SIGNS	28
3.12.	STARTUP AND TEMPORARY OPERATION	28
3.13.	OPERATING AND PERFORMANCE TESTS	28
3.14.	OPERATION AND MAINTENANCE MANUALS	29
3.15.	CLOSE-OUT DOCUMENTATION	29
3.16.	COMMISSIONING	29
3.17.	OPERATING AND PERFORMANCE TESTS	30
3.18.	DEMONSTRATION AND TRAINING	30

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. The requirements of this Section shall apply to all sections of Division 22 - Plumbing.

1.2. DEFINITIONS

- 1.2.1. Exposed: Piping and equipment exposed to view in finished rooms.

1.3. RELATED WORK

- 1.3.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.3.2. Section: 07 84 00 Fire Stopping.
- 1.3.3. Section: 07 92 00 Joint Sealants.
- 1.3.4. Section: 22 05 53 Identification for Plumbing Piping and Equipment.
- 1.3.5. Section: 22 07 00 Plumbing Insulation.
- 1.3.6. Section: 22 08 00 Commissioning of Plumbing.
- 1.3.7. Section: 23 05 13 Common Motor Requirements for HVAC Equipment.
- 1.3.8. Section: 26 05 00 Common Work Results for Electrical.
- 1.3.9. Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables.

1.4. APPLICABLE PUBLICATIONS

- 1.4.1. The publications listed below shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.4.2. Ontario Building Code – Part 7 latest edition
- 1.4.3. Ontario Standard CSA-B149.1 latest edition
- 1.4.4. American Society for Testing and Materials (ASTM):
 - 1.4.4.1. A36/A36M-2012 Standard Specification for Carbon Structural Steel
 - 1.4.4.2. F1760-01(R2011) Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
- 1.4.5. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
 - 1.4.5.1. SP-58-2009 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation

1.4.5.2. SP-69-2003 Pipe Hangers and Supports - Selection and Application

1.4.6. National Fire Protection Association (NFPA):

1.4.6.1. 51B-2014 Standard for Fire Prevention During Welding, Cutting and Other Hot Work

1.4.6.2. 70-2011 National Electrical Code (NEC)

1.5. SUBMITTALS

1.5.1. Submittals, including number of required copies, shall be submitted in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.

1.5.2. Manufacturer's Literature and Data: submit all equipment and material performance and characteristics, operational curves, diagrams and schematic, power wiring schematics and all other pertinent operational information. Submit all equipment physical sizes, weights, methods of lifting and installation, support requirements.

1.5.3. Electric motor data and variable speed drive data shall be submitted with the driven equipment.

1.5.4. Equipment and materials identification.

1.5.5. Fire stopping materials.

1.5.6. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.

1.5.7. Wall, floor, and ceiling plates.

1.5.8. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.

1.6. DUTIES OF MECHANICAL CONTRACTOR

1.6.1. The mechanical contractor shall assume the responsibilities and duties including but not limited to the ones described below:

1.6.2. Superintendence

1.6.2.1. Provide full time on-site superintendent personnel and supporting staff with proven experience in project of similar value and complexity.

- 1.6.2.2. Site superintendent shall have over-all authority to speak for and represent the mechanical contractor.

1.6.3. Coordination

- 1.6.3.1. Coordinate the work with all the sub-trades involved to ensure that the work will be carried out on schedule and in proper sequence.
- 1.6.3.2. Take complete responsibility for all remedial work that results from failure to coordinate any aspect of the mechanical work prior to its fabrication and/or installation.
- 1.6.3.3. Take responsibility for the delivery of equipment necessary to complete the work in accordance with the approved schedule.

1.6.4. Staffing and Scheduling

- 1.6.4.1. Within seven days after the award of the contract, the Mechanical Contractor shall provide to the Client representative the following information:
 - 1.6.4.1.1. Appointment of official representatives in the project.
 - 1.6.4.1.2. Schedule of work.
 - 1.6.4.1.3. Delivery schedule for specified equipment.
 - 1.6.4.1.4. Requirements for temporary facilities, site signs, storage, etc.

1.6.5. Work Completion Meeting

- 1.6.5.1. Prior to application for Substantial Performance of the Work, the mechanical contractor shall participate in the take-over meeting. Agenda to include the following:
 - 1.6.5.1.1. Review of outstanding deficiencies.
 - 1.6.5.1.2. Submission of maintenance manuals, warranties and as-built drawings.
 - 1.6.5.1.3. Results of performance tests and described further in this section.
 - 1.6.5.1.4. Scheduling of training to Board's personnel.

1.7. SCHEDULING OF WORK

- 1.7.1. For all work to be performed under this contract, adhere to Construction Schedule agreed upon with the Client.

1.8. INTENT

- 1.8.1. Bidders for this work shall include for all labor, material, equipment and all other related cost including all applicable taxes (except GST) and fees to provide the work as indicated on the drawings.

- 1.8.2. Misinterpretation of any requirement of the drawings and specifications will not relieve the Mechanical Contractor of responsibility. If in any doubt, the Mechanical Contractor shall contact the Consultant for written clarification prior to submitting a bid for the Work.
- 1.8.3. New plumbing fixtures to be provided for the new washroom 202E and Health room 202D as indicated per drawings.
- 1.8.4. All associated DCW, DHW lines, venting lines, and sanitary lines to be supplied and installed as per the issued drawings. New p-traps, primer connections, and venting to be completed as per OBC requirements. All new lines to have proper slope in accordance with OBC requirements.
- 1.8.5. All new plumbing fixtured to contain accessible isolation valves.
- 1.8.6. New lavatory to have tempering valve.
- 1.8.7. Prior to starting any underground piping work, perform a video inspection of all underground piping intended for connection to determine exact routing, size, and invert elevations. confirm that existing underground piping has sufficient invert elevation to accommodate tie-in of new sanitary piping and new domestic water connections as required.

1.9. INTERFERENCES

- 1.9.1. The mechanical drawings do not show all the architectural and structural details, and any information involving accurate measuring of the building shall be taken from the building drawings or at the building. Make without additional charge, any necessary changes or additions to the runs of drains, pipes, ducts, etc., to accommodate the above conditions. The location of equipment may be altered without charge providing the change is made before installation and does not necessitate major additional material.
- 1.9.2. Wherever differences occur between specifications, riser diagrams or schematics and drawings, the maximum conditions shall govern and the bid shall be based on whichever information indicates the greater cost.
- 1.9.3. Field verifications of dimensions on plans shall be made since actual locations, distances, and levels will be governed by actual field conditions.
- 1.9.4. Discrepancies between different plans, or between plans and actual field conditions, or between plans and specifications shall promptly be brought to the attention of the Consultant for a decision.
- 1.9.5. Install all mechanical services including but not exclusive to drains, pipes, and ducts, to conserve headroom and interfere as little as possible with the free use of the space through which they pass. All drains, pipes, ducts, etc., particularly those which may

interfere with the inside treatment of the building, or conflicting with other trades, shall be installed only after the locations have been approved by the Consultant. Special care shall be taken in the installation of all mechanical services including, but not exclusive to drains, pipes, and ducts, which are to be concealed, to see that they come within the finished lines of floors, walls, and ceilings. Where such drains, pipes, ducts, etc., have been installed in such a manner as to cause interference, they shall be removed and re installed in suitable locations without extra cost to the Board.

- 1.9.6. Before commencing work, check and verify all grade and invert elevations, stacks, levels, and dimensions, to ensure proper and correct installation of the work.
- 1.9.7. In every place where there is space indicated as reserved for future or other equipment, leave such space clear, install blank offs, shut off valves with blind flanges and other work so that the necessary connections can be made without any stoppages to the system. Consult with the consultant whenever necessary for this purpose.
- 1.9.8. In addition to the work specifically mentioned in the Specifications and shown on the drawings, provide all other items that are obviously necessary to make a complete working installation, including those required by the Authorities Having Jurisdiction over the work.
- 1.9.9. The mechanical plans show approximate locations for wall mounted devices. Obtain Consultant's approval of mounting heights and locations before commencement of work.

1.10. EXAMINE SITE

- 1.10.1. Examine the site and the local conditions affecting the work. Examine carefully all drawings and the complete specifications to ensure that the work can be satisfactorily carried out as shown. No allowance will be made later for any expenses incurred through the failure to make these examinations or to report any such discrepancies in writing to the Consultant.

1.11. INTERFERENCE DRAWINGS

- 1.11.1. Complete consolidated and coordinated interference drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:200. Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, controls, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment

or piping layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.

- 1.11.2. Mechanical equipment rooms.
- 1.11.3. Interstitial space.
- 1.11.4. Pipe sleeves.
- 1.11.5. Equipment penetrations of floors, walls, ceilings, or roofs.

1.12. MAINTENANCE DATA AND OPERATING INSTRUCTIONS

- 1.12.1. Maintenance and operating manuals, for systems and equipment. Include complete list indicating all components of the systems with diagrams of the internal wiring for each item of equipment.
- 1.12.2. Include listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

1.13. MATERIALS AND STANDARDS OF ACCEPTANCE

- 1.13.1. Where materials, equipment, apparatus, or other products are specified by the manufacturer, brand name, type or catalogue number, such designation is to establish standards of desired quality style or dimensions and shall be the basis of the Bid. Materials so specified shall be furnished under this Contract.
- 1.13.2. Where two or more designations are listed, the contractor shall choose one of those listed and state the choice made on the Bid Form (where applicable). *First choice shall be given to the equipment selected as the basis of design; equipment listed as equal shall be considered only if it suits the local conditions in terms of clearances, power supply availability and weight restrictions.*

1.14. MATERIAL SUBSTITUTIONS

- 1.14.1. After execution of the Contract, requests for substitution of materials or makes other than those specifically named in the Contract Documents may be reviewed and approved by the Consultant, subject to Client's review and acceptance of the financial credits involved.
- 1.14.2. In the absence of such express approval by the Consultant, the Mechanical Contractor will be held to furnish specified items under the base bid as the standard of acceptance.
- 1.14.3. If equipment is submitted which differs in arrangement from that specified/shown on the documents, provide drawings that show the rearrangement of all associated systems.

Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

1.15. CODES, PERMITS, FEES AND CONNECTIONS

- 1.15.1. Conform to Federal, Provincial and Municipal regulations and perform work in accordance with requirements of By Laws and Regulations in force in area where the building is to be erected.
- 1.15.2. Apply for, obtain, and pay for all permits, fees and service connections for the work and the inspections required by Authorities Having Jurisdiction in the area where the building is to be erected.
- 1.15.3. For information, a specific code or standard might be mentioned. This information must not be taken as the only code or standard applicable.
- 1.15.4. When part of equipment does not bear the required CSA label, the contractor shall obtain from CSA or Hydro Electric Power Commission, when that part of the equipment is an electric component, a special approval and pay the applicable fees.
- 1.15.5. Furnish necessary certificates as evidence that the work installed conforms with laws and regulations of Authorities having jurisdiction. Changes in work requested by an Authority having jurisdiction shall be carried out without charge.

1.16. CONSULTANT'S INSTRUCTIONS

- 1.16.1. During construction the Consultant will issue such instructions as may be necessary for verification and correction of the work. These instructions shall be binding as part of the specification.

1.17. ADDITIONAL WORK AND CHANGES

- 1.17.1. Unless a written order, reviewed by the Consultant and countersigned or otherwise approved by the Client Representative, no additional work shall be undertaken by the Contractor.

1.18. QUALITY ASSURANCE

- 1.18.1. Products Criteria:
 - 1.18.1.1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture, supply and servicing of the specified products for at least 5 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least 5 years.

- 1.18.1.2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, compressors, water heaters, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
 - 1.18.1.3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 - 1.18.1.4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Consultant.
 - 1.18.1.5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 - 1.18.1.6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 - 1.18.1.7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
- 1.18.2. Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
- 1.18.2.1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
 - 1.18.2.2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
- 1.18.3. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Consultant and then incorporated in the Operations and Maintenance Manuals prior to installation. Installation of the item will not be allowed to proceed until the

recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.19. EXECUTION (INSTALLATION, CONSTRUCTION) QUALITY

- 1.19.1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Consultant for resolution at least 10 working days prior to commencing installation of any item.
- 1.19.2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to: all types of valves, filters and strainers, transmitters, and control devices. Prior to commencing installation work, refer conflicts between this requirement and contract documents to COR for resolution.
- 1.19.3. Plumbing Systems: Unless otherwise required herein, perform plumbing work in accordance with the latest version of OBC section 7 and other applicable by-laws by the Authorities Having Jurisdiction.

1.20. CLEANLINESS OF PIPING AND EQUIPMENT SYSTEMS

- 1.20.1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
- 1.20.2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
- 1.20.3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Client. All piping shall be tested in accordance with the specifications and OBC requirements. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
- 1.20.4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.21. DELIVERY, STORAGE AND HANDLING

- 1.21.1. Protection of Equipment:
 - 1.21.1.1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

- 1.21.1.2. Damaged equipment shall be replaced with an identical unit as determined and directed by the COR. Such replacement shall be at no additional cost or additional time to the Client.
- 1.21.1.3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
- 1.21.1.4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

1.22. AS-BUILT DOCUMENTATION

- 1.22.1. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- 1.22.2. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- 1.22.3. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided in at least three hard copies, and a copy of them on Auto-Cad version 2007 or higher provided on at least one USB drive. Should the installing contractor engage the consulting company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party company' requirement.
- 1.22.4. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1. MATERIALS FOR VARIOUS SERVICES

- 2.1.1. Plastic pipe, fittings and solvent cement shall meet C-NSF/ANSI 14 and C-NSF/ANSI 61. Solder or flux containing lead shall not be used with copper pipe.
- 2.1.2. n-line devices such as water meters, building valves, check valves, stops, valves, fittings, tanks and backflow preventers shall comply with C-NSF/ANSI 61 and C-NSF/ANSI 372.
- 2.1.3. End point devices such as drinking fountains, lavatory faucets, kitchen and bar faucets, ice makers supply stops, and end-point control valves used to dispense drinking water must meet requirements of C-NSF/ANSI 61 and C-NSF/ANSI 372.

2.2. FACTORY-ASSEMBLED PRODUCTS

- 2.2.1. Standardization of components shall be maximized to reduce spare part requirements.
- 2.2.2. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
- 2.2.3. All components of an assembled unit need not be products of same manufacturer.
- 2.2.4. Constituent parts that are alike shall be products of a single manufacturer.
- 2.2.5. Components shall be compatible with each other and with the total assembly for intended service.
- 2.2.6. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly at no additional cost or time to the Government.
- 2.2.7. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- 2.2.8. Major items of equipment, which serve the same function, shall be the same make and model.

2.3. COMPATIBILITY OF RELATED EQUIPMENT

- 2.3.1. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.4. SAFETY GUARDS

- 2.4.1. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be

braked and drilled and attached to pump base with minimum of four 8 mm (¼ inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

2.4.2. All Equipment shall have moving parts protected from personal injury.

2.5. LIFTING ATTACHMENTS

2.5.1. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.6. ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING

2.6.1. All material and equipment furnished and installation methods used shall conform to the requirements of Section: 23 05 13 Common Motor Requirements for HVAC Equipment, and Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables. All electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.

2.6.2. Special Requirements:

2.6.2.1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional cost or time to the Government.

2.6.2.2. Assemblies of motors, starters, and controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.

2.6.2.3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:

2.6.2.4. Wiring material located where temperatures can exceed 71° C (160° F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers and water heaters.

2.6.2.5. Other wiring at boilers and water heaters, and to control panels, shall be NFPA 70 designation THWN.

2.6.2.6. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.

2.6.3. Motor sizes shall be selected so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.

- 2.6.4. Motors utilized with variable frequency drives shall be rated “inverter-ready” per NEMA Standard, MG1.
- 2.6.5. Motor Efficiency and Power Factor: All motors, when specified as “high efficiency or Premium Efficiency” by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section: 23 05 13 Common Motor Requirements for HVAC Equipment, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as “NEMA premium efficient”. Motors not specified as “high efficiency or premium efficiency” shall comply with the requirements of the Energy Policy and Conservation Act.
- 2.6.6. Single phase Motors: Capacitor start type for hard starting applications. Motors for centrifugal pumps may be split phase or permanent split capacitor (PSC).
- 2.6.7. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. A time delay (20 seconds minimum) relay shall be provided for switching from high to low speed.
- 2.6.8. Rating: Rating shall be continuous duty at 100 percent capacity in an ambient temperature of 40° C (104° F); minimum horsepower as shown on drawings; maximum horsepower in normal operation shall not exceed nameplate rating without service factor.
- 2.6.9. Insulation Resistance: Not less than one half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

2.7. VARIABLE SPEED MOTOR CONTROLLERS

- 2.7.1. Refer to Section: 26 05 00 Common Work Results for Electrical for specifications.
- 2.7.2. The combination of controller and motor shall be provided by the respective pump manufacturer, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps, shall be product of a single manufacturer.
- 2.7.3. Motors shall be premium efficient type, “inverter duty”, and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor sheaves shall be fixed pitch.
- 2.7.4. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.

2.8. EQUIPMENT AND MATERIALS IDENTIFICATION

- 2.8.1. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Coordinate equipment and valve identification with facility maintenance staff. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section: 22 05 53 Identification for Plumbing Piping and Equipment.
- 2.8.2. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 7 mm (3/16 inch) high of brass with black filled letters, or rigid black plastic with white letters specified in Section: 22 05 53 Identification for Plumbing Piping and Equipment shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, etc. shall be identified.
- 2.8.3. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 7 mm (3/16 inch) high riveted or bolted to the equipment.
- 2.8.4. Control Items: All temperature, pressure, and controllers shall be labeled and the component's function identified. Identify and label each item as they appear on the control diagrams.
- 2.8.5. Valve Tags and Lists:
 - 2.8.5.1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
 - 2.8.5.2. Valve tags: Engraved black filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 8 mm (1/4 inch) for service designation on 19 gage, 40 mm (1 1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 - 2.8.5.3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 215 mm (8 1/2 inches) by 275 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3 ring binder notebook. An additional copy of the valve list shall be mounted in picture frames for mounting to a wall. COR shall instruct contractor where frames shall be mounted.
 - 2.8.5.4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided in the 3-ring binder notebook. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling or access door.

2.9. FIRESTOPPING

- 2.9.1. Section: 07 84 00 Fire Stopping specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping. Refer to Section: 22 07 00 Plumbing Insulation for pipe insulation.

2.10. GALVANIZED REPAIR COMPOUND

- 2.10.1. Mil. Spec. DOD P 21035B, paint.

2.11. PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- 2.11.1. Type Numbers Specified: For materials, design, manufacture, selection, application, and installation refer to MSS SP 58. For selection and application refer to MSS SP 69.
- 2.11.2. For Attachment to Concrete Construction:
 - 2.11.2.1. Concrete insert: Type 18, MSS SP 58.
 - 2.11.2.2. Self drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
 - 2.11.2.3. Power driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- 2.11.3. For Attachment to Steel Construction: MSS SP 58.
 - 2.11.3.1. Welded attachment: Type 22.
 - 2.11.3.2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- 2.11.4. Attachment to Metal Pan or Deck: As required for materials specified
- 2.11.5. For Attachment to Wood Construction: Wood screws or lag bolts.
- 2.11.6. Hanger Rods: Hot rolled steel, ASTM A36/A36M or ASTM A575 for allowable load listed in MSS SP 58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn buckles shall provide 40 mm (1 1/2 inches) minimum of adjustment and incorporate locknuts. All thread rods are acceptable.
- 2.11.7. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 43 mm by 43 mm (1 5/8 inches by 1 5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts.
- 2.11.8. Guide individual pipes on the horizontal member of every other trapeze hanger with 8 mm (1/4 inch) U bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 15 mm (1/2 inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.

2.11.9. Pipe Hangers and Supports: (MSS SP 58), use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 11, PLUMBING INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.

2.11.10. General Types (MSS SP 58):

- 2.11.10.1. Standard clevis hanger: Type 1; provide locknut.
- 2.11.10.2. Riser clamps: Type 8.
- 2.11.10.3. Wall brackets: Types 31, 32 or 33.
- 2.11.10.4. Roller supports: Type 41, 43, 44 and 46.
- 2.11.10.5. Saddle support: Type 36, 37 or 38.
- 2.11.10.6. Turnbuckle: Types 13 or 15.
- 2.11.10.7. U-bolt clamp: Type 24.

2.11.11. Copper Tube:

- 2.11.11.1. Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, copper-coated, plastic coated or taped with isolation tape to prevent electrolysis.
- 2.11.11.2. For vertical runs use epoxy painted, copper-coated or plastic-coated riser clamps.
- 2.11.11.3. For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
- 2.11.11.4. Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.

2.11.12. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.

2.11.13. Spring Supports (Expansion and contraction of vertical piping):

- 2.11.13.1. Movement up to 20 mm (3/4 inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
- 2.11.13.2. Movement more than 20 mm (3/4 inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.
- 2.11.13.3. Spring hangers are required on all plumbing system pumps one horsepower and greater.

2.11.14. Plumbing Piping (Other Than General Types):

- 2.11.14.1. Horizontal piping: Type 1, 5, 7, 9, and 10.
- 2.11.14.2. Chrome plated piping: Chrome plated supports.

- 2.11.14.3. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
- 2.11.15. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.
- 2.11.16. Pre-insulated Calcium Silicate Shields:
 - 2.11.16.1. Provide 360 degree water resistant high density 965 kPa (140 psig) compressive strength calcium silicate shields encased in galvanized metal.
 - 2.11.16.2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
 - 2.11.16.3. Shield thickness shall match the pipe insulation.
 - 2.11.16.4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
 - 2.11.16.5. Shields for supporting cold water shall have insulation that extends a minimum of 25 mm (1 inch) past the sheet metal.
 - 2.11.16.6. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS SP-69. To support the load, the shields shall have one or more of the following features: structural inserts 4138 kPa (600 psig) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36/A36M) wear plates welded to the bottom sheet metal jacket.
 - 2.11.16.7. Shields may be used on steel clevis hanger type supports, trapeze hangers, roller supports or flat surfaces.

2.12. PIPE PENETRATIONS

- 2.12.1. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- 2.12.2. Pipe penetration sleeve materials shall comply with all firestopping requirements for each penetration.
- 2.12.3. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 2.12.3.1. For sleeves: Extend sleeve 50 mm (2 inch) above finished floor and provide sealant for watertight joint.
 - 2.12.3.2. For blocked out floor openings: Provide 40 mm (1 1/2 inch) angle set in silicone adhesive around opening.
 - 2.12.3.3. For drilled penetrations: Provide 40 mm (1 1/2 inch) angle ring or square set in silicone adhesive around penetration.

- 2.12.3.4. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges, with structural engineer prior approval. Any deviation from these requirements must receive prior approval of the Consultant.
- 2.12.4. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- 2.12.5. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.
- 2.12.6. Galvanized steel or an alternate black iron pipe sleeve with asphalt coating sleeves shall be used for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel sleeve shall be provided for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, sleeves shall be connected with a floor plate.
- 2.12.7. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall be connected with a floor plate.
- 2.12.8. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with firestopping material and sealant to prevent the spread of fire, smoke, water and gases.
- 2.12.9. Pipe passing through roof shall be installed through a 4.9 kg per square meter copper flashing with an integral skirt or flange. Skirt or flange shall extend not less than 200 mm (8 inches) from the pipe and set in a solid coating of bituminous cement. Extend flashing a minimum of 250 mm (10 inches) up the pipe. Pipe passing through a waterproofing membrane shall be provided with a clamping flange. The annular space between the sleeve and pipe shall be sealed water

2.13. TOOLS AND LUBRICANTS

- 2.13.1. Furnish, and turn over to the Client, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- 2.13.2. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- 2.13.3. Tool Containers: metal, permanently identified for intended service and mounted, or located, where directed by the Client.

- 2.13.4. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application. Bio-based materials shall be utilized when possible.

2.14. WALL, FLOOR AND CEILING PLATES

- 2.14.1. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- 2.14.2. Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025 inch) for up to 75 mm (3 inch) pipe, 0.89 mm (0.035 inch) for larger pipe.
- 2.14.3. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

PART 3 - EXECUTION

3.1. ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- 3.1.1. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
- 3.1.2. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- 3.1.3. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance, testing and operation of all devices including, but not limited to: all equipment items, valves, backflow preventers, filters, strainers, transmitters, sensors, meters and control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.
- 3.1.4. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.

3.1.5. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

3.1.6. Cutting Holes:

3.1.6.1. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.

3.1.6.2. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.

3.1.6.3. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by the Consultant where working area space is limited.

3.1.7. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, trap priming and other service are not shown but must be provided.

3.2. PROTECTION AND CLEANING:

3.2.1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items in the opinion of the Consultant, shall be replaced at no additional cost or time to the Client.

3.2.2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

3.2.3. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psig) minimum, shall be used for all pad or floor mounted equipment.

3.2.4. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

3.2.5. Interconnection of Electrical Instrumentation and Controls: Electrical interconnection is generally not shown but shall be provided as specified. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, alarms, instruments and computer workstations. Comply with NFPA 70.

3.3. WORK IN EXISTING BUILDING:

- 3.3.1. Make alterations to existing service piping at times that will cause the least interfere with normal operation of the facility.
- 3.3.2. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.
- 3.3.3. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above data equipment, and electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Drain valve shall be provided in low point of casement pipe.
- 3.3.4. Inaccessible Equipment:
 - 3.3.4.1. Where the Client determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost or additional time to the Client.
 - 3.3.4.2. The term "conveniently accessible" is defined as capable of being reached without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.4. TEMPORARY PIPING AND EQUIPMENT

- 3.4.1. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- 3.4.2. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
- 3.4.3. Temporary facilities and piping shall be completely removed back to the nearest active distribution branch or main pipe line and any openings in structures sealed. Dead legs are not allowed in potable water systems. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.5. RIGGING

- 3.5.1. Openings in building structures shall be planned to accommodate design scheme.

- 3.5.2. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.
- 3.5.3. All openings in the building shall be closed when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- 3.5.4. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
- 3.5.5. Contractor shall check all clearances, weight limitations and shall prepare a rigging plan; All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

3.6. THERMOMETERS AND PRESSURE GAUGES

3.6.1. General:

- 3.6.1.1. Locate direct reading thermometers and gauges for reading from floor or platform.
- 3.6.1.2. Provide remote reading thermometers and gauges where direct reading instruments cannot be satisfactorily located.
- 3.6.1.3. Locate engraved lamacoid nameplate as specified in Section Identification, identifying medium adjacent to thermometers and gauges.

3.6.2. Thermometers:

- 3.6.2.1. Industrial, 9" adjustable angle cast aluminum case, CGSB standard CAN/CGSB-14.4-M88 red reading mercury, lens front tube, white scale black embossed figures, clear glass or acrylic window, tapered aluminum stem.
- 3.6.2.2. Scale shall be suitable for 2 times the temperature range of service. Scale shall be combined Celsius and Fahrenheit.
- 3.6.2.3. Standard of Acceptance: Weiss, Ashcroft, Terice.

3.6.3. Pressure Gauges:

- 3.6.3.1. 5" dial, solid front blow out back, fiberglass reinforced polypropylene case, phosphor bronze bourdon tube and brass 1/4" N.P.T. socket, bottom connection, stainless steel rotary type movement, gauge to be registered with the Provincial Boiler and Pressure Vessel Safety Branch with a registration number and conform to ANSI B40.1. Accuracy to be grade "A".

- 3.6.3.2. On pumps liquid filled gauges shall be utilized.
 - 3.6.3.3. Standard of Acceptance: Weiss, Ashcroft, Terice.
 - 3.6.3.4. Provide bronze stop cock, bronze bar stock ¼" N.P.T. bronze porous core pressure snubber for pulsating operation and diaphragm for corrosive service.
 - 3.6.3.5. Use materials compatible with system requirements.
- 3.6.4. Gauges shall have combined kilopascal and psi scales.

3.7. PIPE AND EQUIPMENT SUPPORTS

- 3.7.1. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Consultant
- 3.7.2. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- 3.7.3. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work shall be provided.
- 3.7.4. Overhead Supports:
 - 3.7.4.1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 3.7.4.2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
- 3.7.5. Tubing and capillary systems shall be supported in channel troughs.
- 3.7.6. Floor Supports:
 - 3.7.6.1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
 - 3.7.6.2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and

smoothed, shall have chamfered edges at the top, and shall be suitable for painting.

- 3.7.6.3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.

3.8. LUBRICATION

- 3.8.1. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- 3.8.2. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one liter (one quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be delivered to COR in unopened containers that are properly identified as to application.
- 3.8.3. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- 3.8.4. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- 3.8.5. All lubrication points shall be extended to one side of the equipment.

3.9. PLUMBING SYSTEMS DEMOLITION

- 3.9.1. In an operating plant, cleanliness and safety shall be maintained. The plant shall be kept in an operating condition. Client's personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Work shall be confined to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Dust and debris shall not be permitted to accumulate in the area to the detriment of plant operation. All flame cutting shall be performed to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. All work shall be performed in accordance with recognized fire protection standards.
- 3.9.2. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Client's property. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans

and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.

- 3.9.3. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Client property and shall be removed and delivered to Client and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Client's property expeditiously and shall not be allowed to accumulate.

3.10. CLEANING AND PAINTING

- 3.10.1. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Client, the plant facilities, equipment and systems shall be thoroughly cleaned and painted.

- 3.10.2. In addition, the following special conditions apply:

- 3.10.2.1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.

- 3.10.3. The following Material and Equipment shall NOT be painted:

- 3.10.3.1. Motors, controllers, control switches, and safety switches.
- 3.10.3.2. Control and interlock devices.
- 3.10.3.3. Regulators.
- 3.10.3.4. Pressure reducing valves.
- 3.10.3.5. Control valves and thermostatic elements.
- 3.10.3.6. Lubrication devices and grease fittings.
- 3.10.3.7. Copper, brass, aluminum, stainless steel and bronze surfaces.
- 3.10.3.8. Valve stems and rotating shafts.
- 3.10.3.9. Pressure gages and thermometers.
- 3.10.3.10. Glass.
- 3.10.3.11. Name plates.

- 3.10.4. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint type and color obtained from manufacturer or computer matched.

3.10.5. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump manufacturer.

3.10.6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this. Lead based paints shall not be used.

3.11. IDENTIFICATION SIGNS

3.11.1. Laminated plastic signs, with engraved lettering not less than 7 mm (3/16 inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

3.11.2. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, and performance data shall be placed on factory built equipment.

3.11.3. Pipe Identification: Refer to Section: 22 05 53 Identification for Plumbing Piping and Equipment.

3.12. STARTUP AND TEMPORARY OPERATION

3.12.1. Startup of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation.

3.12.2. Where commission is applicable, the commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Commissioning Agent. Provide a minimum of 1 week weeks prior notice.

3.13. OPERATING AND PERFORMANCE TESTS

3.13.1. Prior to the final inspection, all required tests shall be performed. Submit the test reports and records to the Consultant.

3.13.2. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Client.

3.13.3. When completion of certain work or systems occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings during the first actual seasonal use of the

respective systems following completion of work. Rescheduling of these tests shall be requested in writing to the Consultant for approval.

3.14. OPERATION AND MAINTENANCE MANUALS

- 3.14.1. All new and temporary equipment and all elements of each assembly shall be included.
- 3.14.2. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- 3.14.3. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- 3.14.4. Lubrication instructions, type and quantity of lubricant shall be included.
- 3.14.5. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- 3.14.6. Set points of all interlock devices shall be listed.
- 3.14.7. Trouble-shooting guide for the control system troubleshooting shall be inserted into the Operations and Maintenance Manual.
- 3.14.8. The control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- 3.14.9. Emergency procedures for shutdown and startup of equipment and systems.

3.15. CLOSE-OUT DOCUMENTATION

- 3.15.1. 10 (ten) days prior to substantial performance of work obtain documentation and/or prepare certification of the following items and submit them to the Client representative:
 - 3.15.1.1. All inspection certificates.
 - 3.15.1.2. Guarantee certificates as called for under "Warranty".
 - 3.15.1.3. Record drawings.
 - 3.15.1.4. Operating and Maintenance Manuals.
 - 3.15.1.5. Test certifications as called for under "Testing".
 - 3.15.1.6. Provide a signed statement to the effect that all tests for mechanical systems and equipment have been completely carried out in the Trade Sections of these Specifications and to the manufacturer's recommendations, and in accordance with the requirements of all authorities having jurisdiction.

3.16. COMMISSIONING

- 3.16.1. Where applicable, provide commissioning documentation in accordance with the requirements of Section: 22 08 00 Commissioning of Plumbing.

3.17. OPERATING AND PERFORMANCE TESTS

- 3.17.1. Prior to the final inspection, perform required tests as specified and submit the test reports and records to the Consultant. The timing of the tests shall be arranged to suit the convenience of the Consultant, and the manner and duration shall be as the Consultant deems necessary. Record the daily start and stop times, operating hours and functions performed. Ensure that the performance tests are witnessed by the Consultant.
- 3.17.2. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Client.
- 3.17.3. At the successful completion of Performance Tests and all testing and balancing, make the systems ready for final inspection and subsequent acceptance of the Client. Replace and clean filters, flush out lines and equipment, remove and clean strainers, fill liquid systems and purge air. Provide water treatment to pipes and report in accordance to current by-laws. Disinfect all domestic water as required by current by-laws and Authorities Having Jurisdiction.
- 3.17.4. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.18. DEMONSTRATION AND TRAINING

- 3.18.1. Provide services of manufacturer's technical representative for four hours to instruct Client's personnel in operation and maintenance of the system.
- 3.18.2. Where commissioning is applicable, submit training plans and instructor qualifications in accordance with the requirements of Section: 22 08 00 Commissioning of Plumbing.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. APPLICABLE PUBLICATIONS..... 2

1.4. SUBMITTALS 2

PART 2 - PRODUCTS 3

2.1. FLOOR CLEAN-OUTS 3

2.2. VERTICAL RISERS CLEAN-OUTS 4

2.3. ACCESS DOORS 5

2.4. FLOOR DRAINS..... 6

2.5. PLUMBING FIXTURES CARRIERS 7

2.6. TRAPS..... 9

PART 3 - INSTALLATION..... 9

3.1. EXAMINATION AND PREPARATION 9

3.2. INSTALLATION OF PIPING 9

3.3. INSTALLATION OF CLEANOUTS..... 9

3.4. INSTALLATION OF FLOOR DRAINS 9

3.5. PLUMBING CARRIERS 10

PART 1 - GENERAL

1.1. DESCRIPTION

1.1.1. This section specifies materials and installation for the following specialties:

- 1.1.1.1. Clean-outs
- 1.1.1.2. Access Doors
- 1.1.1.3. Floor Drains
- 1.1.1.4. Trench Drains
- 1.1.1.5. Roof Drains
- 1.1.1.6. Plumbing Fixture Carriers

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 22 05 00 Common Work Results for Plumbing.
- 1.2.3. Section: 22 13 00 Facility Sanitary Sewerage.

1.3. APPLICABLE PUBLICATIONS

- 1.3.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.3.2. American Society for Testing and Materials (ASTM):
 - 1.3.2.1. C891-2011 Standard Practice for Installation of Underground Precast Concrete Utility Structures
- 1.3.3. Ontario Building Code (OBC)
 - 1.3.3.1. Part 7 Plumbing

1.4. SUBMITTALS

- 1.4.1. Submittals, including number of required copies, shall be submitted in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Manufacturer's Literature and Data: For each type of plumbing specialty indicated, the submittal shall include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- 1.4.3. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor or roof drain shall be submitted.

- 1.4.4. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
- 1.4.5. Include complete list indicating all components of the systems.
- 1.4.6. Include complete diagrams of the internal wiring for each item of equipment.
- 1.4.7. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

PART 2 - PRODUCTS

2.1. FLOOR CLEAN-OUTS

2.1.1. Standards of Acceptance:

- 2.1.1.1. J R Smith, Zurn, Watts

2.1.2. Finished Floor Clean-outs Round Top for Carpeted Areas

- 2.1.2.1. Description: Duco cast iron floor level cleanout assembly with round, adjustable, scoriated, nickel bronze top, and no-hub outlet. Bronze top shape to be as per architectural schedules.
- 2.1.2.2. Outlet size: 2" (50 mm) to 8" (200mm) diam.
- 2.1.2.3. Application: pedestrian and medium load wheeled traffic.

2.1.3. Finished Floor Clean-outs Square Top for Tiled Areas

- 2.1.3.1. Description: Duco cast iron floor level cleanout assembly with square, adjustable, scoriated, nickel bronze top, and no-hub outlet. Bronze top shape to be as per architectural schedules. Where square tops are selected, align sides with adjacent tiles patterns or walls.
- 2.1.3.2. Outlet size: 2" (50 mm) to 8" (200mm) diam.
- 2.1.3.3. Application: pedestrian and medium load wheeled traffic.

2.1.4. Finished Floor Clean-Out Square Top for Vinyl Tiles

- 2.1.4.1. Description: Duco Cast Iron Cleanout with Taper Thread Bronze Plug and Square Adjustable Secured Nickel Bronze Top with 1/8 (3 mm) seep Tile Recess. The square top is particularly adaptable to the straight-line patterns of tile designs. Allows for easy floor level adjustment.
- 2.1.4.2. Outlet size: 2" (50 mm) to 8" (200mm) diam.
- 2.1.4.3. Application: pedestrian and medium load wheeled traffic.

2.1.5. Finished Floor Clean-Out Square Top for Terrazzo Floors

- 2.1.5.1. Description: Duco Cast Iron Cleanout with Square Adjustable Secured Nickel Bronze Top with 1/2"(13) Terrazzo Recess. The recess is filled with the floor material, presenting an unobtrusive appearance. Lock-in design firmly holds floor material in recess. The square top is particularly adaptable to the straight-line patterns of tile designs. Allows for easy floor level adjustment.
- 2.1.5.2. Outlet size: 2" (50 mm) to 8" (200mm) diam.
- 2.1.5.3. Application: pedestrian and medium load wheeled traffic.

2.1.6. Unfinished Floor Clean-Outs with Adjustable Round Cast Iron Cover

- 2.1.6.1. Description: Duco Cast Iron Cleanout with Round Adjustable Scoriated Cast Iron Top with Non-Tilt Tractor Cover.
- 2.1.6.2. Spigot outlet
- 2.1.6.3. Outlet size: 2" (50 mm) to 8" (200mm) diam.
- 2.1.6.4. Application: pedestrian up to heavy load wheeled traffic

2.2. VERTICAL RISERS CLEAN-OUTS

2.2.1. Taper Thread Plug with Round Access Cover

- 2.2.1.1. Description: Duco Cast Iron Caulk Ferrule with Cast Bronze Taper Thread Plug. Cover: chrome plated deep cover or stainless-steel shallow cover; refer to architectural finishes schedule.
- 2.2.1.2. Outlet size: 2" (50 mm) to 8" (200mm) diam.
- 2.2.1.3. Applications: Used in hub openings in drainage piping where a cleanout is required. Ribbing on outside of ferrule prevents turning of ferrule in the caulking lead. Face-of-wall cover on finished walls.

2.2.2. Taper Thread Plug with Square Frame and Cover

- 2.2.2.1. Description: Duco Cast Iron Caulk Ferrule with Cast Bronze Taper Thread Plug, Chrome Plated Bronze Square Frame and Secured Cover.
- 2.2.2.2. Outlet Size: 2" (50 mm) to 8" (200mm) diam.
- 2.2.2.3. Applications: Used to cover cleanout plugs concealed in walls. The square design shall be used to adjacent walls, floors, ceilings, etc., that are finished of material in straight line patterns. The anchoring lugs provide easy means for securing the frame to the wall construction. The face-of-wall cover is for tile, masonry, or dry wall construction and shall be installed on an opening provided in the finished wall. The flush-with-wall cover shall be used for plaster or wet wall construction and is installed during the wall construction.

2.2.3. Cleanout Tee with Countersunk Plug and Round Access Cover

- 2.2.3.1. Description: Duco Cast Iron Cleanout Tee and Countersunk Plug with Stainless Steel Round Cover and Screw
- 2.2.3.2. Outlet Size: 2" (50 mm) to 6" (150mm) diam.
- 2.2.3.3. Applications: Used in concealed drainage lines where a cleanout is desired. Removable face-of-wall cover allows access to closure plug.

2.2.4. Cleanout Tee with Square Frame and Cover

- 2.2.4.1. Description: Duco Cast Iron Cleanout Tee and Countersunk Plug with Chrome Plated Bronze Square Frame and Secured Cover.
- 2.2.4.2. Outlet size: 2" (50 mm) to 6" (150mm) diam.
- 2.2.4.3. Application: Used in concealed drainage lines where a cleanout is desired. Face-of-Wall Cover shall be used for tile, masonry or drywall construction. The Flush-with-Wall cover shall be used for plaster or wet wall construction.

2.3. ACCESS DOORS

2.3.1. Face-of-Wall Type Access Door with Frame

- 2.3.1.1. 16-gauge steel door and frame with concealed hinge and screwdriver operated latch which holds the door securely closed. Nailer slots are provided for attaching to studs. When the door opening height is 24 inches (61 cm) or over, a continuous piano hinge and additional latches are provided at the top and bottom of door. When specified with allen latch or cylinder lock, matching latches/locks are furnished.
- 2.3.1.2. Finish: Prime coat - white
- 2.3.1.3. Sizes: 6"x6" (150mmx150mm) to 18"x36" (450mmx900mm)
- 2.3.1.4. Applications: Used to cover cleanout plugs, valves, controls or equipment concealed in walls and ceilings. Larger sizes are used to provide man access to utility and attic spaces. The face-of-the-wall type is for tile, masonry or dry wall construction, and is usually installed in an opening provided in the finished wall. The anchor holes provide a means of securely anchoring so that the face of the cover will be flush with the finished wall.
- 2.3.1.5. Standard of Acceptance: J R Smith, Zurn

2.3.2. Fire Rated Wall Access Door

- 2.3.2.1. Access door and frame shall be fabricated from 16 gage, galvanized steel with a prime coat finish suitable for painting. Hinge shall be concealed type. Door shall have a heavy-duty spring to provide positive latching when closed, and an interior latch release slide enabling door to be opened from the inside. Exterior latch shall be recessed and operated using ring attached to the sliding bolt.
- 2.3.2.2. Finish: Prime coat - white

- 2.3.2.3. Sizes: 8"x8" (200mmx200mm) to 36"x48" (900mmx1,200mm)
- 2.3.2.4. Applications: Used to cover cleanout plugs, valves, controls or equipment concealed in walls. Larger sizes are used to provide man access to utility spaces.
- 2.3.2.5. Standard of Acceptance: J R Smith, Zurn

2.3.3. Fire Rated Ceiling Access Door

- 2.3.3.1. Access door frame shall be fabricated from 16 gage galvanized steel with a prime coat finish and provided with masonry anchors and bolt holes. Access door panel shall be fabricated from 20 gage, galvanized steel with a prime coat finish. Door shall be filled with 2" thick, fire rated insulation, and be welded panel type. Access door shall have automatic closer, be self-latching and contain interior latch release. Exterior latching shall be recessed and universal self-latching bolt, operated by either a knurled knob or flush key.
- 2.3.3.2. Finish shall be a prime coat suitable for painting.
- 2.3.3.3. Access door and fire door assembly rated at 1 1/2 hours.
- 2.3.3.4. Sizes: 8"x8" (200mmx200mm) to 24"x36" (600mmx900mm)
- 2.3.3.5. Standard of Acceptance: J R Smith, Zurn

2.4. FLOOR DRAINS

2.4.1. Standard of Acceptance:

- 2.4.1.1. J R Smith, Zurn, Watts.

2.4.2. Floor Drains with Adjustable Strainer Round Heads

- 2.4.2.1. Duco Cast Iron Body, Adjustable Strainer. Selected with 4"(100) Wide Flange and Secondary Flashing Flange.
- 2.4.2.2. Applications: General service floor drain for use in showers, toilets, kitchens, and other finished areas where foot traffic is expected. The round top strainer head is used for all types of poured finished floors. General service floor drain for use in showers, toilets, kitchens, and other finished areas where foot traffic is expected. The round top strainer head is used for all types of poured finished floors.
- 2.4.2.3. ½" (13) Trap Primer connection

2.4.3. Floor Drain with Adjustable Square Strainer Head

- 2.4.3.1. Duco Cast Iron Body with Flashing Collar and Adjustable Strainer Square Head
- 2.4.3.2. Applications: General service floor drain for use in showers, toilets, kitchens and other finished areas where foot traffic is expected. The square top strainer head is used for all types of poured finished floors. The square top is particularly adaptable to floors that are finished in material of square or straight-line pattern.

Reversible flashing collar permits adjustment of the strainer to meet finished floor level.

- 2.4.3.3. ½"(13) Trap Primer connection

2.4.4. Funnel Floor Drain

- 2.4.4.1. Epoxy coated cast iron floor drain with anchor flange, reversible membrane clamp with primary and secondary weepholes, 5 in. (127mm) diameter 1/4 in. (6mm) thick adjustable nickel bronze strainer, 4 in. (102mm) x9 in. (229mm) oval cast iron (standard) funnel, and no hub (standard) outlet.
- 2.4.4.2. The funnel prevents splashing and directs the waste into the drain. The exposed portion of grate serves as drain for any other waste on the floor. The funnel is attached to the grate by means of concealed screws and it may be moved to any grate location desired.
- 2.4.4.3. Applications: mechanical rooms

2.4.5. Heavy Duty Floor Drains with 12" Top Solid Free Standing Sediment Bucket

- 2.4.5.1. Duco Cast Iron Body and Flashing Collar with Cast Iron Tractor Grate and Solid Free Standing Sediment Bucket.
- 2.4.5.2. Application: Used in heavy trucking or traffic areas where waste water contains sand, sediment and other debris. Drain has solid free-standing bucket to intercept this type of debris.
- 2.4.5.3. ½"(13) Trap Primer connection

2.5. **PLUMBING FIXTURES CARRIERS**

- 2.5.1. Standard of Acceptance:

- 2.5.1.1. J R Smith, Zurn, Watts

2.5.2. Wall -Mounted Urinal Carrier

- 2.5.2.1. Wall urinal support system complete with Dura-Coated carbon structural steel rectangular tubing uprights, conforming to ASTM A500 Grade C, with welded base feet having slotted floor anchor holes.
- 2.5.2.2. Lower bearing plate is vertically adjustable with slot to accommodate bearing jack placement. Upper universal hanger plate is pre-notched for back spud inlet and is designed for various hardware positions and fixtures. Includes mounting fasteners and hardware. Carrier system exceeds load and deflection requirements as outlined in ASME Standard A112.6.1M.

2.5.3. Wall Mounted Toilet Carrier - Single Side Arrangement

- 2.5.3.1. Horizontal siphon jet water closet carrier system, with high performance Dura-Coated cast iron main fitting with hydro-mechanically optimized sweep, 4" [102 mm] no-hub connections, and extended 2" [51 mm] vent.
 - 2.5.3.2. Corrosion resistant, adjustable 3" [76 mm] dia. X 6" [152 mm] coupling with integral test cap, designed to increase flow velocity and line carry, and bonded gasket optimizes flow performance while reducing installation steps.
 - 2.5.3.3. Complete system includes an adjustable, gasketed faceplate; floor mounted foot supports; fixture bolts, trim, and stud protectors. Carrier complies with all applicable requirements of ASME A112.6.1M up to a 500 lbs [227 kg] maximum static load.
- 2.5.4. Wall Mounted Toilet Carrier - Back-to-Back Arrangement
- 2.5.4.1. Horizontal siphon jet water closet carrier system, with high performance Dura-Coated cast iron main fitting with hydro-mechanically optimized sweep, 4" [102 mm] hub & spigot connections, and extended 2" [51 mm] vent. Corrosion resistant, adjustable 3" [76 mm] dia. X 6" [152 mm] couplings with integral test caps, designed to increase flow velocity and line carry, and bonded gaskets optimize flow performance while reducing installation steps. Complete system includes adjustable, gasketed faceplates; floor mounted foot supports; fixture bolts, trim, and stud protectors.
 - 2.5.4.2. Carrier system complies with all applicable requirements of ASME A112.6.1M up to a 500 lbs [227 kg] maximum static load.
- 2.5.5. Concealed Arm System - Wall Lavatories
- 2.5.5.1. Wall Hung Lavatory Support System complete with Dura-Coated upright supports made from structural carbon-steel square tubing, conforming to ASTM A500 Grade C standards, with welded steel plate mounting feet featuring separate bolt patterns for using either 3/8" [10mm] or 1/2" [13mm] anchors, both meeting OSHPD spacing requirements. Includes lower and upper plates, marked with an indexed ruler guide for accurate adjustability of upright spacing, from 15" [381mm] to 22" [560mm].
 - 2.5.5.2. Individual slotted header plates with integral welded arm sleeves provide 2" [51mm] of additional horizontal adjustment per plate allowing for a total horizontal adjustment range of 11" [279mm] to 26" [660mm]. Arms are Dura-Coated cast iron and include leveling screws and soft-set elastomeric locking devices. Uprights, plates, and header plates are all factory assembled for easy installation. Carrier system exceeds load and deflection requirements when tested in accordance to ASME Standard A112.6.1M at any adjustment position.

2.6. TRAPS

- 2.6.1. Cast iron body deep seal traps, threaded, hub, or spigot on inlet.

PART 3 - INSTALLATION

3.1. EXAMINATION AND PREPARATION

- 3.1.1. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.
- 3.1.2. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.
- 3.1.3. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

3.2. INSTALLATION OF PIPING

- 3.2.1. Refer to Related Section: 22 07 00 Plumbing Insulation for additional requirements

3.3. INSTALLATION OF CLEANOUTS

- 3.3.1. Cleanout locations should be indicated on drawings.
- 3.3.2. Provide cleanouts at each change in direction of piping greater than 45 degrees, where indicated on drawings and where required by code. Clean-outs shall be same size as pipe served through 4". Above ground cleanouts: install cleanouts at base of each vertical soil or waste stack.
- 3.3.3. Encase exterior cleanouts in concrete flush with grade.
- 3.3.4. Cleanouts shall be aesthetically located with respect to tile patterns, masonry bond and alignment. Coordinate installation with masonry and concrete work.
- 3.3.5. Prior to acceptance of the system, demonstrate that cleanout plugs are easily removable and can be easily rodded.
- 3.3.6. When cleanouts are required in above grade floors, flash and clamp cleanouts in floors provided with membrane waterproofing as specified for floor drains.

3.4. INSTALLATION OF FLOOR DRAINS

- 3.4.1. Install floor drains as indicated on drawings, at low points of surface areas to be drained.
- 3.4.2. Provide trap for all floor drains, minimum 3" trap and waste.
- 3.4.3. Check drainage of surfaces by flooding with the hose.

3.4.4. Provide vent for floor drain piping per code, minimum 1 1/2".

3.5. PLUMBING CARRIERS

3.5.1. Install in accordance with the manufacturer's instructions.

3.5.2. Coordinate with the architectural division the width of the sanitary chases to ensure adequate access for maintenance and replacement.

TABLE OF CONTENTS

PART 1 - GENERAL	2
1.1. DESCRIPTION	2
1.2. RELATED WORK	2
1.3. APPLICABLE PUBLICATIONS	2
1.4. SUBMITTALS	3
1.5. DELIVERY, STORAGE, AND HANDLING	3
PART 2 - PRODUCTS	4
2.1. VALVES, GENERAL	4
2.2. SHUT-OFF VALVES	4
2.3. BALANCING VALVES	5
2.4. CHECK VALVES	5
2.5. GLOBE VALVES	6
2.6. WATER PRESSURE REDUCING VALVE AND CONNECTIONS	6
2.7. STRAINERS	7
2.8. TRAP PRIMERS	7
2.9. THERMOSTATIC MIXING VALVES	8
PART 3 - EXECUTION	10
3.1. EXAMINATION	10
3.2. INSTALLATION	10
3.3. STRAINERS	11
3.4. ELECTRONIC TRAP PRIMING	11
3.5. THERMOSTATIC MIXING VALVES	11
3.6. LABELING AND IDENTIFYING	12
3.7. ADJUSTING	12
3.8. COMMISSIONING	12
3.9. DEMONSTRATION AND TRAINING	13

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section describes the requirements for general-duty valves for domestic water and sewer systems.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 22 05 00 Common Work Results for Plumbing.

1.3. APPLICABLE PUBLICATIONS

- 1.3.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.3.2. American Society of Mechanical Engineers (ASME):
 - 1.3.2.1. A112.14.1-2003 Backwater Valves
- 1.3.3. American Society of Sanitary Engineering (ASSE):
 - 1.3.3.1. 1001-2008 Performance Requirements for Atmospheric Type Vacuum Breakers
 - 1.3.3.2. 1003-2009 Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems
 - 1.3.3.3. 1017-2009 Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems
 - 1.3.3.4. 1069-2005 Performance Requirements for Automatic Temperature Control Mixing Valves
 - 1.3.3.5. 1070-2004 Performance Requirements for Water Temperature Limiting Devices
 - 1.3.3.6. 1071-2012 Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
- 1.3.4. American Society for Testing and Materials (ASTM):
 - 1.3.4.1. A126-2004(R2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - 1.3.4.2. A276-2013a Standard Specification for Stainless Steel Bars and Shapes
 - 1.3.4.3. A536-1984(R2009) Standard Specification for Ductile Iron Castings
- 1.3.5. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

- 1.3.5.1. SP-25-2008 Standard Marking Systems for Valves, Fittings, Flanges and Unions
 - 1.3.5.2. SP-67-2011 Butterfly Valves
 - 1.3.5.3. SP-70-2011 Gray Iron Gate Valves, Flanged and Threaded Ends
 - 1.3.5.4. SP-71-2011 Gray Iron Swing Check Valves, Flanged and Threaded Ends
 - 1.3.5.5. SP-80-2013 Bronze Gate, Globe, Angle, and Check Valves
 - 1.3.5.6. SP-85-2011 Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
 - 1.3.5.7. SP-110-2010 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- 1.3.6. NSF International (NSF):
- 1.3.6.1. 61-2012 Drinking Water System Components – Health Effects
 - 1.3.6.2. 372-2011 Drinking Water System Components – Lead Content

1.4. SUBMITTALS

- 1.4.1. Submittals, including number of required copies, shall be submitted in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1.4.2.1. Ball Valves.
 - 1.4.2.2. Gate Valves.
 - 1.4.2.3. Butterfly Valves.
 - 1.4.2.4. Balancing Valves.
 - 1.4.2.5. Check Valves.
 - 1.4.2.6. Globe Valves.
 - 1.4.2.7. Water Pressure Reducing Valves and Connections.
 - 1.4.2.8. Vacuum Breakers
 - 1.4.2.9. Thermostatic Mixing Valves.
 - 1.4.2.10. Trap primer devices
 - 1.4.2.11. Strainers

1.4.3. Test and Balance reports for balancing valves.

1.4.4. Piping diagrams of thermostatic mixing valves to be installed.

1.5. DELIVERY, STORAGE, AND HANDLING

1.5.1. Valves shall be prepared for shipping as follows:

- 1.5.1.1. Protect internal parts against rust and corrosion.

- 1.5.1.2. Protect threads, flange faces, grooves, and weld ends.
 - 1.5.1.3. Set angle, gate, and globe valves closed to prevent rattling.
 - 1.5.1.4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 1.5.1.5. Set butterfly valves closed or slightly open.
 - 1.5.1.6. Block check valves in either closed or open position.
- 1.5.2. Valves shall be prepared for storage as follows:
- 1.5.2.1. Maintain valve end protection.
 - 1.5.2.2. Store valves indoors and maintain at higher than ambient dew point temperature.

PART 2 - PRODUCTS

2.1. VALVES, GENERAL

- 2.1.1. Asbestos packing and gaskets are prohibited.
- 2.1.2. All valves shall have seats, stem seals and disc materials compatible with intended fluid, temperature, pressure and service.
- 2.1.3. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.
- 2.1.4. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.
- 2.1.5. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 m (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.
- 2.1.6. All valves used to supply potable water shall meet the requirements of NSF 61 and NSF 372.
- 2.1.7. Unless noted otherwise, valves shall be same size as piping.
- 2.1.8. Standards of acceptance: Jenkins, Crane, Toyo, Kitz

2.2. SHUT-OFF VALVES

- 2.2.1. Cold, Hot and Re-circulating Hot Water:
 - 2.2.1.1. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of

1035 kPa (150 psig) and a CWP rating of 4138 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be non-lead solder.

- 2.2.1.2. Less than 100 mm DN100 (4 inches): Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A536, ductile iron.

- 2.2.1.3. 100 mm DN100 (4 inches) and larger:

2.2.1.3.1. Class 125, OS&Y, Cast Iron Gate Valve. The gate valve shall meet MSS SP-70 type I standard. The gate valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall meet ASTM A126, grey iron with bolted bonnet, flanged ends, bronze trim, and positive-seal resilient solid wedge disc. The gate valve shall be gear operated for sizes under 200 mm or DN200 (8 inches) and crank operated for sizes 200 mm or DN200 (8 inches) and above.

2.2.1.3.2. Single flange, ductile iron butterfly valves: The single flanged butterfly valve shall meet the MSS SP-67 standard. The butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The butterfly valve shall be lug type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange. The body material shall comply with ASTM A536 ductile iron. The seat shall be EPDM with stainless steel disc and stem.

2.3. BALANCING VALVES

2.3.1. Hot Water Re-circulating, 75 mm or DN75 (3 inches) and smaller: manual balancing valve shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read-out ports shall be fitting with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (1/4 inch NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to set point without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.

2.3.2. Larger than 75 mm or DN75 (3 inches): Manual balancing valves shall be of heavy duty cast iron flanged construction with 861 kPa (125 psig) flange connections. The flanged manual balancing valves shall have either a brass ball with glass and carbon filled TFE seal rings or fitted with a bronze seat, replaceable bronze disc with EPDM seal insert and stainless-steel stem. The design pressure shall be 1200 kPa (175 psig) at 121 degrees C (250 degrees F).

2.3.3. Standard of Acceptance: Armstrong, Bell&Gossett, T&A suitable for potable water.

2.4. CHECK VALVES

- 2.4.1. 75 mm or DN75 (3 inches) and smaller shall be Class 125, bronze swing check valves with non-metallic disc suitable for type of service. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B62, solder joints, and PTFE or TFE disc.
- 2.4.2. 100 mm or DN100 (4 inches) and larger: Check valves shall be Class 125, iron swing check valve with lever and weight closure control. The check valve shall meet MSS SP-71 Type I standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a clear or full waterway body design with gray iron body material conforming to ASTM A126, bolted bonnet, flanged ends, bronze trim.
- 2.4.3. All check valves on the discharge side of submersible sump pumps shall have factory installed exterior level and weight with sufficient weight to prevent the check valve from hammering against the seat when the sump pump stops.

2.5. GLOBE VALVES

- 2.5.1. 75 mm or DN75 (3 inches) or smaller: Class 150, bronze globe valve with non-metallic disc. The globe valve shall meet MSS SP-80, Type 2 standard. The globe valve shall have a CWP rating of 2070 kPa (300 psig). The valve material shall be bronze with integral seal and union ring bonnet conforming to ASTM B62 with solder ends, copper-silicon bronze stem, PTFE or TFE disc, and malleable iron hand wheel.
- 2.5.2. Larger than 75 mm or DN75 (3 inches): Similar to above, except with cast iron body and bronze trim, Class 125, iron globe valve. The globe valve shall meet MSS SP-85, Type 1 standard. The globe valve shall have a CWP rating of 1380 kPa (200 psig). The valve material shall be gray iron with bolted bonnet conforming to ASTM A126 with flanged ends, bronze trim, and malleable iron handwheel.

2.6. WATER PRESSURE REDUCING VALVE AND CONNECTIONS

- 2.6.1. 75 mm or DN75 (3 inches) or smaller: The pressure reducing valve shall consist of a bronze body and bell housing, a separate access cover for the plunger, and a bolt to adjust the downstream pressure. The pressure reducing valve shall meet ASSE 1003. The bronze bell housing and access cap shall be threaded to the body and shall not require the use of ferrous screws. The assembly shall be of the balanced piston design and shall reduce pressure in both flow and no flow conditions. The assembly shall be accessible for maintenance without having to remove the body from the line.
- 2.6.2. 100 mm or DN100 (4 inches) and larger: The pressure reducing valve shall consist of a flanged cast iron body and rated to 1380 kPa (200 psig). The valve shall have a large elastomer diaphragm for sensitive response. The pressure reducing valve shall meet ASSE 1003.

- 2.6.3. The regulator shall have a tap for pressure gauge.
- 2.6.4. The regulator shall have a temperature rating of 100 degrees C (212 degrees F) for hot water or hot water return service. Pressure regulators shall have accurate pressure regulation to 6.9 kPa (+/- 1 psig).
- 2.6.5. Setting: Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the drawings.
- 2.6.6. Connections Valves and Strainers: Shut off valves shall be installed on each side of reducing valve and a bypass line equal in size to the regulator inlet pipe shall be installed with a normally closed globe valve. A strainer shall be installed on inlet side of, and same size as pressure reducing valve. A pressure gage shall be installed on the inlet and outlet of the valve.
- 2.6.7. Standard of Acceptance: Watts, Zurn, Powers

2.7. STRAINERS

- 2.7.1. Minimum service rating of 860 kPa (125 psi) gauge pressure or 1½ times system pressure whichever is greater.
- 2.7.2. Cast iron body, cleanable Y pattern, Wye-pattern, removable stainless steel 20 (standard) mesh screen.
- 2.7.3. NSF 61/ANSI 372 compliant.
- 2.7.4. NPS 50 mm (2") nominal and under, screwed with brass cap.
- 2.7.5. NPS 65 mm (2½") and over flanged with bolted cap. Threaded screwed off center opening; blow down valve same diameter as threaded opening.
- 2.7.6. Standard of Acceptance; Zurn, Watts, Apollo

2.8. TRAP PRIMERS

- 2.8.1. Pressure operated (max. 4 traps)
 - 2.8.1.1. Diaphragm operated primer with 13 mm (½") NPT connection, automatically activated when the pressure drops. Operating range of 138 to 552 kPa (20 to 80 psig) for a maximum of four (4) drain traps. To be installed on a cold fresh water line of 38 mm (1½") or less. Max. distance between trap primer and most remote trap: as per manufacturer's instruction
 - 2.8.1.2. Provide ½" Type K hard copper tubing connection between trap primer valve and floor drain.
 - 2.8.1.3. Acceptable product: PPP Oregon series or Approved Equivalent.

2.8.2. Electronic trap primer (max. 12 traps)

- 2.8.2.1. With 13 mm (½") NPT connection, for a maximum of twelve (12) drain traps.
- 2.8.2.2. Supplied in a NEMA 1 box, power supply 115V. To be installed on a cold fresh water line of 38 mm (1½") or less. The prime-time priming assembly will supply a minimum of 600 ml (1 oz.) of potable water at 20 PSIG at a preset factory setting of 6 seconds every 24 hours.
- 2.8.2.3. The entire unit is pre-assembled in a steel cabinet ready to be either surface or flush wall mounted. The Priming assembly must be mounted above the finished floor.
- 2.8.2.4. Factory assembled with a bronze body ball valve, water hammer arrestor, solenoid valve, atmospheric vacuum breaker, 24 hour timer, 3/4" NPT connection, and a type L copper manifold. Electronic single point power connection 120V/1 amp draw and manual override switch
- 2.8.2.5. Provide ½" Type K hard copper tubing connection between trap primer valve and floor drain.
- 2.8.2.6. Acceptable product: PPP PTS series or Approved Equivalent.

2.9. THERMOSTATIC MIXING VALVES

2.9.1. Thermostatic Mixing Valves shall comply with the following general performance requirements:

- 2.9.1.1. Shall meet ASSE requirements for water temperature control.
- 2.9.1.2. The body shall be cast bronze or brass with corrosion resistant internal parts preventing scale and biofilm build-up. Provide chrome-plated finish in exposed areas.
- 2.9.1.3. No special tool shall be required for temperature adjustment, maintenance, replacing parts and disinfecting operations.
- 2.9.1.4. Valve shall be able to be placed in various positions without making temperature adjustment or reading difficult.
- 2.9.1.5. Valve shall allow easy temperature adjustments to allow hot water circulation. Internal parts shall be able to withstand disinfecting operations of chemical and thermal treatment of water temperatures up to 82°C (180°F) for 30 minutes or 50 mg/L (50 ppm) chlorine residual concentration for 24 hours.
- 2.9.1.6. Parts shall be easily removed or replaced without dismantling the valves, for easy scale removal and disinfecting of parts.
- 2.9.1.7. Valve shall have a manual adjustable temperature control with locking mechanism to prevent tampering by end user. Outlet temperature shall be visible to ensure outlet temperature does not exceed specified limits, particularly after thermal eradication procedures.
- 2.9.1.8. Standards of Acceptance: Powers, Leonard.

2.9.2. Master Thermostatic Water Mixing Valves:

- 2.9.2.1. Application: Tempered water distribution from central hot water source at relatively constant flow.
- 2.9.2.2. Connections: Flanged or threaded union inlets and outlet.
- 2.9.2.3. Standard: ASSE 1017.
- 2.9.2.4. Pressure Rating: 861 kPa (125 psig).
- 2.9.2.5. Suitable for flows between 3 gpm and 200 gpm (0.2 l/s to 12.6 l/s)
- 2.9.2.6. Valves feature advanced paraffin actuation technology for dynamic response
- 2.9.2.7. Valves feature a single-seat design for virtual shut down in the event of cold-water failure, triple-duty check stops with screens, and a 5°F (3°C) approach temperature for low temperature hot water supply.
- 2.9.2.8. Construction: rough Lead-Free* bronze.
- 2.9.2.9. Dirt and lime resistant poppet and seat design.
- 2.9.2.10. Vandal-resistant locking mechanism to secure temperature setting
- 2.9.2.11. Rotatable union triple-duty checkstops
- 2.9.2.12. Standard of Acceptance: Powers Hydroguard LFMM 430 series, max pressure drop: 5 psi (34.5 kPa).

2.9.3. Hi-Lo Water-Mixing-Valve Assemblies:

- 2.9.3.1. Application: Tempered water distribution from hot water source covering a wide range of flow.
- 2.9.3.2. Multi-valve Hi/Lo tempering valves are fully assembled, factory tested
- 2.9.3.3. Each system is equipped with highly-responsive thermostatic tempering valves listed to ASSE 1017 and CSA B125
- 2.9.3.4. Each system includes a PRV, ball valves, pressure/temperature gauges and triple-duty check stops.
- 2.9.3.5. Dirt and lime resistant poppet and seat design
- 2.9.3.6. The valves shall be constructed using Lead Free* brass.
- 2.9.3.7. Valves assembly shall also include copper piping, ball valve(s) and temperature/pressure gauge for diagnostics. The tempering valve shall have union checkstops, an outlet temperature range of 90 – 160°F (32 – 71°C) (with lockable means), and a single seat design for positive shutoff.
- 2.9.3.8. Tempering valves are listed to ASSE 1017 and CSA B125.
- 2.9.3.9. Minimum flow: 0.5 gpm (1.9 l/min)
- 2.9.3.10. Minimum approach temperature: 5 deg.F (3 deg.C) above setpoint.
- 2.9.3.11. Standard of Acceptance: Powers LFSH 1430 series; max. pressure drop: 5 psi (34.5 kPa).

2.9.4. Water Temperature Limiting Devices (point of use tempering valves)

- 2.9.4.1. Application: Single plumbing fixture point-of-use such as sinks or lavatories.

- 2.9.4.2. Standard: ASSE 1070.
- 2.9.4.3. Pressure Rating: 861 kPa (125 psig).
- 2.9.4.4. Thermostatic tempering valve shall be constructed using lead free* cast copper silicon alloy material.
- 2.9.4.5. The valve shall feature advanced paraffin-based actuation technology and union connections for ease of maintenance. All internal components shall be corrosion-resistant. Valve shall feature integral checks to prevent crossflow and inlet screens to filter out debris. The valve shall be ASSE 1069, ASSE 1070, ASSE 1017 and IAPMO CUPC listed.
- 2.9.4.6. Capacity of the valve shall be up to 12.0 gpm (45.0 lpm) at 45psi (310 kPa) differential. Valve shall perform to a minimum flow of 0.5 gpm (2 lpm) to ASSE 1070.
- 2.9.4.7. Control temperature shall be adjustable between 80°F - 120°F (27 - 49°C). The valve shall feature a vandal-resistant lockable handle to prevent tampering.
- 2.9.4.8. Standard of acceptance: Powers Hydroguard LFLM 495. Max. Pressure drop: 5 psi (34.5 kPa).

PART 3 - EXECUTION

3.1. EXAMINATION

- 3.1.1. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- 3.1.2. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- 3.1.3. Threads on valve and mating pipe shall be examined for form and cleanliness.
- 3.1.4. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- 3.1.5. Do not attempt to repair defective valves; replace with new valves.

3.2. INSTALLATION

- 3.2.1. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- 3.2.2. Valves Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

- 3.2.3. Valves shall be located for easy access and shall be provide with separate support.
- 3.2.4. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- 3.2.5. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- 3.2.6. Valves shall be installed in a position to allow full stem movement.
- 3.2.7. Install chain wheels on operators for all valves 100 mm (4 inches) and larger and more than 3.6 m (12 feet) above floor. Chains shall be extended to 1524 mm (60 inches) above finished floor.
- 3.2.8. Check valves shall be installed for proper direction of flow and as follows:
 - 3.2.8.1. Swing Check Valves: In horizontal position with hinge pin level and on top of valve.
 - 3.2.8.2. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment or system.
 - 3.2.8.3. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3.2.8.4. Install pressure gages on outlet of backflow preventers.
 - 3.2.8.5. Do not install bypass piping around backflow preventers.
- 3.2.9. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets.
- 3.2.10. Install cabinet-type units recessed in or surface mounted on wall as specified.

3.3. STRAINERS

- 3.3.1. Install upstream of all:
 - 3.3.1.1. Solenoid valves
 - 3.3.1.2. Pressure reducing valves

3.4. ELECTRONIC TRAP PRIMING

- 3.4.1. Make all wiring and power supply connections in accordance with the manufacturer's instructions.

3.5. THERMOSTATIC MIXING VALVES

- 3.5.1. Install and pipe in strict accordance with the manufacturer's instructions
- 3.5.2. Provide all accessories required by the manufacturer's instructions (balancing valves, check valves, etc)
- 3.5.3. Start-up and adjustment: by manufacturer's representative

3.6. LABELING AND IDENTIFYING

- 3.6.1. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
- 3.6.2. Calibrated balancing valves.
- 3.6.3. Master, thermostatic, water mixing valves.
- 3.6.4. Manifold, thermostatic, water-mixing-valve assemblies.
- 3.6.5. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.7. ADJUSTING

- 3.7.1. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Valves shall be replaced if persistent leaking occurs.
- 3.7.2. Set field-adjustable flow set points of balancing valves and record data. Ensure recorded data represents actual measured or observed conditions. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- 3.7.3. Set field-adjustable temperature set points of temperature-actuated water mixing valves.
- 3.7.4. Testing and adjusting of balancing valves shall be performed by an independent NEBB Accredited Test and Balance Contractor. A final settings and flow report shall be submitted to the Client.

3.8. COMMISSIONING

- 3.8.1. Provide commissioning documentation in accordance with the requirements of Section: 22 08 00 Commissioning of Plumbing.
- 3.8.2. Components provided under this section of the specification will be tested as part of a larger system.

3.9. DEMONSTRATION AND TRAINING

- 3.9.1. Provide services of manufacturer's technical representative for four hours to instruct Client's Personnel in operation and maintenance of the system.
- 3.9.2. Submit training plans and instructor qualifications in accordance with the requirements of Section: 22 08 00 Commissioning of Plumbing.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. RELATED DOCUMENTS 2

1.2. SUMMARY 2

1.3. ACTION SUBMITTALS 2

1.4. COORDINATION 2

1.5. WORK INCLUDED 2

PART 2 - PRODUCTS 3

2.1. GENERAL 3

2.2. EQUIPMENT NAMEPLATES 3

2.3. PIPE IDENTIFICATION AND VALVE TAGS 3

2.4. VALVE DATA BASE 5

2.5. UTILITY ENTRANCE DESIGNATIONS 6

PART 3 - EXECUTION 6

3.1. PREPARATION 6

3.2. INSTALLATION 6

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

- 1.1.1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 - General Requirements, apply to this Section.

1.2. SUMMARY

- 1.2.1. Section Includes:

- 1.2.1.1. Equipment labels.
- 1.2.1.2. Pipe labels.
- 1.2.1.3. Valve tags.
- 1.2.1.4. Warning tags.

1.3. ACTION SUBMITTALS

- 1.3.1. Product Data: For each type of product indicated.
- 1.3.2. Samples: For color, letter style, and graphic representation required for each identification material and device.
- 1.3.3. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- 1.3.4. Valve numbering scheme.
- 1.3.5. Valve Schedules: For each piping system to include in maintenance manuals.

1.4. COORDINATION

- 1.4.1. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- 1.4.2. Coordinate installation of identifying devices with locations of access panels and doors.
- 1.4.3. Install identifying devices before installing acoustical ceilings and similar concealment.

1.5. WORK INCLUDED

- 1.5.1. Furnish and install nameplates, valve tags, valve charts, and pipe markers on all Plumbing equipment, and piping.
- 1.5.2. Provide nameplates with the unit number and service designation on all plumbing equipment.

- 1.5.3. Indicate all valve tag numbers on Record Drawings and submit framed under glass valve tag charts including valve service and location.
- 1.5.4. Install color coded ceiling tacks in acoustical tile ceilings or color-coded tape on ceiling grid to identify location of equipment, valves and dampers that require regular maintenance or are part of a life safety system (fire dampers, smoke dampers, sprinkler valves or main isolation valves).
- 1.5.5. Concealed fire protection valves shall be marked by red label triangles (3" equilateral) and circle dots (1" diameter). Triangles shall be placed on the wall nearest the valve with the apex pointing toward the ceiling tile. Dots shall be placed on border of ceiling tile.
- 1.5.6. Provide underground plastic pipe markers 6 to 8 inches below finish grade, directly above buried pipes.
- 1.5.7. Prepare valve charts and frame under glass. All valves and the tag numbers shall be shown on the Record As-Built Drawings.
- 1.5.8. Provide valve computer data base to match chart.
- 1.5.9. Prepare and install exterior protected brass plaques indicating underground service entrances.

PART 2 - PRODUCTS

2.1. GENERAL

- 2.1.1. Acceptable manufactures contingent on compliance with the specification.

- 2.1.1.1. Seton
- 2.1.1.2. Brady Corporation
- 2.1.1.3. Marking Services Incorporated

2.2. EQUIPMENT NAMEPLATES

- 2.2.1. Equipment nameplates shall be 3" x 6" long, 0.02" aluminum with a black enamel background with engraved natural aluminum letters similar to Seton Style 2065-20. Nameplate shall have pressure sensitive taped backing.
- 2.2.2. The nameplate shall contain the unit or equipment designation ("AHU" for air handling unit, "P" for circulating pump, etc.), unit number and area or system served.
- 2.2.3. Nameplates for exterior equipment shall be applied with waterproof adhesive.

2.3. PIPE IDENTIFICATION AND VALVE TAGS

- 2.3.1. General Requirements for Manufactured Pipe Labels:

- 2.3.1.1. Preprinted, color-coded, with lettering indicating service, showing flow direction, and area served (i.e. "domestic cold water").
- 2.3.1.2. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- 2.3.1.3. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
- 2.3.1.4. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction, and visible all-around pipe.
- 2.3.1.5. Lettering Size: At least 1-1/2 inches high.
- 2.3.2. All piping, except that piping which is within inaccessible chases, shall be identified.
- 2.3.3. Each marker background shall be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ASME A13.1-1981).
- 2.3.4. Setmark snap-around markers shall be used for overall diameters up to 6" and strap around markers shall be used above 6" overall diameters.
- 2.3.5. Markers shall be located:
 - 2.3.5.1. Adjacent to each valve
 - 2.3.5.2. At each branch
 - 2.3.5.3. At each cap for future
 - 2.3.5.4. At each riser takeoff,
 - 2.3.5.5. At each pipe passage through wall (each side)
 - 2.3.5.6. At each pipe passage at 20' – 0" intervals maximum.
 - 2.3.5.7. At each piece of equipment.
 - 2.3.5.8. At all access doors.
 - 2.3.5.9. A minimum of one (1) marker shall be provided at each room.
- 2.3.6. Underground pipe markers:
 - 2.3.6.1. Provide detectable tape on all underground piping:
 - 2.3.6.2. Labels shall be color coded and labeled the same as indoors.
- 2.3.7. Valve tags
 - 2.3.7.1. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart. Valve tags shall include what room(s) the valve serves and piece of equipment served.

- 2.3.7.2. Valve tags shall be color coded 0.032" anodized aluminum tags, with engraved letters similar to Seton S Type 250-BL or approved equal.
- 2.3.8. HVAC tags shall be round 2" diameter, similar to Seton 15426.
- 2.3.9. Plumbing tags shall be square 2" x 2" similar to Seton 42769.
- 2.3.10. Fire Protection tags shall be square 2" x 2" similar to Seton 42769 RED.
- 2.3.11. Lettering shall be ¼" high for type service and ½" for valve number. Tag shall indicate service and valve number.
- 2.3.12. Each service shall be a different color.
- 2.3.13. Tag shall be attached to valves with chain similar to Seton No 16 stainless steel jack chain.
- 2.3.14. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.
- 2.3.15. Provide a tag for every valve except:
 - 2.3.15.1. Perimeter radiation shut-off valves that are located at the finned tube radiation element within the accessible (from the space) heating enclosure.
- 2.3.16. Furnish a minimum of two (2) typed valve lists
- 2.3.17. Each framed under glass or Plexiglas. Each chart shall be enclosed in an approved 0.015" thick plastic closure for permanent protection.
- 2.3.18. Valve numbers shall correspond to those indicated on the Record Drawings and on the printed valve lists.
- 2.3.19. The printed list shall include the valve number, location and purpose of each valve. It shall state other necessary information such as the required opening or closing of another valve when one valve is to be opened or closed.
- 2.3.20. Printed framed valve lists shall be displayed in each Mechanical Room or in a location designated by the Client.

2.4. VALVE DATA BASE

- 2.4.1. Provide a valve data base for all valves to operate on the building computer.
- 2.4.2. Every valve shall include:
 - 2.4.2.1. Tag Number
 - 2.4.2.2. Service (Hot water, Chilled water, Sprinkler, etc.)

- 2.4.2.3. Size
- 2.4.2.4. Operation
- 2.4.2.5. Location
- 2.4.2.6. Manufacture
- 2.4.2.7. Model number
- 2.4.2.8. Submittal reference

2.5. UTILITY ENTRANCE DESIGNATIONS

- 2.5.1. Provide a brass wall plaque, minimum 0.020" thickness, secured to the exterior wall just above the grade line for all buried service entrances or exits. Samples are: Water Service Below; Gas Service Below; Sanitary Sewer Below; Storm Sewer Below; Irrigation Water Below; etc.
- 2.5.2. Ceiling Tacks or Tape.
 - 2.5.2.1. Provide steel color coded 3/4-inch diameter ceiling tacks in acoustical tile ceilings or color-coded tape applied to ceiling grid to locate equipment, valves or dampers that require regular maintenance or are part of a Life Safety System.
 - 2.5.2.2. The tacks or tapes shall be color codes as follows:
 - 2.5.2.2.1. Yellow – HVAC
 - 2.5.2.2.2. Red – Life Safety (fire dampers, sprinkler valves, etc.)
 - 2.5.2.2.3. Green - Plumbing Valves.
 - 2.5.2.2.4. Blue – Heating/Cooling Valves.

PART 3 - EXECUTION

3.1. PREPARATION

- 3.1.1. All surfaces shall be cleaned and insulated (if applicable) prior to installing any identification.
- 3.1.2. Exterior surfaces of outdoor equipment shall be dry and prepared to accept the specified identification.

3.2. INSTALLATION

- 3.2.1. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion. Seal with clear lacquer.
- 3.2.2. Install valve tags with chain.
- 3.2.3. Install plastic pipe markers in accordance with manufacturer's Instructions.
- 3.2.4. Install plastic tape markers complete around pipe in accordance with manufacturer's instructions.

- 3.2.5. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- 3.2.6. Identify air handling units, pumps, domestic hot water heaters, fire pumps, heat transfer equipment tanks, water treatment devices, etc. with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- 3.2.7. Identify control panels and major control components outside panels with plastic nameplates.
- 3.2.8. Install detector tape on all underground services in accordance with the manufacture's recommendations.
- 3.2.9. Identify thermostats relating to air handling equipment serving multiple spaces.
- 3.2.10. Identify valves in main and branch piping with valve tags.
- 3.2.11. Tag automatic controls, instruments and relays. Key to control schematic.
- 3.2.12. Identify piping, concealed or exposed, with pipe markers or, where buried using plastic tape pipe markers. Use tags on piping $\frac{3}{4}$ inch diameter and smaller. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 7 m (20 feet) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 3

1.5. STORAGE AND HANDLING OF MATERIAL 3

1.6. APPLICABLE PUBLICATIONS 3

1.7. STANDARDS OF ACCEPTANCE 4

PART 2 - PRODUCTS 4

2.1. MINERAL FIBER OR FIBER GLASS 4

2.2. INSULATION FACINGS AND JACKETS 4

2.3. PIPE COVERING PROTECTION SADDLES..... 6

2.4. ADHESIVE, MASTIC, CEMENT 6

2.5. MECHANICAL FASTENERS..... 6

2.6. FIRESTOPPING MATERIAL..... 6

2.7. FLAME AND SMOKE..... 6

PART 3 - EXECUTION 7

3.1. GENERAL REQUIREMENTS..... 7

3.2. INSULATION INSTALLATION..... 8

3.3. FIELD-APPLIED JACKET APPLICATION 9

3.4. COMMISSIONING 9

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. Field applied insulation for thermal efficiency and condensation control for Plumbing piping and equipment.
- 1.1.2. Re-insulation of plumbing piping and equipment after asbestos abatement.
- 1.1.3. Definitions
 - 1.1.3.1. ASJ: All service jacket, white finish facing or jacket.
 - 1.1.3.2. Air-conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
 - 1.1.3.3. Cold: Equipment or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
 - 1.1.3.4. Concealed: Piping above ceilings and in chases, interstitial space, and pipe chases.
 - 1.1.3.5. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
 - 1.1.3.6. Hot: Plumbing equipment or piping handling media above 41 degrees C (105 degrees F).
 - 1.1.3.7. Thermal conductance: Heat flow rate through materials.
 - 1.1.3.8. Flat surface: Watts per square meter (BTU per hour per square foot).
 - 1.1.3.9. Pipe or Cylinder: Watts per square meter (BTU per hour per linear foot).
 - 1.1.3.10. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
 - 1.1.3.11. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). or the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.

1.2. RELATED WORK

- 1.2.1. Section: 22 05 00 Common Work Results for Plumbing: General mechanical requirements and items, which are common to more than one section of Division 22.
- 1.2.2. Section: 22 08 00 Commissioning of Plumbing. Requirements for commissioning, systems readiness checklists, and training.

1.3. QUALITY ASSURANCE

- 1.3.1. Criteria:

- 1.3.1.1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4,
- 1.3.1.2. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
- 1.3.1.3. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- 1.3.1.4. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Shop Drawings:
 - 1.4.2.1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
 - 1.4.2.2. Insulation materials: Specify each type used and state surface burning characteristics.
 - 1.4.2.3. Insulation facings and jackets: Each type used.
 - 1.4.2.4. Insulation accessory materials: Each type used.
 - 1.4.2.5. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
 - 1.4.2.6. Make reference to applicable specification paragraph numbers for coordination.

1.5. STORAGE AND HANDLING OF MATERIAL

- 1.5.1. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6. APPLICABLE PUBLICATIONS

- 1.6.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- 1.6.2. National Fire Protection Association (NFPA):
 - 1.6.2.1. 101-09 Life Safety Code

- 1.6.2.2. 251-06 Standard methods of Tests of Fire Endurance of Building Construction Materials
- 1.6.2.3. 255-06 Standard Method of tests of Surface Burning Characteristics of Building Materials
- 1.6.3. Underwriters Laboratories, Inc (UL):
 - 1.6.3.1. 723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 08/03
- 1.6.4. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):
 - 1.6.4.1. SP58-2002 Pipe Hangers and Supports Materials, Design, and Manufacture

1.7. STANDARDS OF ACCEPTANCE

- 1.7.1. Owens/Corning, Knauf, Johns Mansville

PART 2 - PRODUCTS

2.1. MINERAL FIBER OR FIBER GLASS

- 2.1.1. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), class 1, k = 0.037 (0.26) at 24 degrees C (75 deg. F), for use at temperatures from -20 deg. C (-4 deg. F) and up to 230 deg. C (450 deg. F) with an all-service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
- 2.1.2. Application: all domestic water supply piping (hot, cold, recirculation), all horizontal sections of storm drains.
- 2.1.3. Thickness:
 - 2.1.3.1. Piping larger than 75mm (3"): 38 mm thickness
 - 2.1.3.2. Piping nominal 25mm-75mm (1-3"): 25 mm thickness
 - 2.1.3.3. Piping nominal 19mm (3/4") and less: 12 mm thickness
 - 2.1.3.4. Outdoor insulation (any size): increase insulation thickness by 12 mm (1/2")
- 2.1.4. At fittings and flanges (including water meter and body of roof drains), insulate with wrapped fiberglass insulation of same thickness as adjacent pipe, and cover with pre-molded PVC jackets. Seal edge of jacket with self-sealing vapor barrier tape.
- 2.1.5. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights.

2.2. INSULATION FACINGS AND JACKETS

- 2.2.1. Vapor Retarder, higher strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on pipe insulation jackets.
- 2.2.2. Facings and jackets
 - 2.2.2.1. Concealed indoor areas:
 - 2.2.2.1.1. Shall be all service type (ASJ) in concealed spaces and PVC Vapor Retarder jacketing in all exposed areas, including mechanical rooms and service areas.
 - 2.2.2.1.2. All service Jacket (ASJ) shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
 - 2.2.2.1.3. Standard of Acceptance: Zeston, Ceeco, Proto
 - 2.2.2.2. Exposed indoor areas:
 - 2.2.2.2.1. Shall be heavy PVC fitting covers (0.75 mm thickness. Overlap PVC covers on pipe insulation jackets as least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 - 2.2.2.3. Indoor Fittings Jackets
 - 2.2.2.3.1. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
 - 2.2.2.3.2. Adhesive: Compatible with PVC jacket, and recommended by insulation material manufacturer.
 - 2.2.2.3.3. Standard of Acceptance: Zeston, Ceeco, Proto
 - 2.2.2.4. Aluminum Jackets – Outdoor Piping and Fittings
 - 2.2.2.4.1. Aluminum Jacket-Piping systems: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless-steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
 - 2.2.2.4.2. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping as well as on interior piping exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) The vapor barrier jacket shall consist of a multi-

layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

- 2.2.2.4.3. Neither rivets, screws, staples nor any other fastener capable of penetrating the underlying vapor retarder shall be used to secure the aluminum jacketing.
- 2.2.2.4.4. Standards of Acceptance: Childers-Lock-on and Pabco-Surfeit.

2.3. PIPE COVERING PROTECTION SADDLES

- 2.3.1. Cold pipe support - indoors: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).
- 2.3.2. Warm or hot pipe supports - indoors: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).
- 2.3.3. All piping – outdoors: Metallic shield shall be made of galvanized steel painted on both sides with a minimum two coats of aluminum paint. 180 degrees for clevises and roller type hangers and 360 degrees for clamp type hangers and supports. Shield and insert length and gauge shall be 400 mm (16") long and min. 2.75 mm (12ga) thickness.

2.4. ADHESIVE, MASTIC, CEMENT

- 2.4.1. Insulation manufacturers' published recommendations.

2.5. MECHANICAL FASTENERS

- 2.5.1. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- 2.5.2. Bands: 13 mm (1/2 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.6. FIRESTOPPING MATERIAL

- 2.6.1. Other than pipe insulation, refer to Section: 07 84 00 Fire Stopping.

2.7. FLAME AND SMOKE

- 2.7.1. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION

3.1. GENERAL REQUIREMENTS

- 3.1.1. Required pressure tests of piping joints and connections shall be completed and the work approved by the Consultant for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- 3.1.2. Except for specific exceptions, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full-length section will fit.
- 3.1.3. Insulation materials shall be installed in a first-class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- 3.1.4. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- 3.1.5. Construct insulation on parts of equipment such as cold-water pumps and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- 3.1.6. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- 3.1.7. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- 3.1.8. Plumbing work not to be insulated:
- 3.1.8.1. Piping and valves of fire protection system.

- 3.1.8.2. Factory pre-insulated components.
- 3.1.8.3. Over equipment nameplates.
- 3.1.8.4. Chromium plated brass piping.
- 3.1.8.5. Water piping in contact with earth.
- 3.1.8.6. Vibration control devices
- 3.1.8.7. Air chambers, unions, strainers, check valves, flow regulators.
- 3.1.8.8. Small horizontal cold-water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).
- 3.1.9. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- 3.1.10. Firestop Pipe insulation:
 - 3.1.10.1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed.
 - 3.1.10.2. Pipe penetrations requiring fire stop insulation including, but not limited to the following:
 - 3.1.10.2.1. Pipe risers through floors
 - 3.1.10.2.2. Pipe chase walls and floors
 - 3.1.10.2.3. Smoke partitions
 - 3.1.10.2.4. Fire partitions
 - 3.1.10.2.5. Freeze protection of above grade outdoor piping (over heat tracing tape): 20 mm (0.75) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide where indicated on the drawings
- 3.1.11. Provide vapor barrier jackets over insulation as follows:
 - 3.1.11.1. All piping exposed to outdoor weather.
 - 3.1.11.2. All interior piping conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.
- 3.1.12. Provide metal jackets over insulation as follows:
 - 3.1.12.1. All plumbing piping exposed to outdoor weather.

3.2. INSULATION INSTALLATION

- 3.2.1. Molded Mineral Fiber Pipe and Tubing Covering:
 - 3.2.1.1. Fit insulation to pipe, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor

retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.

3.2.2. Contractor's options for fitting, flange and valve insulation:

- 3.2.2.1. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
- 3.2.2.2. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
- 3.2.2.3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

3.3. FIELD-APPLIED JACKET APPLICATION

- 3.3.1. Apply PVC jacket where indicated, with 1 inch (25 mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
- 3.3.2. Apply metal jacket where indicated, with 2-inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel band 12 inches (300 mm) o.c. and at end joints. Provide vapor-barrier jackets. Aluminum jackets shall have seams located below the horizontal plane of the horizontal piping route. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and cover with aluminum jackets.

3.4. COMMISSIONING

- 3.4.1. Provide commissioning documentation in accordance with the requirements of Section: 22 08 00 Commissioning of Plumbing for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- 3.4.2. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section: 22 08 00 Commissioning of Plumbing and related sections for contractor responsibilities for system commissioning.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. SUBMITTALS 2

1.4. APPLICABLE PUBLICATIONS 2

1.5. QUALITY ASSURANCE 3

PART 2 - PRODUCTS 3

2.1. MATERIALS 3

2.2. UNDERGROUND WATER SERVICE CONNECTIONS TO BUILDINGS 4

2.3. ABOVE GROUND (INTERIOR) WATER PIPING 4

2.4. EXPOSED WATER PIPING 5

2.5. TRAP PRIMER WATER PIPING 5

2.6. STRAINERS 5

2.7. DIELECTRIC FITTINGS 5

PART 3 - EXECUTION 6

3.1. INSTALLATION..... 6

3.2. COPPER PIPE JOINTS 6

3.3. THREADED PIPE JOINTS 7

3.4. PIPE HANGERS, SUPPORTS AND ACCESSORIES 7

3.5. PENETRATIONS 8

3.6. TESTS..... 8

3.7. VALVES INSTALLATION 8

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.

1.2. RELATED WORK

- 1.2.1. Section: 22 05 00 Common Work Results for Plumbing.
- 1.2.2. Section: 22 07 00 Plumbing Insulation.

1.3. SUBMITTALS

- 1.3.1. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.3.2. Manufacturer's Literature and Data: All items listed in Part 2 - Products.

1.4. APPLICABLE PUBLICATIONS

- 1.4.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.4.2. Ontario Building Code – Part 7
- 1.4.3. American National Standards Institute (ANSI):
 - 1.4.4. A13.1 Scheme for Identification of Piping Systems
 - 1.4.5. B16.3-2011 Malleable Iron Threaded Fittings Classes 150 and 300
 - 1.4.6. B16.9-2007 Factory-Made Wrought Butt Welding Fittings
 - 1.4.7. B16.11-2011 Forged Fittings, Socket-Welding and Threaded
 - 1.4.8. B16.15-2006 Cast Copper Alloy Threaded Fittings Classes 125 and 250
 - 1.4.9. B16.18-2001 Cast Copper Alloy Solder-Joint Pressure Fittings
 - 1.4.10. B16.22-2012 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - 1.4.11. NSF/ANSI 61-2012 Drinking Water System Components - Health Effects
 - 1.4.12. American Society for Testing and Materials (ASTM):
 - 1.4.12.1. A183-03(2009) Carbon Steel Track Bolts and Nuts
 - 1.4.12.2. B32-08 Solder Metal
 - 1.4.12.3. B61-08 Steam or Valve Bronze Castings

- 1.4.12.4. B75/B75M-11 Seamless Copper Tube
- 1.4.12.5. B88-09 Seamless Copper Water Tube
- 1.4.12.6. B584-12a Copper Alloy Sand Castings for General Applications
- 1.4.12.7. B687-99(2011) Brass, Copper, and Chromium-Plated Pipe Nipples
- 1.4.12.8. E1120-08 Liquid Chlorine
- 1.4.12.9. E1229-08 Calcium Hypochlorite
- 1.4.13. American Water Works Association (AWWA):
 - 1.4.14. C110/A21.10-12 Ductile Iron and Gray Iron
 - 1.4.15. C151/A21.51-09 Ductile-Iron Pipe, Centrifugally Cast
 - 1.4.16. C153/A21.53-11 Ductile-Iron Compact Fittings
 - 1.4.17. C651-05 Disinfecting Water Mains
 - 1.4.18. NSF International (NSF)
 - 1.4.18.1. NSF/ANSI 61 (2012) Drinking Water System Components – Health Effects
 - 1.4.18.2. NSF/ANSI 372 (2011) Drinking Water System Components – Lead Content

1.5. QUALITY ASSURANCE

- 1.5.1. All piping materials shall be compatible for temperature, pressure and service.
- 1.5.2. All piping materials of a given type shall be manufactured by a single source, and supplied by a single supplier.
- 1.5.3. All wetted seals shall be made from materials that are immune from chloramine degradation.
- 1.5.4. All joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer.
- 1.5.5. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

PART 2 - PRODUCTS

2.1. MATERIALS

- 2.1.1. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372. Endpoint devices used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9.

2.2. UNDERGROUND WATER SERVICE CONNECTIONS TO BUILDINGS

- 2.2.1. From inside face of exterior wall to a distance of approximately 5 feet (1500 mm) outside of building and underground inside building, material to be the same for the size specified inside of the building.
- 2.2.2. Three inches (75 mm) Diameter and Over: Ductile iron, AWWA C151, 125 psi (850 kPa) water steam pressure (WSP), exterior bituminous coating, and cement lined. Provide flanged and anchored connection to interior piping.
- 2.2.3. Under 3 inch (75 mm) Diameter: Copper tubing, ASTM B88, Type K, seamless, annealed. Fittings as specified under Part 2, INTERIOR DOMESTIC WATER PIPING. Use brazing alloys, AWS A5.8, Classification BCuP.
- 2.2.4. Flexible Expansion Joint: Ductile iron with ball joints rated for 250 psi (1725 kPa) working pressure conforming to ANSI/AWWA C153/A21.53, capable of deflecting a minimum of 20 degrees in each direction and expanding simultaneously to the amount shown on the drawings. Flexible expansion joint size shall match the pipe size it is connected to and shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene. The flexible expansion fitting shall not expand or exert an axial thrust under internal water pressure. Provide piping joint restraints at each mechanical joint end connection and piping restraints at the penetration of the building wall. The restraints shall be provided to address the developed thrust at the change of piping direction.

2.3. ABOVE GROUND (INTERIOR) WATER PIPING

- 2.3.1. Pipe: Copper tube, ASTM B88, Type K or L, drawn.
- 2.3.2. Fittings for Copper Tube:
 - 2.3.2.1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 & SP 110, Solder or braze joints. Use 95/5 tin and antimony for all soldered joints.
 - 2.3.2.2. Adapters: Provide adapters for joining screwed pipe to copper tubing.
- 2.3.3. Unions And Flanges:
 - 2.3.3.1. Unions, flanges and gasket materials to have a pressure rating of not less than 150 psig at 180 degrees. Gasket material for flanges and flanged fittings shall be teflon type. Treated paper gaskets are not acceptable.
 - 2.3.3.2. 50 mm (2") and smaller copper unions:

2.3.3.2.1. ANSI B16.18 cast bronze union coupling or ANSI B15.24 Class 150 cast bronze flanges.

2.3.3.3. 65 mm (2½ ") and larger flanges:

2.3.3.3.1. ANSI B15.24 Class 150 cast bronze flanges with full face teflon gaskets.

2.3.4. Solder: For installation of the potable water systems, only lead free solder shall be used, as required by the Ontario Act. Regulation 815/84 of the Ontario Water Resources.

2.4. EXPOSED WATER PIPING

2.4.1. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, casework, cabinets, equipment when not concealed.

2.4.2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish.

2.4.3. Nipples: ASTM B 687, Chromium-plated.

2.4.4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish. Unions 2-1/2 inches (65 mm) and larger shall be flange type with approved gaskets.

2.4.5. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome plated brass piping is not required.

2.5. TRAP PRIMER WATER PIPING

2.5.1. Pipe: Copper tube, ASTM B88, type K, hard drawn.

2.5.2. Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.

2.5.3. Solder: ASTM B32 composition Sb5. Provide non-corrosive flux.

2.6. STRAINERS

2.6.1. Provide on high pressure side of pressure reducing valves, upstream of solenoid valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.

2.6.2. Water: Basket or "Y" type with easily removable cover and brass strainer basket.

2.6.3. Body: Smaller than 3 inches (80 mm), brass or bronze; 3 inches (80 mm) and larger, cast iron or semi-steel.

2.7. DIELECTRIC FITTINGS

2.7.1. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment.
- 3.1.2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.
- 3.1.3. Install union and shut-off valve on pressure piping at connections to equipment.
- 3.1.4. Lay out pipe lines straight, plumb and in true alignment. Offset as required to avoid interference with other work, to conceal piping, to allow maximum headroom and to avoid interference with windows and doors. Lay out all pipes and establish their levels from bench marks, existing floors or finished grades.
- 3.1.5. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- 3.1.6. Piping shall be concealed unless indicated otherwise on drawings. Do not conceal piping until it has been inspected, tested, flushed and approved.
- 3.1.7. Use eccentric reducing fittings to increase or decrease pipe sizes. Bushings are not acceptable. Orient reducers to prevent trapping of water.
- 3.1.8. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves. Install hot and cold water lines at least 6 inches apart. Install piping at least 3 inches clear of electrical conduit and avoid running pipe within 3'-6" of electrical equipment, from floor to ceiling.
- 3.1.9. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
- 3.1.10. All domestic water piping shall be insulated throughout. For cold water, use vapor barrier.
- 3.1.11. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

3.2. COPPER PIPE JOINTS

- 3.2.1. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux and assemble joint to socket stop.

Apply flame to fitting until solder melts when placed at joint. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

3.3. THREADED PIPE JOINTS

- 3.3.1. Use a thread lubricant or teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.4. PIPE HANGERS, SUPPORTS AND ACCESSORIES

- 3.4.1. All piping shall be supported per the requirements of the Ontario Building Code part 7
- 3.4.2. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with red lead or zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- 3.4.3. Floor, Wall and Ceiling Plates, Supports, Hangers:
 - 3.4.3.1. Solid or split un-plated cast iron.
 - 3.4.3.2. All plates shall be provided with set screws.
 - 3.4.3.3. Pipe Hangers: Height adjustable clevis type.
 - 3.4.3.4. Adjustable Floor Rests and Base Flanges: Steel.
 - 3.4.3.5. Concrete Inserts: "Universal" or continuous slotted type.
 - 3.4.3.6. Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - 3.4.3.7. Riser Clamps: Malleable iron or steel.
 - 3.4.3.8. Rollers: Cast iron.
 - 3.4.3.9. Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
 - 3.4.3.10. Hangers and supports utilized with insulated pipe and tubing shall have 180 degree metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gauge steel. The shield shall be sized for the insulation.
- 3.4.4. For cold piping, install hangers and supports to maintain an effective continuous thermal and vapor barrier between cold piping and hangers and supports.
- 3.4.5. Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories.
- 3.4.6. With the installation of each flexible expansion joint, provide piping restraints for the upstream and downstream section of the piping at the flexible expansion joint. Provide calculations supporting the restraint length design and type of selected restraints.

- 3.4.7. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

3.5. PENETRATIONS

- 3.5.1. Install pipe sleeves where piping passes through building construction including all walls, floors and ceilings.
- 3.5.2. For new wall construction, promptly and accurately locate and securely set sleeves in forms before concrete is poured. For masonry construction, set the sleeves over the piping for Masonry Contractor to build around.
- 3.5.3. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section: 07 84 00 Fire Stopping. Completely fill and seal clearances between raceways and openings with the fire stopping materials.
- 3.5.4. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant

3.6. TESTS

- 3.6.1. General: Test system either in its entirety or in sections.
- 3.6.2. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 150 psi (1040 kPa) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.
- 3.6.3. All Other Piping Tests: Test new installed piping under 1-1/2 times actual operating conditions and prove tight.

3.7. VALVES INSTALLATION

- 3.7.1. Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible. Install valve in each water connection to fixture.
- 3.7.2. Install union and shut off valve on piping at connections to equipment and at all other locations indicated on the drawings.
- 3.7.3. Provide isolation valves on all main branch feeds to washroom fixture groups. Where possible, locate all valves in accessible ceilings. In hard ceiling areas, group valves to be accessed from one access door.

- 3.7.4. Backflow prevention device shall be installed in an accessible location, 5 (five) feet above finish floor.
- 3.7.5. Connect to fixtures and equipment in accordance with manufacturer's instructions.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. APPLICABLE PUBLICATIONS 2

1.4. SUBMITTALS 2

1.5. AS-BUILT DOCUMENTATION 2

PART 2 - PRODUCTS 3

2.1. UNDERGROUND SANITARY DRAINS – GRAVITY FLOW 3

2.2. ABOVE GROUND SANITARY DRAINS/VENTS - GRAVITY FLOW 3

2.3. SANITARY DRAINS – PUMPED FLOW 4

2.4. EXPOSED SANITARY PIPING 5

2.5. SPECIALTY PIPE FITTINGS..... 5

2.6. PENETRATION SLEEVES..... 6

PART 3 - EXECUTION 6

3.1. PIPE INSTALLATION..... 6

3.2. JOINT CONSTRUCTION..... 7

3.3. SPECIALTY PIPE FITTINGS..... 8

3.4. PIPE HANGERS, SUPPORTS AND ACCESSORIES 8

3.5. TESTS..... 9

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section pertains to sanitary sewer and sanitary vent systems, including piping, equipment and all necessary accessories as designated in this section.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 22 05 00 Common Work Results for Plumbing.
- 1.2.3. Section: 22 07 00 Plumbing Insulation.

1.3. APPLICABLE PUBLICATIONS

- 1.3.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
 - 1.3.1.1. Ontario Building Code – Part 7

1.4. SUBMITTALS

- 1.4.1. Submittals, including number of required copies, shall be submitted in accordance with Section 01 23 33, SHOP DRAWINGS AND PROJECT DOCUMENTATION.
- 1.4.2. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1.4.2.1. Piping.
 - 1.4.2.2. Penetration Sleeves.
 - 1.4.2.3. Pipe Fittings.
 - 1.4.2.4. Exposed Piping and Fittings.
- 1.4.3. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

1.5. AS-BUILT DOCUMENTATION

- 1.5.1. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them on Auto-Cad version 2007 or higher provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

- 1.5.2. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1. UNDERGROUND SANITARY DRAINS – GRAVITY FLOW

- 2.1.1. Main line sewers will be PVC SDR35 sewer pipe and shall be in compliance with ASTM D3040 or ASTM F1760 and third party certified to CSA B182.2.
- 2.1.2. Sewer laterals will be PVC SDR28 sewer pipe and shall be third party certified by CSA as above.
- 2.1.3. Joints
 - 2.1.3.1. Sealing gaskets must meet the requirements of ASTM D3034 or ASTM F1760, CSA B182.2.
 - 2.1.3.2. In addition, the pipe joints must be able to withstand a minimum hydrostatic pressure of 345 kPa (50 psi) without leakage.
- 2.1.4. Pipe Stiffness
 - 2.1.4.1. The minimum ring stiffness shall be 320 kPa (46 psi) for SDR35 pipe and 625 kPa (90 psi) for SDR 28.
 - 2.1.4.2. This stiffness will be determined using the test methods prescribed by ASTM D3034 and ASTM F1760.
- 2.1.5. Fittings
 - 2.1.5.1. Injection-molded gasketed PVC fittings shall meet the requirements of ASTM 3034 and ASTM F1336 and shall be certified to CSA B182.1 or CSA B182.2.
 - 2.1.5.2. Fabricated fittings must conform to ASTM F1336 and CSA B182.2.
- 2.1.6. Standard of Acceptance: IPEX Ring-Tite

2.2. ABOVE GROUND SANITARY DRAINS/VENTS - GRAVITY FLOW

- 2.2.1. Smaller than 75 mm (3") diam.
 - 2.2.1.1. Copper DWV tube sanitary waste, drain and vent drawn temper conforming to ASTM B306.
 - 2.2.1.2. The copper drainage fittings shall be cast copper or wrought copper conforming to CSA B158.1, ASME B16.23 or ASME B16.29.

- 2.2.1.3. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

2.2.2. Larger than 100 mm (4") diam

- 2.2.2.1. Cast iron Pipe shall be bell and spigot or hubless (plain end or no-hub or hubless).
- 2.2.2.2. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CSA B70, ASTM A888, or ASTM A74.
- 2.2.2.3. Cast iron pipe and fittings shall be made from a minimum of 95 percent post-consumer recycled material.
- 2.2.2.4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM C564.

2.3. **SANITARY DRAINS – PUMPED FLOW**

2.3.1. Smaller than 75 mm (3") diam above ground:

- 2.3.1.1. Copper pump discharge pipe and fittings:
 - 2.3.1.1.1. Copper tube shall be hard drawn Type K or L conforming to ASTM B88.
 - 2.3.1.1.2. Fittings shall be cast copper alloy conforming to ASME B16.18 or wrought copper conforming to ASME B16.22 with solder joint ends.
 - 2.3.1.1.3. Unions shall be copper alloy, hexagonal stock body with ball and socket, metal to metal seating surface conforming to MSS SP-123 with female solder-joint or threaded ends.
 - 2.3.1.1.4. Flanges shall be Class 150, cast copper conforming to ASME B16.24 with solder-joint end.
 - 2.3.1.1.5. Flange gaskets shall be full face, flat nonmetallic, asbestos free conforming to ASME B16.21.
 - 2.3.1.1.6. Flange nuts and bolts shall be carbon steel conforming to ASME B18.2.1.
 - 2.3.1.1.7. Solder shall be lead free, water flushable flux conforming to ASTM B32 and ASTM B813.

2.3.2. Larger than 100 mm (4") diam) above ground

- 2.3.2.1. Galvanized steel pump discharge pipe and fittings:
 - 2.3.2.1.1. Galvanized steel pipe shall be Schedule 40 weight class conforming to ASTM A53/A53M, with square cut grooved or threaded ends to match joining method.
 - 2.3.2.1.2. Fittings shall be Class 125, gray-iron threaded fittings conforming to ASME B16.4.

- 2.3.2.1.3. Unions shall be Class 150 hexagonal-stock body with ball and socket, metal to metal, bronze seating surface, malleable iron conforming to ASME B16.39 with female threaded ends.
- 2.3.2.1.4. Flanges shall be Class 125 cast iron conforming to ASME B16.1.
- 2.3.2.1.5. Flange gaskets shall be full face, flat nonmetallic, asbestos free conforming to ASME B16.21.
- 2.3.2.1.6. Flange nuts and bolts shall be carbon steel conforming to ASME B18.2.1.

2.3.3. All sizes, buried pumped sanitary pipe:

- 2.3.3.1. Polyethylene piping, Series 160 or higher of CAN/CSA-B137.1

2.4. EXPOSED SANITARY PIPING

2.4.1. Chrome plated brass piping of full iron pipe size shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, and equipment when not concealed by apron.

- 2.4.1.1. The Pipe shall meet ASTM B43, regular weight.
- 2.4.1.2. The Fittings shall conform to ASME B16.15 and ASTM D2665.
- 2.4.1.3. Nipples shall conform to ASTM B687, Chromium-plated.
- 2.4.1.4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2 1/2 inches) and larger shall be flange type with approved gaskets.

2.4.2. The finished room classification does not include mechanical Rooms, service rooms. .

2.5. SPECIALTY PIPE FITTINGS

2.5.1. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:

- 2.5.1.1. For cast iron drain pipes, the sleeve material shall be rubber conforming to ASTM C564.
- 2.5.1.2. For PVC drain pipes, the sleeve material shall be elastomeric seal or PVC, conforming to ASTM F477 or ASTM D5926.
- 2.5.1.3. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.

2.5.2. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 861 kPa (125 psig) at a minimum temperature of 82 degrees C (180 degrees F). The end connection shall be solder joint copper alloy and threaded ferrous.

- 2.5.3. Dielectric flange insulating kits shall be of non-conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- 2.5.4. The di-electric nipples shall be electroplated steel nipple complying with ASTM F1545 with a pressure rating of 2070 kPa (300 psig) at 107 degrees C (225 degrees F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

2.6. PENETRATION SLEEVES

- 2.6.1. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.

PART 3 - EXECUTION

3.1. PIPE INSTALLATION

- 3.1.1. The pipe installation shall comply with the requirements of the Ontario Building Code part 7 and these specifications.
- 3.1.2. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment.
- 3.1.3. Provide and size venting to all plumbing fixtures and fixture groups in accordance to Ontario Water Resources Act, Plumbing Code most recent edition, and local authorities having jurisdiction.
- 3.1.4. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- 3.1.5. All pipe runs shall be laid out to avoid interference with other work.
- 3.1.6. The piping shall be installed above accessible ceilings where possible.
- 3.1.7. The piping shall be installed to permit valve servicing or operation.
- 3.1.8. The piping shall be installed free of sags and bends.
- 3.1.9. Seismic restraint shall be installed where required by code.

- 3.1.10. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- 3.1.11. Provide minimum slope of 1% for all horizontal sections larger than 100 mm (4") diam and 2% for all horizontal sections of 75 mm (3") or less. Buried drain lines and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- 3.1.12. Except for where a single sink is served, no buried sanitary line shall be less than 100 mm (4") diam. Run buried piping min 200 mm (8") below the bottom of concrete slabs.

3.2. JOINT CONSTRUCTION

- 3.2.1. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- 3.2.2. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- 3.2.3. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- 3.2.4. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
 - 3.2.4.1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service.
 - 3.2.4.2. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- 3.2.5. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.

- 3.2.6. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

3.3. SPECIALTY PIPE FITTINGS

- 3.3.1. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- 3.3.2. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.4. PIPE HANGERS, SUPPORTS AND ACCESSORIES

- 3.4.1. All piping shall be supported according to the requirement of Ontario Building Code and these specifications. Where conflicts arise between the code, these specifications and Section: 22 05 00 Common Work Results for Plumbing the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- 3.4.2. Hangers, supports, rods, inserts and accessories used for pipe supports shall be painted. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- 3.4.3. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- 3.4.4. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
 - 3.4.4.1. 40 mm or DN40 to 50 mm or DN50 (NPS 1-1/2 inch to NPS 2 inch): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
 - 3.4.4.2. 75 mm or DN75 (NPS 3 inch): 1500 mm (60 inches) with 15 mm (1/2 inch) rod.
 - 3.4.4.3. 100 mm or DN100 to 125 mm or DN125 (NPS 4 inch to NPS 5 inch): 1500 mm (60 inches) with 18 mm (5/8 inch) rod.
 - 3.4.4.4. 150 mm or DN150 to 200 mm or DN200 (NPS 6 inch to NPS 8 inch): 1500 mm (60 inches) with 20 mm (3/4 inch) rod.
 - 3.4.4.5. 250 mm or DN250 to 300 mm or DN300 (NPS 10 inch to NPS 12 inch): 1500 mm (60 inch) with 23 mm (7/8 inch) rod.
- 3.4.5. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.6 m (15 feet).
- 3.4.6. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, Floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:

- 3.4.6.1. Solid or split unplated cast iron.
 - 3.4.6.2. All plates shall be provided with set screws.
 - 3.4.6.3. Height adjustable clevis type pipe hangers.
 - 3.4.6.4. Adjustable floor rests and base flanges shall be steel.
 - 3.4.6.5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - 3.4.6.6. Riser clamps shall be malleable iron or steel.
 - 3.4.6.7. Rollers shall be cast iron.
 - 3.4.6.8. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING SYSTEMS, for requirements on insulated pipe protective shields at hanger supports.
 - 3.4.6.9. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
 - 3.4.6.10. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- 3.4.7. Penetrations:
- 3.4.7.1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
 - 3.4.7.2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant
- 3.4.8. Sanitary vents shall be extended separately through roof.

3.5. TESTS

- 3.5.1. Storm and sanitary waste and drain systems shall be tested either in third entirety or in sections.
- 3.5.2. If tests are required by an Authority Having Jurisdiction, perform tests in the presence of each governing authority and obtain certification. Repeat tests as often as necessary to obtain certification.
- 3.5.3. Tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
- 3.5.4. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in

sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.

- 3.5.5. For an air test, an air pressure of 34 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the air test.
- 3.5.6. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. APPLICABLE PUBLICATIONS..... 2

1.4. SUBMITTALS 2

1.5. FIXTURES AND TRIM 3

1.6. QUALITY ASSURANCE 3

1.7. WARRANTY 3

PART 2 - PRODUCTS 3

2.1. GENERAL..... 3

2.2. [LV-1] LAVATORY (WALL HUNG SINK WITH ELECTRONIC FAUCET) 4

2.3. [WC-1] FLOOR MOUNTED (TANK) WATER CLOSET 4

2.4. [S-1] TOP Mounted Slnk 5

PART 3 - EXECUTION 5

3.1. EXAMINATION AND PREPARATION 5

3.2. INSTALLATION OF FIXTURES 5

3.3. INSTALLATION OF WATER CLOSETS - STANDARD AND BARRIER FREE..... 6

3.4. INSTALLATION OF THERMOSTATIC MIXING VALVES (NON-EMERGENCY FIXTURES)..... 6

3.5. COMMISSIONING 7

3.6. ADJUSTING AND CLEANING..... 7

PART 1 - GENERAL

1.1. DESCRIPTION

1.1.1. This section specifies materials and installation for the following plumbing fixtures as applicable to the project:

- 1.1.1.1. Water closets
- 1.1.1.2. Lavatories, sinks, service sinks, and related Faucets and Trim
- 1.1.1.3. Emergency fixtures, Tempering Valve, Alarm System
- 1.1.1.4. Thermostatic Mixing valves

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 22 05 00 Common Work Results for Plumbing.
- 1.2.3. Section: 22 05 15 Plumbing Specialties and Accessories.
- 1.2.4. Section: 22 13 00 Facility Sanitary Sewerage.
- 1.2.5. Division 26 – Electrical.

1.3. APPLICABLE PUBLICATIONS

- 1.3.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.3.2. Do the work in accordance with CAN 3-B45 Series-M81 and CSA B125-1975 except where specified otherwise.
- 1.3.3. Ontario Building Code (OBC)
 - 1.3.3.1. Part 7 Plumbing

1.4. SUBMITTALS

- 1.4.1. Submittals, including number of required copies, shall be submitted in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Manufacturer's Literature and Data:
 - 1.4.2.1. Construction details, material descriptions, rated capacities, operating characteristics dimensions of individual components and profiles, and finishes for fixtures.
 - 1.4.2.2. Water consumption data.

1.4.2.3. Wiring diagrams for power, signal, and control wiring.

1.4.3. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:

1.4.4. Include complete list indicating all components of the systems.

1.4.5. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

1.5. FIXTURES AND TRIM

1.5.1. Architectural drawings to govern in determination of number and location of fixtures.

1.5.2. Fixtures to be product of one manufacturer.

1.5.3. Unless specified otherwise, trim to be product of one manufacturer.

1.6. QUALITY ASSURANCE

1.6.1. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

1.6.2. The Contractor shall verify and resolve compatibility between separate components (e.g. that lavatory hole quantity and centering match that of the specified faucet, supports are compatible with respective urinals and water closets, etc.). Model numbers, when provided, are partial model numbers for identifying style. Provide fixtures that meet all the specified requirements.

1.7. WARRANTY

1.7.1. Provide a complete part and labor warranty for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1. GENERAL

2.1.1. Plumbing fixtures shall be as indicated and specified with all required supports, accessories, wastes, vent and water connections as required to make the fixture complete and operational.

2.1.2. Unless specified otherwise, fixtures shall be in accordance with the Architect's color schedule.

- 2.1.3. Unless specified otherwise, all exposed valves, pipe, escutcheon, etc., shall be polished chrome finish.
- 2.1.4. Fixtures and trim shall be new and free of all defects or blemishes. Finished surfaces shall be clean, smooth, and bright guaranteed not to craze, change colour or scale. Imperfections of any kind shall be sufficient reason for rejection and the item shall be removed and an acceptable replacement installed at no additional cost.
- 2.1.5. Provide all lavatory hot and cold-water supply lines with a renewable disc, chromium plated lock shield stop valve.
- 2.1.6. Provide cast brass chrome plated escutcheon plates with set screws on all water and drain pipes where such lines pass through, floors, walls and partitions.
- 2.1.7. Protect fixtures with enamel or glazed surface from damage by covering or coating as recommended in the Bulletin "Handling & Care of Enameled C.I. Plumbing Fixtures".
- 2.1.8. Fixture type is specified below. Refer to plumbing drawings for fixture quantity.

2.2. [LV-1] LAVATORY (WALL HUNG SINK WITH ELECTRONIC FAUCET)

- 2.2.1. Basin: American Standard Lucerne Model 0355.012 (4" centers OR Eljer OR Crane, complete with wall carrier.
- 2.2.2. Waste and Trim: Sloan ETF-600-A-VPB-MIX60-A "Optima" electronic "no-touch" faucet with SS box, mixing valve and EL-154 120/24 volt transformer, McGuire #155A CP 32 mm (1.¼") cast plug with open grid strainer trap, McGuire #8872C CP 32mm (1.¼") cast "P" trap with cleanout escutcheon, McGuire H165LKN5 supplies. Carrier: Zurn ZX-1231 concealed fixture carrier with arms.
- 2.2.3. Thermostatic mixing valve: Delta Model R2570, installed in recess mount housing (box 10.13" (257 mm) high) c/w stainless steel cover.

2.3. [WC-1] FLOOR MOUNTED (TANK) WATER CLOSET

- 2.3.1. Standard of Acceptance: American Standard Cadet elongated right height toilet model 215A.A004.
- 2.3.2. Vitreous china, elongated bowl 16.5" high, low-consumption (6.0 Lpf/1.6 gpf) floor-mounted, Low consumption (6.0 Lpf/1.6 gpf) toilet. Trade exclusive tank c/w PowerWash® rim scrubs bowl with each flush. Robust metal trip lever & metal shank fill valve. Includes EZ-Install Tools w/color match bowl caps. EverClean® surface included; 3" flush valve; Fully-glazed 2-1/8" trapway; 10" or 12" (305mm) rough-in; Generous 9" x 8" water surface area; Chrome finish trip lever is supplied.
- 2.3.3. Nominal dimensions: 767 x 441 x 771mm (30-1/8" x 17-3/8" x 30-3/8").

2.3.4. Exceeds the Following Specifications: ASME A112.19.2-2008/CSA B45.1-08 for Vitreous China Fixtures.

2.3.5. Seat: Centoco 500STSCC (White) open front, less cover for elongated bowl, antimicrobial OR Bemis/Olsonite.

2.4. [S-1] TOP MOUNTED SINK

2.4.1. Basin: Steel Queen Model QDL2020-7-3, Finish Stainless Steel, Installation type Top mount. Steel Queen 20-in x 20.5-in Drop In Single Bowl 1 or 3-Hole Stainless Steel Kitchen Sink. Combining design and durability worthy of the Kindred Crown, Steel Queen sinks have been a homeowner's favorite for years. Widely regarded as some of the easiest-to-install sinks, these versatile drop in models are the top choice of many home renovators. The EZ Torque™ fastener system simplifies the installation of your sink by allowing you to drop and drill it into place, securely locking the sink to the countertop. Steel Queen sinks are made from durable 20-gauge stainless steel with a finish that will stand up to hard work, year in and year out

2.4.2. Alternative manufacturer: Franke

2.4.3. Faucet: Moen Adler single-handle kitchen faucet, Models 87604 and 87603, flexible supply lines with 3/8" compression fittings, Side Spray with direct connect onto valve body installation. Lever style handle, Temperature controlled by 100-degree arc of handle travel will operate with less than 5 lbs. of force. Aerator is limited to 1.5 gpm max (5.7 L/min). 1255 Duralast Cartridge, nonmetallic/nonferrous and stainless-steel material. Third part certified to ASME 112.18.1/ CSA B-125.1 and all applicable requirements certified to NSF 61/9 & 372.

PART 3 - EXECUTION

3.1. EXAMINATION AND PREPARATION

3.1.1. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

3.1.2. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.

3.1.3. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

3.2. INSTALLATION OF FIXTURES

3.2.1. Connect fixtures complete with supplies and drains, traps and cleanouts, supported level and square, such as to make them completely functional.

- 3.2.2. Hot water faucets shall be on left. Where indicated and applicable, supply and install the tempering valves in accordance with the manufacturer's instructions.
- 3.2.3. Provide venting for all plumbing fixtures as required by codes.
- 3.2.4. All barrier-free fixtures to be mounted at heights to be in accordance with all codes and local Authorities Having Jurisdiction.
- 3.2.5. Provide chrome plated flexible supplies to fixtures with screw driver stops, reducers and escutcheons.
- 3.2.6. All piping shall be recessed unless otherwise approved. Piping to be installed in recessed areas (such as under cabinetry, counters and other millwork or ceiling spaces) shall be run in neat parallel lines as tight as possible to walls and ceilings.
- 3.2.7. Provide ball isolation valves for connections to all fixtures.
- 3.2.8. All angle valves for fixtures shall be chrome plated.
- 3.2.9. All sanitary drains visible under the counter shall be either chromed or painted to match the color of the wall behind.

3.3. INSTALLATION OF WATER CLOSETS - STANDARD AND BARRIER FREE

- 3.3.1. Mounting Heights:
- 3.3.2. Water closets - standard: 15 in. to 17 in. from top of toilet seat to finished floor.
- 3.3.3. Water closets - barrier free: 17 in. from top of toilet seat to finished floor.
- 3.3.4. Flush Valve: Mount flush valve handle on wide side of stall or room.
- 3.3.5. Apply dual flush instruction plates to wall centered above flushometer.
- 3.3.6. Install toilet seats on water closets.

3.4. INSTALLATION OF THERMOSTATIC MIXING VALVES (NON-EMERGENCY FIXTURES)

- 3.4.1. Install in a location readily accessible for cleaning, adjustment, and valve/cartridge replacement.
- 3.4.2. Install mixing valve after checks and stops are installed. Thoroughly flush all piping immediately prior to mixing valve installation.
- 3.4.3. Install isolation valves on the hot and cold water inlet pipe connections, near the mixing valve.

3.4.4. Install check valves between the mixing valve and the mixing valve isolation valves. These check valves are in addition to the mixing valve's integral check valves.

3.4.5. Adjust valve temperature set point to 110 deg. F, following manufacturer's adjustment instructions.

3.5. COMMISSIONING

3.5.1. Perform the commissioning activities as outlined in the Division 01 Section for Commissioning and other requirements of the Contract Documents.

3.6. ADJUSTING AND CLEANING

3.6.1. Flush all water closets and urinals and verify performance. Adjust or clean flush valves to produce proper flow.

3.6.2. Back-flush shower heads, faucet aerators/spray heads, and in-line strainers at electric water coolers, emergency fixtures, and wherever installed, and reinstall.

3.6.3. Adjust pop-up drains for proper operation.

3.6.4. Adjust eyewashes to provide proper flow.

3.6.5. Adjust shower control valve limit stops to deliver maximum 120 deg. water.

3.6.6. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise or overflow.

3.6.7. Replace dead batteries in sensor operated flush valves and faucets. Adjust sensor operation to satisfaction of commissioner.

3.6.8. At completion of project, remove excess caulk and sealants and clean plumbing fixtures and equipment.

TABLE OF CONTENTS

PART 1 - GENERAL	4
1.1. DESCRIPTION	4
1.2. DEFINITIONS	4
1.3. RELATED WORK	4
1.4. QUALITY ASSURANCE	4
1.5. PRODUCTS CRITERIA.....	4
1.6. EQUIPMENT SERVICE ORGANIZATIONS	5
1.7. EXECUTION (INSTALLATION, CONSTRUCTION) QUALITY	5
1.8. DUTIES OF MECHANICAL CONTRACTOR.....	5
1.9. COMMISSIONING	6
1.10. SCHEDULING OF WORK	7
1.11. INTENT	7
1.12. INTERFERENCES	8
1.13. EXAMINE SITE	9
1.14. INTERFERENCE AND SLEEVING DRAWINGS.....	9
1.15. WARRANTY	9
1.16. SUBMITTALS	10
1.17. MATERIALS AND STANDARDS OF ACCEPTANCE	11
1.18. MATERIAL SUBSTITUTIONS.....	11
1.19. CODES, PERMITS, FEES AND CONNECTIONS	12
1.20. CONSULTANT'S INSTRUCTIONS	12
1.21. ADDITIONAL WORK AND CHANGES	12
1.22. DELIVERY, STORAGE AND HANDLING.....	12
1.23. HAULING OPERATIONS	13
1.24. JOB CONDITIONS – WORK IN EXISTING BUILDING	13
PART 2 - PRODUCTS	14
2.1. FACTORY-ASSEMBLED PRODUCTS.....	14
2.2. COMPATIBILITY OF RELATED EQUIPMENT	15
2.3. BELT DRIVES.....	15
2.4. DRIVE GUARDS	16

2.5.	LIFTING ATTACHMENTS.....	16
2.6.	EQUIPMENT REQUIREMENTS AND INSTALLATION	16
2.7.	ELECTRIC MOTORS.....	17
2.8.	VARIABLE SPEED MOTOR CONTROLLERS	17
2.9.	EQUIPMENT AND MATERIALS IDENTIFICATION	18
2.10.	FIRESTOPPING	18
2.11.	GALVANIZED REPAIR COMPOUND	19
2.12.	HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS	19
2.13.	PIPE PENETRATIONS – ROOFS	21
2.14.	PIPE PENETRATIONS THROUGH INTERIOR BUILDING ELEMENTS	21
2.15.	DUCT PENETRATIONS - ROOFS.....	22
2.16.	DUCT PENETRATIONS – INTERIOR BUILDING ELEMENTS	23
2.17.	SPECIAL TOOLS AND LUBRICANTS	23
2.18.	WALL, FLOOR AND CEILING PLATES	23
PART 3 -	EXECUTION	23
3.1.	ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING.....	24
3.2.	THERMOMETERS AND PRESSURE GAUGES	24
3.3.	EQUIPMENT AND PIPING SUPPORT	25
3.4.	ITEMS NOT SHOWN BUT REQUIRED.....	25
3.5.	PROTECTION AND CLEANING	25
3.6.	WORK IN EXISTING BUILDING.....	26
3.7.	TEMPORARY PIPING AND EQUIPMENT	26
3.8.	RIGGING.....	27
3.9.	PIPE AND EQUIPMENT SUPPORTS.....	27
3.10.	CLEANING AND PAINTING	29
3.11.	IDENTIFICATION SIGNS	30
3.12.	MOTOR AND DRIVE ALIGNMENT	30
3.13.	LUBRICATION	30
3.14.	CONCRETE.....	30
3.15.	METALS	30
3.16.	CUTTING, PATCHING, ROOFING, AND X-RAY	30

3.17. OPERATING AND MAINTENANCE MANUALS 31

3.18. CLOSE-OUT DOCUMENTATION 31

3.19. COMMISSIONING 31

3.20. STARTUP AND TEMPORARY OPERATION 32

3.21. OPERATING AND PERFORMANCE TESTS 32

3.22. INSTRUCTIONS TO BOARD PERSONNEL 32

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. The requirements of this Section apply to all sections of Division 23.

1.2. DEFINITIONS

- 1.2.1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
- 1.2.2. Option or optional: Contractor's choice of an alternate material or method.

1.3. RELATED WORK

- 1.3.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.3.2. Section: 22 05 53 Identification for Plumbing Piping and Equipment.
- 1.3.3. Section: 23 05 13 Common Motor Requirements for HVAC Equipment.
- 1.3.4. Section: 23 05 48 Vibration and Seismic Controls for HVAC.
- 1.3.5. Section: 23 05 93 Testing, Adjusting and Balancing For HVAC.
- 1.3.6. Section: 23 07 00 HVAC Insulation.

1.4. QUALITY ASSURANCE

- 1.4.1. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC.

1.5. PRODUCTS CRITERIA

- 1.5.1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.

- 1.5.2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
- 1.5.3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Consultant.
- 1.5.4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- 1.5.5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- 1.5.6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
- 1.5.7. Asbestos products or equipment or materials containing asbestos shall not be used.

1.6. EQUIPMENT SERVICE ORGANIZATIONS

- 1.6.1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located within 50 miles to the site.
- 1.6.2. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
 - 1.6.2.1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
 - 1.6.2.2. Comply with provisions of ASME B31 series "Code for Pressure Piping".

1.7. EXECUTION (INSTALLATION, CONSTRUCTION) QUALITY

- 1.7.1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the Consultant for resolution.
- 1.7.2. Provide complete layout drawings, schematics, diagrams, sections, notes and specifications as required to allow for competitive bidding and construction. Do not commence construction work on any system until the layout drawings have been approved.

1.8. DUTIES OF MECHANICAL CONTRACTOR

1.8.1. The mechanical contractor shall assume the responsibilities and duties of a general contractor including but not limited to the ones described below:

1.8.1.1. Superintendence

- 1.8.1.1.1. Provide full time on-site superintendent personnel and supporting staff with proven experience in project of similar value and complexity.
- 1.8.1.1.2. Site superintendent shall have over-all authority to speak for and represent the mechanical contractor.

1.8.1.2. Coordination

- 1.8.1.2.1. Coordinate the work with all the sub-trades involved to ensure that the work will be carried out on schedule and in proper sequence.
- 1.8.1.2.2. Take complete responsibility for all remedial work that results from failure to coordinate any aspect of the mechanical work prior to its fabrication and/or installation.
- 1.8.1.2.3. Take responsibility for the delivery of equipment necessary to complete the work in accordance with the approved schedule.

1.8.1.3. Staffing and Scheduling

- 1.8.1.3.1. Within seven days after the award of the contract, the Mechanical Contractor shall provide to the Board representative the following information:
 - Appointment of official representatives in the project.
 - Schedule of work.
 - Delivery schedule for specified equipment.
 - Requirements for temporary facilities, site signs, storage, etc.

1.8.1.4. Work Completion Meeting

- 1.8.1.4.1. Prior to application for Substantial Performance of the Work, the mechanical contractor shall participate in the take-over meeting. Agenda to include the following:
 - Review of outstanding deficiencies.
 - Submission of maintenance manuals, warranties and as-built drawings.
 - Results of performance tests and described further in this section.
 - Scheduling of training to Board's personnel.

1.9. COMMISSIONING

1.9.1. The Board may at its discretion use a third party as a commissioning agent for the construction portion of the work. The requirement for commissioning shall be included in the front-end documents of the bidders' package.

1.9.2. If commissioning is included, the contractor shall provide all manpower and will take into account all the hours required to participate in the commissioning process including meetings with the commissioning agent, completion of forms and check-lists,

verifications, simulations, rectifications of deficiencies and other activities associated with the commissioning process.

1.10. SCHEDULING OF WORK

- 1.10.1. For all work to be performed under this contract, adhere to Construction Schedule agreed upon with the Board.

1.11. INTENT

- 1.11.1. Bidders for this work shall include for all labor, material, equipment and all other related cost including all applicable taxes (except HST) and fees to provide the work as indicated on the drawings.
- 1.11.2. Misinterpretation of any requirement of the drawings and specifications will not relieve the Mechanical Contractor of responsibility. If in any doubt, the Mechanical Contractor shall contact the Consultant for written clarification prior to submitting a bid for the Work.
- 1.11.3. The scope of work for this project includes but is not limited to:

1.11.3.1. New Layout Work

- 1.11.3.1.1. The installation of new wall-fin convectors c/w accessories, new control valves, and hydronic (HWS & HWR) piping.
- 1.11.3.1.2. Installation of new mini split system (wall mounted evaporator unit and outdoor condenser) c/w accessories for new elevator machine room. All associated refrigerant piping to be included.
- 1.11.3.1.3. New ceiling mounted exhaust fan for new washroom to be provided. Wall box termination with birdscreen to be included.
- 1.11.3.1.4. The installation of new ducted ceiling mounted VRF (fancoil unit) and associated outdoor condenser serving the new office spaces.
- 1.11.3.1.5. All new ductwork and supports to be provided for new mechanical equipment. All seismic restraints and bracing for non-structural components in accordance with applicable requirements of OBC, including clause 4.1.8.18 and standards referenced within. All seismic restraint requirements shall be coordinated with architect and structural engineer.
- 1.11.3.1.6. All new diffusers and grilles to be provided as indicated on the drawings.
- 1.11.3.1.7. New ERV unit and electric duct heaters to be provided.
- 1.11.3.1.8. New transfer ducts to be provided as per drawings.
- 1.11.3.1.9. New exhaust air and outdoor air louvers to be provided as indicated per drawings.
- 1.11.3.1.10. All new refrigerant piping for new equipment to be provided.
- 1.11.3.1.11. All new fire dampers to be provided as indicated per drawings.
- 1.11.3.1.12. All new piping and ductwork insulation to be provided.

- 1.11.3.1.13. All new thermostats and control devices for new mechanical equipment to be provided.
- 1.11.3.1.14. All new isolation and balancing valves to be provided for new and existing equipment as indicated per drawings.
- 1.11.3.1.15. Flush and fill hydronic loops as required for system.
- 1.11.3.1.16. At the conclusion of the work and installation of the new wall-fin convectors, drain and re-fill the hot water loops and deaerate system completely. flush all piping as required and specified and provide chemical treatment necessary. pressure testing of the new installation is required.
- 1.11.3.1.17. Dog house for new refrigerant/conduit penetrations through roof to be provided.
- 1.11.3.1.18. Relocation of all equipment, piping, and devices to be completed as per issued drawings.
- 1.11.3.1.19. All new motorized dampers to be provided as indicated per drawings.

1.12. INTERFERENCES

- 1.12.1. The mechanical drawings do not show all the architectural and structural details, and any information involving accurate measuring of the building shall be taken from the building drawings or at the building. Make without additional charge, any necessary changes or additions to the runs of drains, pipes, ducts, etc., to accommodate the above conditions. The location of equipment may be altered without charge providing the change is made before installation and does not necessitate major additional material.
- 1.12.2. Wherever differences occur between specifications, riser diagrams or schematics and drawings, the maximum conditions shall govern and the bid shall be based on whichever information indicates the greater cost.
- 1.12.3. Field verifications of dimensions on plans shall be made since actual locations, distances, and levels will be governed by actual field conditions.
- 1.12.4. Discrepancies between different plans, or between plans and actual field conditions, or between plans and specifications shall promptly be brought to the attention of the Consultant for a decision.
- 1.12.5. Install all mechanical services including but not exclusive to drains, pipes, and ducts, to conserve headroom and interfere as little as possible with the free use of the space through which they pass. All drains, pipes, ducts, etc., particularly those which may interfere with the inside treatment of the building, or conflicting with other trades, shall be installed only after the locations have been approved by the Consultant. Special care shall be taken in the installation of all mechanical services including, but not exclusive to drains, pipes, and ducts, which are to be concealed, to see that they come within the finished lines of floors, walls, and ceilings. Where such drains, pipes, ducts, etc., have been

installed in such a manner as to cause interference, they shall be removed and re installed in suitable locations without extra cost to the Board.

- 1.12.6. Before commencing work, check and verify all grade and invert elevations, stacks, levels, and dimensions, to ensure proper and correct installation of the work.
- 1.12.7. In every place where there is space indicated as reserved for future or other equipment, leave such space clear, install blank offs, shut off valves with blind flanges and other work so that the necessary connections can be made without any stoppages to the system. Consult with the consultant whenever necessary for this purpose.
- 1.12.8. In addition to the work specifically mentioned in the Specifications and shown on the drawings, provide all other items that are obviously necessary to make a complete working installation, including those required by the Authorities Having Jurisdiction over the work.
- 1.12.9. The mechanical plans show approximate locations for wall mounted devices. Obtain Consultant's approval of mounting heights and locations before commencement of work.

1.13. EXAMINE SITE

- 1.13.1. Examine the site and the local conditions affecting the work prior to submission of the tender price. Examine carefully all drawings and the complete specifications to ensure that the work can be satisfactorily carried out as shown. No allowance will be made later for any expenses incurred through the failure to make these examinations or to report any such discrepancies in writing to the Consultant.

1.14. INTERFERENCE AND SLEEVING DRAWINGS

- 1.14.1. Submit complete consolidated and coordinated interference drawings for all new air handling systems, and for existing systems that are in the same areas.
- 1.14.2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:200. Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, ductwork, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
- 1.14.3. Do not install equipment foundations, equipment, ductwork or piping until interference drawings have been approved.

1.15. WARRANTY

1.15.1. All work completed under this contract shall carry a min. 1-year warranty (labour and material) from the date of substantial completion.

1.15.2. **All equipment supplied under this contract shall carry a 1-year warranty.** Where certain equipment specifications call for a for a longer warranty on certain components, the longest period shall apply.

1.16. SUBMITTALS

1.16.1. Submit documentation in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples, and with requirements in the individual specification sections.

1.16.2. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

1.16.3. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

1.16.4. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

1.16.5. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient.

1.16.6. Manufacturer's Literature and Data:

1.16.6.1. Submit all information pertaining to the performance and capacity of the equipment.

1.16.6.2. Submit all information pertaining to methods of connection to piping and ductwork, electrical wiring, controls and noise generated by the equipment (as applicable to the project).

1.16.6.3. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Consultant.

1.16.6.4. Submit electric motor data and variable speed drive data with the driven equipment.

1.16.6.5. Equipment and materials identification.

1.16.6.6. Fire-stopping materials.

1.16.6.7. Hangers, inserts, supports and bracing, for both indoor and outdoor installations. Where applicable, provide load ratings and deflection for spring supports and hangers.

1.16.6.8. Wall, floor, and ceiling plates.

1.16.7. HVAC Maintenance Data and Operating Instructions:

1.16.7.1. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

1.16.7.2. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

1.17. MATERIALS AND STANDARDS OF ACCEPTANCE

1.17.1. Where materials, equipment, apparatus, or other products are specified by the manufacturer, brand name, type or catalogue number, such designation is to establish standards of desired quality style or dimensions and shall be the basis of the Bid. Materials so specified shall be furnished under this Contract.

1.17.2. Where two or more designations are listed, the contractor shall choose one of those listed and state the choice made on the Bid Form (where applicable). *Note that the basis of design equipment has specific physical characteristics in terms of footprint and clearances requirements. Inclusion of a manufacturer other than the one for the Basis of Design in the Standard of Acceptance is not an automatic approval for submission of equipment which cannot be installed due to specific site conditions.*

1.17.3. *Should the contractor select a approved alternate manufacturer, the contractor remains responsible for all structural, electrical, and mechanical adjustments necessary to install the new equipment.*

1.18. MATERIAL SUBSTITUTIONS

1.18.1. After execution of the Contract, requests for substitution of materials or makes other than those specifically named in the Contract Documents may be reviewed and approved by the Consultant, subject to Board's review and acceptance of the financial credits involved.

1.18.2. In the absence of such express approval by the Consultant, the Mechanical Contractor will be held to furnish specified items under the base bid as the standard of acceptance.

1.18.3. If equipment is submitted which differs in arrangement from that specified/shown on the documents, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

1.19. CODES, PERMITS, FEES AND CONNECTIONS

- 1.19.1. Conform to Federal, Provincial and Municipal regulations and perform work in accordance with requirements of By Laws and Regulations in force in area where the building is to be erected.
- 1.19.2. Apply for, obtain, and pay for all permits, fees and service connections for the work and the inspections required by Authorities Having Jurisdiction in the area where the work will take place
- 1.19.3. Where applicable, apply for, obtain, and pay for all permits, fees and service connections for the work and the inspections required by Authorities Having Jurisdiction in the area where the work will take place, including TSSA and ESA. Where applicable, have the work inspected and certified by PV [Boilers and Pressure Vessels Reg], OE [Operating Engineers Reg.] and FS [Fuel Safety Reg.] branches of TSSA. At the end of the work, the new plant shall be fully TSSA certified.
- 1.19.4. For information, a specific code or standard might be mentioned. This information must not be taken as the only code or standard applicable.
- 1.19.5. When part of equipment does not bear the required CSA label, the contractor shall obtain from CSA or Hydro Electric Power Commission, when that part of the equipment is an electric component, a special approval and pay the applicable fees.
- 1.19.6. Furnish necessary certificates as evidence that the work installed conforms with laws and regulations of Authorities having jurisdiction. Changes in work requested by an Authority having jurisdiction shall be carried out without charge.

1.20. CONSULTANT'S INSTRUCTIONS

- 1.20.1. During construction the Consultant will issue such instructions as may be necessary for verification and correction of the work. These instructions shall be binding as part of the specification.

1.21. ADDITIONAL WORK AND CHANGES

- 1.21.1. Unless a written order, reviewed by the Consultant and countersigned or otherwise approved by the Board Representative, no additional work shall be undertaken by the Contractor.

1.22. DELIVERY, STORAGE AND HANDLING

- 1.22.1. Protection of Equipment:
 - 1.22.1.1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Board has reimbursed

the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

- 1.22.1.2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Consultant. Such repair or replacement shall be at no additional cost to the Board.
- 1.22.1.3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
- 1.22.1.4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

1.22.2. Cleanliness of Piping and Equipment Systems:

- 1.22.2.1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
- 1.22.2.2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
- 1.22.2.3. Clean interior of all tanks prior to delivery for beneficial use by the Board.
- 1.22.2.4. Boilers shall be left clean following final internal inspection by Board insurance representative or inspector.
- 1.22.2.5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.23. HAULING OPERATIONS

- 1.23.1. Maintain roadways and paving in the hauling areas clean on a daily basis and as required by Municipal Authorities.
- 1.23.2. Parking is not ample or readily available in the area where the building is located. Coordinate delivery of equipment with the Board representatives.
- 1.23.3. Contractor is responsible for all craning & lifting operations. It is the Contractor's responsibility to coordinate with the respective Municipality & pay/obtain all required permits.
- 1.23.4. Contractor is responsible for providing a craning plan for review & approval by the Client.

1.24. JOB CONDITIONS – WORK IN EXISTING BUILDING

- 1.24.1. Building Operation: Board employees will be continuously operating and managing all facilities, including temporary facilities, that serve the building.

- 1.24.2. Maintenance of Service: Schedule all work to permit continuous service as required by the Board.
- 1.24.3. Services Interruptions: Limited service interruptions, as required for interconnections of new and existing systems, will be coordinated with the Board and permitted by the Board during the agreed-upon schedule of interruption. Provide at least one week advance notice to the Board representatives.
- 1.24.4. Phasing of Work: Comply with all requirements shown on drawings or specified.
- 1.24.5. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean up of construction and demolition debris on all floor surfaces and on all equipment being operated by the Board.
- 1.24.6. Acceptance of Work for Board Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Board, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Consultant will process necessary acceptance and the equipment will then be under the control and operation of Board personnel.

PART 2 - PRODUCTS

2.1. FACTORY-ASSEMBLED PRODUCTS

- 2.1.1. Provide maximum standardization of components to reduce spare part requirements.
- 2.1.2. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
- 2.1.3. All components of an assembled unit need not be products of same manufacturer.
- 2.1.4. Constituent parts that are alike shall be products of a single manufacturer.
- 2.1.5. Components shall be compatible with each other and with the total assembly for intended service.
- 2.1.6. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- 2.1.7. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a

conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

- 2.1.8. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.2. COMPATIBILITY OF RELATED EQUIPMENT

- 2.2.1. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

2.3. BELT DRIVES

- 2.3.1. Type: ANSI/RMA standard V belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- 2.3.2. Dimensions, rating and selection standards: ANSI/RMA IP 20 and IP 21.
- 2.3.3. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.
- 2.3.4. Maximum Speed: 25 m/s (5000 feet per minute).
- 2.3.5. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take up.
- 2.3.6. Drives may utilize a single V Belt (any cross section) when it is the manufacturer's standard.
- 2.3.7. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- 2.3.8. Sheaves and Pulleys:
 - 2.3.8.1. Material: Pressed steel, or close grained cast iron.
 - 2.3.8.2. Bore: Fixed or bushing type for securing to shaft with keys.
 - 2.3.8.3. Balanced: Statically and dynamically.
 - 2.3.8.4. roove spacing for driving and driven pulleys shall be the same.
 - 2.3.8.5. Drive Types, Based on ARI 435.
- 2.3.9. Provide adjustable pitch or fixed pitch drive as follows:
 - 2.3.9.1. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.

- 2.3.9.2. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
- 2.3.9.3. Provide fixed pitch drives for drives larger than those listed above.

2.3.10. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable pitch motor sheave or by fan law calculation if a fixed pitch drive is used initially.

2.4. DRIVE GUARDS

- 2.4.1. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- 2.4.2. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- 2.4.3. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- 2.4.4. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- 2.4.5. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

2.5. LIFTING ATTACHMENTS

- 2.5.1. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.6. EQUIPMENT REQUIREMENTS AND INSTALLATION

- 2.6.1. Permit equipment maintenance and disassembly by use of unions or flanges to minimize disturbance to connecting piping and duct systems and without interference from building structure or other equipment.
- 2.6.2. Provide accessible means for lubricating equipment including permanent lubricated bearings.

- 2.6.3. For all base mounted boilers, pumps, compressors, air handling units, fans and other rotating equipment, provide chamfered edge housekeeping pads a minimum of 4" high and 4" larger than equipment dimensions all around. Work shall be performed by the trades specializing in this work.
- 2.6.4. Pipe drain lines, overflows and safety relief vents to drains. If the horizontal drains present a tripping hazard, use aluminum checkered plate covers.
- 2.6.5. Line up equipment, rectangular cleanouts and similar items with building walls wherever possible.

2.7. ELECTRIC MOTORS

- 2.7.1. All material and equipment furnished and installation methods shall conform to the requirements of Section: 23 05 13 Common Motor Requirements for HVAC Equipment, and Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables, Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

2.8. VARIABLE SPEED MOTOR CONTROLLERS

- 2.8.1. Refer to Section: 26 05 00 Common Work Results for Electrical and for specifications.
- 2.8.2. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.
- 2.8.3. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- 2.8.4. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
- 2.8.5. Controller shall be provided with the following operating features and accessories:
 - 2.8.5.1. Suitable for variable torque load.
 - 2.8.5.2. Provide thermal magnetic circuit breaker or fused switch with external operator and incoming line fuses. Provide output line reactors on line between drive and motor for motors over 50 HP or where the distance between the breaker and motor exceeds 50 feet.

2.9. EQUIPMENT AND MATERIALS IDENTIFICATION

2.9.1. Refer to Section: 23 05 53 Identification for HVAC Piping and Equipment.

2.10. FIRESTOPPING

2.10.1. Provide either factory built (Firestop Devices) or field installed (through-Penetration Firestop Systems) to form a specific building system maintaining required integrity of the fire barrier and stop the passage of gases or smoke. Firestop systems to accommodate building movements without impairing their integrity.

2.10.2. Through-penetration firestop systems and firestop devices tested in accordance with ASTM E814 or UL 1479 using the "F" or "T" rating to maintain the same rating and integrity as the fire barrier being sealed. "T" ratings are not required for penetrations smaller than or equal to 101 mm (4 inches) nominal pipe or 0.01 square meter (16 square inches) in overall cross sectional area.

2.10.3. Firestop sealants used for firestopping or smoke sealing to have the following properties:

- 2.10.3.1. Contain no flammable or toxic solvents.
- 2.10.3.2. Release no dangerous or flammable out gassing during the drying or curing of products.
- 2.10.3.3. Water-resistant after drying or curing and unaffected by high humidity, condensation or transient water exposure.
- 2.10.3.4. When installed in exposed areas, capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.

2.10.4. Firestopping system or devices used for penetrations by glass pipe, plastic pipe or conduits, unenclosed cables, or other non-metallic materials to have following properties:

- 2.10.4.1. Classified for use with the particular type of penetrating material used.
- 2.10.4.2. Penetrations containing loose electrical cables, computer data cables, and communications cables protected using firestopping systems that allow unrestricted cable changes without damage to the seal.

2.10.5. Maximum flame spread of 25 and smoke development of 50 when tested in accordance with ASTM E84 or UL 723. Material to be an approved firestopping material as listed in UL Fire Resistance Directory or by a nationally recognized testing laboratory.

2.10.6. FM, UL, or WH rated or tested by an approved laboratory in accordance with ASTM E814.

2.10.7. Materials to be nontoxic and noncarcinogen at all stages of application or during fire conditions and to not contain hazardous chemicals. Provide firestop material that is free from Ethylene Glycol, PCB, MEK, and asbestos.

2.10.8. For firestopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.

- 2.10.8.1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
- 2.10.8.2. For floor penetrations with annular spaces exceeding 101 mm (4 inches) or more in width and exposed to possible loading and traffic, provide firestop systems capable of supporting the floor loads involved either by installing floor plates or by other means acceptable to the firestop manufacturer.
- 2.10.8.3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

2.11. GALVANIZED REPAIR COMPOUND

- 2.11.1. Mil. Spec. DOD P 21035B, paint form.

2.12. HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- 2.12.1. Vibration Isolators: Refer to Section: 23 05 48 Vibration and Seismic Controls for HVAC.

- 2.12.2. Supports for Roof Mounted Items:

- 2.12.2.1. Equipment: Refer to details on mechanical and structural drawings.
- 2.12.2.2. Pipe Supports: Refer to details on the drawings.
- 2.12.2.3. Supports for Indoor Mounted Items

- 2.12.2.3.1. Attachment to Concrete Building Construction:

- Concrete insert: MSS SP-58, Type 18.
- Self drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Consultant for each job condition.
- Power driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Consultant for each job condition.

- 2.12.2.3.2. Attachment to Steel Building Construction:

- Welded attachment: MSS SP 58, Type 22.
- Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C clamp may be used for individual copper tubing up to 23mm (7/8 inch) outside diameter.

- 2.12.2.3.3. Attachment to existing structure: Support from existing floor/roof frame

- Attachment to Wood Construction: Wood screws or lag bolts.

- Hanger Rods: Hot rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP 58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn buckles shall provide 38 mm (1 1/2 inches) minimum of adjustment and incorporate locknuts. All thread rods are acceptable.

2.12.2.3.4. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1 5/8 inches by 1 5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.

2.12.2.3.5. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).

2.12.2.3.6. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4 inch) U bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2 inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.

2.12.3. Supports for Piping Systems:

- 2.12.3.1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11 for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or pre-insulated calcium silicate shields. Provide Type 40 insulation shield or pre-insulated calcium silicate shield at all other types of supports and hangers including those for pre-insulated piping.

2.12.4. Piping Systems (MSS SP 58):

- 2.12.4.1. Standard clevis hanger: Type 1; provide locknut.
2.12.4.2. Riser clamps: Type 8.
2.12.4.3. Wall brackets: Types 31, 32 or 33.
2.12.4.4. Roller supports: Type 41, 43, 44 and 46.
2.12.4.5. Saddle support: Type 36, 37 or 38.
2.12.4.6. Turnbuckle: Types 13 or 15. Preinsulate.
2.12.4.7. U bolt clamp: Type 24.

2.12.5. Copper Tube:

- 2.12.5.1. Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non-adhesive isolation tape to prevent electrolysis.
2.12.5.2. For vertical runs use epoxy painted or plastic coated riser clamps.
2.12.5.3. For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.

2.12.6. Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.

2.12.7. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.

2.12.8. Piping with Vertical Expansion and Contraction:

2.12.8.1. Movement up to 20 mm (3/4 inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.

2.12.8.2. Movement more than 20 mm (3/4 inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.

2.12.8.3. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.

2.12.9. For pipe sizes larger than (50 mm) 2-inches:

2.12.9.1. Pre-insulated Calcium Silicate Shields:

2.12.9.1.1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.

2.12.9.1.2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.

2.12.9.1.3. Shield thickness shall match the pipe insulation.

2.12.9.1.4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.

2.12.9.1.5. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.

2.12.9.1.6. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.

2.12.9.1.7. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces

2.13. PIPE PENETRATIONS – ROOFS

2.13.1. Refer to details on the drawings

2.14. PIPE PENETRATIONS THROUGH INTERIOR BUILDING ELEMENTS

2.14.1. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.

2.14.2. To prevent accidental liquid spills from passing to a lower level, provide the following:

- 2.14.2.1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
- 2.14.2.2. For blocked out floor openings: Provide 40 mm (1½ inch) angle set in silicone adhesive around opening.
- 2.14.2.3. For drilled penetrations: Provide 40 mm (1½ inch) angle ring or square set in silicone adhesive around penetration.

2.14.3. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Consultant.

2.14.4. Sheet Metal, Plastic, or Moisture resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

2.14.5. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.

2.14.6. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.

2.14.7. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.

2.14.8. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.

2.14.9. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

2.15. DUCT PENETRATIONS - ROOFS

2.15.1. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.

2.15.2. Refer to details on mechanical and structural drawings.

2.16. DUCT PENETRATIONS – INTERIOR BUILDING ELEMENTS

2.16.1. Provide sheet metal sleeves min 150 mm (6") raised above the penetrated floors. Seal space between sleeves and ducts.

2.16.2. For penetrations through fire rated building elements, refer to details on the drawings.

2.16.3. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly.

2.17. SPECIAL TOOLS AND LUBRICANTS

2.17.1. Furnish, and turn over to the Board, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

2.17.2. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

2.17.3. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.

2.17.4. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Consultant.

2.17.5. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.18. WALL, FLOOR AND CEILING PLATES

2.18.1. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

2.18.2. Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3 inch pipe), 0.89 mm (0.035-inch) for larger pipe.

2.18.3. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

PART 3 - EXECUTION

3.1. ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- 3.1.1. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the interference drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- 3.1.2. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, temperature but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.

3.2. THERMOMETERS AND PRESSURE GAUGES

3.2.1. General:

- 3.2.1.1. Locate direct reading thermometers and gauges for reading from floor or platform.
- 3.2.1.2. Provide remote reading thermometers and gauges where direct reading instruments cannot be satisfactorily located.
- 3.2.1.3. Locate engraved lamacoid nameplate as specified in Section Identification, identifying medium adjacent to thermometers and gauges.

3.2.2. Thermometers:

- 3.2.2.1. Industrial, 9" adjustable angle cast aluminum case, CGSB standard CAN/CGSB-14.4-M88 red reading mercury, lens front tube, white scale black embossed figures, clear glass or acrylic window, tapered aluminum stem.
- 3.2.2.2. Scale shall be suitable for 2 times the temperature range of service. Scale shall be combined Celsius and Fahrenheit.
- 3.2.2.3. Standard of Acceptance: Weiss, Ashcroft, Terice.

3.2.3. Pressure Gauges:

- 3.2.3.1. 5" dial, solid front blow out back, fiberglass reinforced polypropylene case, phosphor bronze bourdon tube and brass 1/4" N.P.T. socket, bottom connection, stainless steel rotary type movement, gauge to be registered with the Provincial Boiler and Pressure Vessel Safety Branch with a registration number and conform to ANSI B40.1. Accuracy to be grade "A".

- 3.2.3.2. On pumps liquid filled gauges shall be utilized.
- 3.2.3.3. Standard of Acceptance: Weiss, Ashcroft, Terice.
- 3.2.3.4. Provide bronze stop cock, bronze bar stock ¼" N.P.T. bronze porous core pressure snubber for pulsating operation and diaphragm for corrosive service.
- 3.2.3.5. Use materials compatible with system requirements.

3.2.4. Gauges shall have combined kilopascal and psi scales.

3.3. EQUIPMENT AND PIPING SUPPORT

- 3.3.1. Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- 3.3.2. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- 3.3.3. Cutting Holes:
 - 3.3.3.1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Consultant where working area space is limited.
 - 3.3.3.2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Consultant. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Consultant for approval.
 - 3.3.3.3. Do not penetrate membrane waterproofing.

3.4. ITEMS NOT SHOWN BUT REQUIRED

- 3.4.1. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- 3.4.2. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- 3.4.3. Electrical and Pneumatic Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

3.5. PROTECTION AND CLEANING

- 3.5.1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the

manufacturer's recommendations and as approved by the Consultant. Damaged or defective items in the opinion of the Consultant, shall be replaced.

- 3.5.2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

3.6. WORK IN EXISTING BUILDING

- 3.6.1. Make alterations to existing service piping at times that will least interfere with normal operation of the facility.
- 3.6.2. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Board. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Consultant for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Consultant's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
- 3.6.3. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 ft.) above the equipment to ceiling structure, whichever is lower (NFPA 70).
- 3.6.4. Inaccessible Equipment:
 - 3.6.4.1. Where the Board determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Board.
 - 3.6.4.2. The term "conveniently accessible" is defined as capable of being reached without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.7. TEMPORARY PIPING AND EQUIPMENT

- 3.7.1. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- 3.7.2. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
- 3.7.3. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

3.8. RIGGING

- 3.8.1. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- 3.8.2. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Board under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- 3.8.3. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Board operation and maintenance of service.
- 3.8.4. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Board will check structure adequacy and advise Contractor of recommended restrictions.
- 3.8.5. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- 3.8.6. Rigging plan and methods shall be referred to Consultant for evaluation prior to actual work.
- 3.8.7. Restore building to original condition upon completion of rigging work.

3.9. PIPE AND EQUIPMENT SUPPORTS

- 3.9.1. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Consultant.

- 3.9.2. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- 3.9.3. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work.
- 3.9.4. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP 69. Provide additional supports at valves, strainers, in line pumps and other heavy components. Provide a support within one foot of each elbow.
- 3.9.5. HVAC Vertical Pipe Supports:
 - 3.9.5.1. Up to 150 mm (6 inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
 - 3.9.5.2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- 3.9.6. Overhead Supports:
 - 3.9.6.1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 3.9.6.2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
- 3.9.7. Tubing and capillary systems shall be supported in channel troughs.
- 3.9.8. Floor Supports:
 - 3.9.8.1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
 - 3.9.8.2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.

- 3.9.9. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

3.10. CLEANING AND PAINTING

- 3.10.1. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Board, the plant facilities, equipment and systems shall be thoroughly cleaned and painted.
- 3.10.2. At the completion of the project, clean and prepare all floors in the fan rooms for painting. Cover the entire floors for the mechanical room (in the area of work) with two coats of urethane-based paint (colour: battleship gray). Refer to Section 09 91 00.
- 3.10.3. In addition, the following special conditions apply:
- 3.10.3.1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
- 3.10.4. Material And Equipment Not To Be Painted Includes:
- 3.10.4.1. Motors, controllers, control switches, and safety switches.
- 3.10.4.2. Control and interlock devices.
- 3.10.4.3. Regulators.
- 3.10.4.4. Pressure reducing valves.
- 3.10.4.5. Control valves and thermostatic elements.
- 3.10.4.6. Lubrication devices and grease fittings.
- 3.10.4.7. Copper, brass, aluminum, stainless steel and bronze surfaces.
- 3.10.4.8. Valve stems and rotating shafts.
- 3.10.4.9. Pressure gauges and thermometers.
- 3.10.4.10. Glass.
- 3.10.4.11. Name plates.
- 3.10.5. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
- 3.10.6. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
- 3.10.7. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
- 3.10.8. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

3.11. IDENTIFICATION SIGNS

3.11.1. Refer to Section: 23 05 53 Identification for HVAC Piping and Equipment.

3.12. MOTOR AND DRIVE ALIGNMENT

3.12.1. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.

3.12.2. Direct connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

3.13. LUBRICATION

3.13.1. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.

3.13.2. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to Consultant in unopened containers that are properly identified as to application.

3.13.3. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.

3.13.4. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

3.14. CONCRETE

3.14.1. All concrete work required to complete this project, whether shown on the drawings or not, shall be the Contractor's responsibility.

3.14.2. Refer to this specification section for requirements for housekeeping pad.

3.15. METALS

3.15.1. All steel construction required for the completion of this project, whether shown on the drawings or not, shall be the Contractor's responsibility.

3.16. CUTTING, PATCHING, ROOFING, AND X-RAY

3.16.1. All cutting, patching, roofing and X-Rays required for the completion of this project whether shown on the drawings or not, shall be the Contractor's responsibility. The cutting and patching work shall be performed in accordance with the following:

- 3.16.1.1. All cutting and patching shall be done by the trades specializing in the materials to be cut.
- 3.16.1.2. All flashing and equipment supports on the roof shall be done in strict accordance with the Board standards by Board-approved roofing contractors only.
- 3.16.1.3. Should any cutting, roofing and/or repairing of finished surfaces be required, the Sub-trade contractor for the Contractor shall employ the particular trades engaged on the site for this type of work.
- 3.16.1.4. None of the roofing work shall affect any current roof warranty. Coordinate with the Board representative the status of the roof, and if under warranty, coordinate all the work with the warranty holder.
- 3.16.1.5. Supporting members of any floor, wall or the building structure shall be cut only in such a location and manner as approved by the Consultant.
- 3.16.1.6. Where slabs in the portions of the building which are existing must be saw-cut or core drilled, all locations shall be x-rayed prior to saw-cutting or core-drilling. All x-raying shall be done by personnel qualified in the use of the type of equipment required to x-ray the saw-cuts shall be permitted to perform this work on the site. No allowance will be made later for expenses incurred through the failure of performing these x-rays.

3.17. OPERATING AND MAINTENANCE MANUALS

- 3.17.1. Refer to Section: 01 33 23 Shop Drawings, Product Data, and Samples.

3.18. CLOSE-OUT DOCUMENTATION

- 3.18.1. 10 (ten) days prior to substantial performance of work obtain documentation and/or prepare certification of the following items and submit them to the Board representative:
 - 3.18.1.1. All inspection certificates.
 - 3.18.1.2. Guarantee certificates as called for under "Warranty".
 - 3.18.1.3. Record drawings.
 - 3.18.1.4. Operating and Maintenance Manuals.
 - 3.18.1.5. Test certifications as called for under "Testing".
 - 3.18.1.6. Provide a signed statement to the effect that all tests for mechanical systems and equipment have been completely carried out in the Trade Sections of these Specifications and to the manufacturer's recommendations, and in accordance with the requirements of all authorities having jurisdiction.

3.19. COMMISSIONING

- 3.19.1. Where applicable and the commissioning process is part of the project, provide commissioning documentation and all the manpower required for all inspection, start up,

and contractor testing required above and required by the Checklists provided by the Commissioning Agent.

- 3.19.2. Coordinate with the Commissioning Agent if the start up and operation of the installed equipment is part of larger systems which require additional testing and verification.

3.20. STARTUP AND TEMPORARY OPERATION

- 3.20.1. Startup equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation.

3.21. OPERATING AND PERFORMANCE TESTS

- 3.21.1. Prior to the final inspection, perform required tests as specified and submit the test reports and records to the Consultant. The timing of the tests shall be arranged to suit the convenience of the Consultant, and the manner and duration shall be as the Consultant deems necessary. Record the daily start and stop times, operating hours and functions performed. Ensure that the performance tests are witnessed by the Consultant.
- 3.21.2. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Board.
- 3.21.3. At the successful completion of Performance Tests and all testing and balancing, make the systems ready for final inspection and subsequent acceptance of the Board. Replace and clean filters, flush out lines and equipment, remove and clean strainers, fill liquid systems and purge air. Provide water treatment to pipes and report in accordance to current by-laws. Disinfect all domestic water as required by current by-laws and Authorities Having Jurisdiction.
- 3.21.4. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.22. INSTRUCTIONS TO BOARD PERSONNEL

- 3.22.1. Provide in accordance with Section: 01 79 00 Demonstration and Training.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. SUBMITTALS 2

1.4. APPLICABLE PUBLICATIONS 2

1.5. STANDARDS OF ACCEPTANCE 3

PART 2 - PRODUCTS 3

2.1. MOTORS 3

2.2. MOTOR ENCLOSURES 4

2.3. ENERGY EFFICIENT MOTORS (MOTOR EFFICIENCIES): 6

PART 3 - EXECUTION 7

3.1. INSTALLATION..... 7

3.2. FIELD TESTS..... 7

3.3. STARTUP AND TESTING 7

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the furnishing, installation and connection of motors for HVAC equipment.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 23 05 00 Common Work Results for HVAC.
- 1.2.3. Section: 26 05 00 Common Work Results for Electrical.
- 1.2.4. Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables.

1.3. SUBMITTALS

- 1.3.1. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples, and Section: 26 05 00 Common Work Results for Electrical.
- 1.3.2. Shop Drawings:
 - 1.3.2.1. Provide documentation to demonstrate compliance with drawings and specifications.
 - 1.3.2.2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- 1.3.3. Manuals:
 - 1.3.3.1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.
 - 1.3.3.2. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:
 - 1.3.3.3. Certification that the motors have been applied, installed, adjusted, lubricated, and tested according to manufacturer published recommendations.

1.4. APPLICABLE PUBLICATIONS

- 1.4.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.4.2. National Electrical Manufacturers Association (NEMA):

- 1.4.2.1. MG 1-2006 Rev. 1 2009 Motors and Generators
- 1.4.2.2. MG 2-2001 Rev. 1 2007 Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators
- 1.4.3. National Fire Protection Association (NFPA):
 - 1.4.3.1. 70-latest National Electrical Code (NEC)
- 1.4.4. Institute of Electrical and Electronics Engineers (IEEE):
 - 1.4.4.1. 112-04 Standard Test Procedure for Polyphase Induction Motors and Generators
- 1.4.5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - 1.4.5.1. 90.1-latest Energy Standard for Buildings Except Low-Rise Residential Buildings

1.5. STANDARDS OF ACCEPTANCE

- 1.5.1. Baldor Electric Company
- 1.5.2. Leeson Electric
- 1.5.3. General Electric
- 1.5.4. Dayton

PART 2 - PRODUCTS

2.1. MOTORS

- 2.1.1. All material and equipment furnished and installation methods shall conform to the requirements of Section: 26 29 10 Motor Starters to 600 V and Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- 2.1.2. Single phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- 2.1.3. Electrically Commutated motor (EC Type): Motor shall be brushless DC type specifically designed for applications with heavy duty ball bearings and electronic commutation. The motor shall be speed controllable down to 20% of full speed and 85% efficient at all speeds.

- 2.1.4. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
- 2.1.5. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- 2.1.6. Number of phases shall be as follows:
 - 2.1.6.1. Motors, less than 373 W (1/2 HP): Single phase.
 - 2.1.6.2. Motors, 373 W (1/2 HP) and larger: 3 phase.
 - 2.1.6.3. Exceptions:
 - 2.1.6.3.1. Hermetically sealed motors.
 - 2.1.6.3.2. Where specified otherwise on the equipment schedules
 - 2.1.6.3.3. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- 2.1.7. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.
- 2.1.8. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.

2.2. MOTOR ENCLOSURES

- 2.2.1. Shall be the NEMA types as specified and/or shown on the drawings.
- 2.2.2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed.
- 2.2.3. Enclosure requirements for certain conditions are as follows:
 - 2.2.3.1. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
 - 2.2.3.2. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
 - 2.2.3.3. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
 - 2.2.3.4. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- 2.2.4. Special Requirements:

- 2.2.4.1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Client.
- 2.2.4.2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
- 2.2.5. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
 - 2.2.5.1. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
 - 2.2.5.2. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
 - 2.2.5.3. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
- 2.2.6. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
- 2.2.7. Motors less than 3 HP:
 - 2.2.7.1. Steel or cast iron motor frames, cast aluminum, cast iron, or steel end plates, steel or cast iron terminal box, copper windings. Motor nameplates shall be steel, engraved-type, riveted to motor.
 - 2.2.7.2. Bearings: Regreasable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings, selected for a minimum L-10 bearing life of 26,280 hours, for belted and direct drive.
- 2.2.8. Motors 3 HP and above:
 - 2.2.8.1. Cast iron motor frame and mounting feet, cast iron end plates (bells), steel or cast iron terminal box, copper windings. Motor nameplates shall be stainless steel engraved type, riveted to the motor.
 - 2.2.8.2. Bearings shall be regreasable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings. Rated for an L-10 life of 40,000 hours (belted) or 130,000 hours (direct connected).
- 2.2.9. Bearing life calculations shall be per ABMA 9, and for belted applications shall be based on the maximum external side load limits for belted applications per NEMA MG-1 Table 14-1A. L-10 life calculations for vertical motors and horizontal motors mounted in the vertical position shall consider the application's thrust loading.
- 2.2.10. TEFC motors shall also include an external shaft slinger on drive end.

2.2.11. Motors shall not exceed dBA levels listed in NEMA MG-1 54 PART 9 Tables 9-1 and 9-3, at all speeds.

2.2.12. Motors utilized with variable frequency drives shall be rated “inverter-duty” per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.

2.3. ENERGY EFFICIENT MOTORS (MOTOR EFFICIENCIES):

2.3.1. All permanently wired polyphase motors of 746 Watts (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table.

2.3.2. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated.

2.3.3. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Premium Efficiencies				Minimum Premium Efficiencies			
Open Drip-Proof				Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%

22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%

2.3.4. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.

PART 3 - EXECUTION

3.1. INSTALLATION

Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

3.2. FIELD TESTS

- 3.2.1. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before start-up. All shall test free from grounds.
- 3.2.2. Perform Load test in accordance with ANSI/IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.
- 3.2.3. Insulation Resistance: Not less than one half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.
- 3.2.4. All test data shall be compiled into a report form for each motor and provided to the contracting officer or their representative.

3.3. STARTUP AND TESTING

- 3.3.1. The Commissioning Agent will observe startup and contractor testing of all equipment. Coordinate the startup and contractor testing schedules with Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

TABLE OF CONTENTS

PART 1 - GENERAL	2
1.1. DESCRIPTION	2
1.2. RELATED WORK	2
1.3. SUBMITTALS	2
1.4. APPLICABLE PUBLICATIONS	2
1.5. SCOPE OF WORK	2
1.6. QUALITY ASSURANCE	2
1.7. ACCEPTABLE MANUFACTURERS	3
PART 2 - PRODUCTS	3
2.1. SUSPENDED VIBRATION ISOLATION	3
2.2. FLOOR MOUNTED VIBRATION ISOLATION	5
2.3. PIPING CONNECTIONS	8
2.4. DUCTWORK CONNECTIONS	9
PART 3 - EXECUTION	9
3.1. GENERAL	9
3.2. FLOOR MOUNTED FANS AND AIR HANDLING EQUIPMENT	10
3.3. PIPING ISOLATION	10
3.4. CEILING SUSPENDED EQUIPMENT	11
3.5. AIR COOLED CONDENSING UNITS	11
3.6. DUCT CONNECTORS	11
3.7. ELECTRICAL CONNECTIONS	11
3.8. INSPECTION	11
3.9. COMMISSIONING	11

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the application of noise, vibration, and seismic control techniques for equipment including air handling equipment, fans, compressors and motors.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.

1.3. SUBMITTALS

- 1.3.1. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
 - 1.3.1.1. Noise and Vibration Control Devices; include with the equipment submittals.
 - 1.3.1.2. Provide separate shop drawings for each isolated system complete with performance and product data.
 - 1.3.1.3. Submit type of isolator, size, height when uncompressed and maximum allowable static deflection weight of all isolated equipment, loads on each isolator and static deflection of each isolator under the specific design load.
 - 1.3.1.4. Submit marked up plans indicating all locations where pipes are to be isolated in mechanical rooms and as specified.

1.4. APPLICABLE PUBLICATIONS

- 1.4.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- 1.4.2. ASHRAE - 1995 - HVAC Applications, Chapter 43 - "Sound and Vibration Control".

1.5. SCOPE OF WORK

- 1.5.1. Provide vibration control items for isolating vibration of mechanical equipment, piping and ductwork.
- 1.5.2. Provide all hangers, isolators, bases, pads, sleeves and other devices specified, required, or detailed for the project. Include all vibration isolation system elements as recommended by the equipment manufacturer's representative to make a complete, correct and safe installation. Supply and install all incidental materials needed.

1.6. QUALITY ASSURANCE

- 1.6.1. Work of this section shall be performed by skilled workers who are experienced in the necessary crafts to meet the requirements of this Section.

- 1.6.2. Provide field supervision and inspection to assure proper installation, adjustment and performance. Replace any isolators that are found to resonate with the supported equipment.
- 1.6.3. As a minimum provide vibration control per ASHRAE - 1995 - HVAC Applications, Chapter 43 - "Sound and Vibration Control".
- 1.6.4. Isolators shall be selected, installed and adjusted to prevent the transmission of objectionable vibration and noise to the building structure.
- 1.6.5. The size and number of mounts and hangers shall be chosen to meet these specifications, even if not specifically shown on the plans. Brackets, rails, bases, braces, etc., shall be provided as needed for a complete and correct installation.

1.7. ACCEPTABLE MANUFACTURERS

- 1.7.1. Subject to compliance with the Contract Documents, manufacturers for products specified in this Section shall be one of the following:
 - 1.7.1.1. Kinetics Noise Controls.
 - 1.7.1.2. Mason Industries, Inc.
 - 1.7.1.3. Vibron Ltd.

PART 2 - PRODUCTS

2.1. SUSPENDED VIBRATION ISOLATION

2.1.1. Combination isolation hanger assembly with neoprene insert

- 2.1.1.1. Vibration isolators for suspended equipment with minimum static deflection requirement exceeding 0.4" (10 mm), and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable spring in series with an elastomer-in-shear insert complete with load transfer plates and assembled in a stamped or welded steel bracket.
- 2.1.1.2. The bracket shall be finished with an polyester powder coating. The manufacturer shall provide independent laboratory testing showing that the bracket with this finish has endured a minimum of 1,000 hours of exposure to salt spray fog testing per ASTM B117 without signs of corrosion.
- 2.1.1.3. The elastomer insert shall be molded from oil-resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range.
- 2.1.1.4. The spring element shall have a minimum lateral stiffness of 1.0 times the rated vertical stiffness.
- 2.1.1.5. Springs shall be color coded or otherwise identified to indicate load capacity.

- 2.1.1.6. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.
- 2.1.1.7. The 1" and 2" hanger brackets shall incorporate spring caps with indexed steps which correspond to the washer diameter of appropriately sized hanger rod to keep the rod centered in the spring cap and reduce rod misalignment. The spring caps are protected under U.S. patent number 5,653,426.
- 2.1.1.8. Isolation hangers shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.
- 2.1.1.9. *Applications: Suspended mechanical equipment such as in-line fans, cabinet fans, and piping and ductwork in close proximity to mechanical equipment.*
- 2.1.1.10. Standard of Acceptance: Kinetics Noise Control SRH series.

2.1.2. Neoprene Isolation Hangers

- 2.1.2.1. Vibration isolators with maximum static deflection requirements under operating load conditions not exceeding 0.57" (15 mm) shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap.
- 2.1.2.2. The elastomer insert shall be molded from oil resistant compounds, shall be color coded to indicate load capacity and selected to operate within its published load range.
- 2.1.2.3. The hanger bracket shall be designed to carry a 500% overload without failure and to allow support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.
- 2.1.2.4. Isolation hangers shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.
- 2.1.2.5. *Applications: isolation of vibration produced by suspended mechanical equipment, in-line and exhaust fans, ductwork, piping.*
- 2.1.2.6. Standard of Acceptance: Kinetics Noise Control SRH series.

2.1.3. Piping Hangers Spring Vibration isolators

- 2.1.3.1. Vibration isolators for suspended equipment with minimum static deflection requirement exceeding 0.4" (10 mm), and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable spring in series with an elastomer-in-shear insert complete with load transfer plates and assembled in a stamped or welded steel bracket.
- 2.1.3.2. The bracket shall be finished with a polyester powder coating. The manufacturer shall provide independent laboratory testing showing that the bracket with this

finish has endured a minimum of 1,000 hours of exposure to salt spray fog testing per ASTM B117 without signs of corrosion.

- 2.1.3.3. The elastomer insert shall be molded from oil-resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range.
- 2.1.3.4. The spring element shall have a minimum lateral stiffness of 1.0 times the rated vertical stiffness.
- 2.1.3.5. Springs shall be color coded or otherwise identified to indicate load capacity.
- 2.1.3.6. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.
- 2.1.3.7. The 1" and 2" hanger brackets shall incorporate spring caps with indexed steps which correspond to the washer diameter of appropriately sized hanger rod to keep the rod centered in the spring cap and reduce rod misalignment. The spring caps are protected under U.S. patent number 5,653,426.
- 2.1.3.8. Isolation hangers shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.
- 2.1.3.9. *Application: first three pipe hangers upstream/downstream of pumping equipment.*
- 2.1.3.10. The combination isolation hanger assembly with neoprene insert shall be Model SRH, as manufactured by Kinetics Noise Control, Inc.

2.2. FLOOR MOUNTED VIBRATION ISOLATION

2.2.1. Restrained Spring Isolators

- 2.2.1.1. Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stabile steel springs assembled into welded steel housing assemblies designed to limit vertical movement of the supported equipment.
- 2.2.1.2. Housing assemblies shall be fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with internal non-skid noise isolation pads. Housing shall be electrozinc plated or hot dip galvanized for corrosion resistance. Housing should be designed to provide a constant free and operating height within 1/8" (0.06 mm).
- 2.2.1.3. Spring elements shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be polyester powder coated, and shall have a 1000 hr rating when tested in accordance with ASTM B-117.

- 2.2.1.4. All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have k_x/k_y ratios of at least 0.9. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.
 - 2.2.1.5. Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule
 - 2.2.1.6. Operating static deflections are available up to 4" (102 mm) to compensate for long span flexible floor structures and maintain a high degree of noise and vibration isolation.
 - 2.2.1.7. Springs shall be selected to provide maximum deflections; select from manufacturer's literature based on supported equipment weight. Springs shall be color coded or otherwise identified to indicate load capacity.
 - 2.2.1.8. *Vertically restrained spring isolation mounts are recommended as a noise and vibration isolator for heavy mechanical equipment, or when the equipment to be isolated has significant changes of weight during maintenance operations, and for equipment subjected to moderate external forces or wind loads, such as chillers, cooling towers, condensing units larger than 50 ton capacity, air handlers and utility type exhaust fans larger than 10,000 cfm capacity, and similar.*
 - 2.2.1.9. Standards of Acceptance: Kinetics Noise Controls FRS (supported weight up to 1,500 kg) or FLS series (supported equipment weight above 1,500 kg).
- 2.2.2. Neoprene Isolation Pads
- 2.2.2.1. Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having maximum deflections between 0.08" to 0.14"
 - 2.2.2.2. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm²) tensile strength, oil resistant compounds with no color additives.
 - 2.2.2.3. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm²) loading at maximum rated deflections.
 - 2.2.2.4. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate.
 - 2.2.2.5. *Application: floor/concrete curb/sleeper mounted equipment such as boilers pumps, utility type exhaust fans of less than 10,000 cfm capacity, condensing units of less than 50 ton capacity, condensers/fluid coolers, and similar*
 - 2.2.2.6. Standard of Acceptance: Kinetics Noise Control models NPS, NPD, NGS or NGD to suit weight of equipment and max. deflection rates.

2.2.3. Elastomeric Isolation Mounts

- 2.2.3.1. One-piece molded neoprene mounts with encapsulated metal inserts, color coded to identify capacity, with non-skid ribs on the bottom load surfaces. Each isolator incorporates two bolt-down holes on the bottom load surface and a tapped steel load top plate for attachment to the supported equipment. The neoprene is highly oil resistant and has been designed to operate within the strain limits of the isolator to provide maximum isolation and longest life expectancy possible using neoprene compounds.
- 2.2.3.2. *Isolation mounts are designed for up to 0.5" (13 mm) deflection, available in four sizes and eleven capacities from 55 lbs. to 4,000 lbs. (25 kg to 1814 kg).*
- 2.2.3.3. Standard of Acceptance: Kinetics Noise Control model RDS.

2.2.4. Inertia Base Pads

- 2.2.4.1. Isolation bases shall be constructed of concrete cast into fabricated inertia base frames, the steel members of which are designed and supplied by the isolator manufacturer. The concrete shall be poured into a welded steel frame, incorporating prelocated equipment anchor bolts, 1/2-in (13 mm) diameter reinforcing bars on nominal 8-in (203 mm) centers each way, and recessed isolator mounting brackets to reduce the mounting height of the equipment, and reduce the footprint of the base. The thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 6 in (152 mm), or as indicated on the drawings. Where inertia bases are used to mount pumps, the bases shall be sized to support piping elbows.
- 2.2.4.2. Applications: Support of heavy equipment where preventing noise transmission to adjacent spaces is critical. Inertia bases are used to support mechanical equipment, reduce equipment vibration, provide for attachment of vibration isolators, prevent differential movement between driving and driven members, reduce rocking by lowering equipment center of gravity, reduce motion of equipment during start-up and shut-down, act to reduce reaction movement due to operating loads on equipment, and act as a noise barrier.
- 2.2.4.3. *Typical uses for inertia base frames, with poured concrete and supported by noise and vibration isolators, include use with open-type centrifugal chillers, reciprocating air and refrigeration compressors, chillers, and heat pumps, close-coupled and base-mounted pumps, centrifugal fans, internal combustion engines, and similar types of equipment.*
- 2.2.4.4. Standard of Acceptance: Kinetics Noise Control model CIB-L

2.2.5. Vibration Isolator Rails

- 2.2.5.1. Spring components shall be 1"/25 mm for air handling equipment/condensing units and 2"/50 mm deflection for cooling towers/chillers, free-standing, un-

housed, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed for 50% overload to solid.

- 2.2.5.2. Springs shall be color coded to indicate load capacity.
- 2.2.5.3. Rails shall provide continuous support for the rooftop equipment and shall be designed to provide isolation against casing-radiated vibration in the rooftop equipment housing and structure borne vibration from rotating and mechanical equipment in the rooftop package.
- 2.2.5.4. Rail assembly shall consist of extruded aluminum top and bottom members connected by spring isolators and a continuous air- and water-tight seal. The seal shall be a beaded elastomeric material retained in a keyway along the top extrusion. The weather strip shall be sealed along the bottom with an aluminum fascia strip.
- 2.2.5.5. Rail assemblies shall incorporate means for attachment to the building and the supported equipment and shall incorporate additional stiffening members if necessary to assure stability.
- 2.2.5.6. Vibration isolators shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.
- 2.2.5.7. *Application: designed and engineered to isolate packaged roof mounted equipment from the roof structure. Typical applications: cooling tower, condensing units, roof mounted air handling equipment and similar*
- 2.2.5.8. Where specified, the vibration isolation rails shall have a positive elastomeric air and weather seal permitting the inside of the unit to be used as a return air plenum. The KSR mates with the inside of the manufacturers' curb eliminating any internal interference.
- 2.2.5.9. Standard of Acceptance: Kinetics Noise Control Model KSR

2.3. PIPING CONNECTIONS

2.3.1. Flexible Piping Connectors

- 2.3.1.1. Flexible Braided Hose Connectors – HVAC Systems
 - 2.3.1.1.1. Type 321 Stainless Steel Hose with type 304 Stainless Steel Outer Braid and 150# Carbon Steel Flat Faced Drilled Bolting Flanges
 - 2.3.1.1.2. Length: 229 mm (9") to 356" (14") depending on diameter. max. lateral offset: 10 mm (0.125")
 - 2.3.1.1.3. Application: piping connected to rotating equipment to reduce the transmission of noise and vibration, and to eliminate stresses in piping systems due to misalignment and thermal movement of the piping, where fluid temperature may exceed 90°C.
 - 2.3.1.1.4. Standard of Acceptance: Kinetics Noise Control model BFMC-FFF

2.3.1.2. Refrigerant Piping Flexible Hose Connectors

2.3.1.2.1. Bronze flexible bellows with bronze braided outer cover and shall have bronze female copper sweat ends.

2.3.1.2.2. Standards of Acceptance: Kinetics Noise Control model BFMC-CFE

2.3.2. Twin Sphere Neoprene Connector

2.3.2.1. Made of molded EPDM reinforced with nylon tire cord and shall have mild steel floating flanges. Use control rods to limit deflections and movements to within the prescribed values indicated by the manufacturer.

2.3.2.2. Axial compression: 50 mm (2"). Axial elongation: 30 mm (1.25"). Transverse movement: 40 mm (1.5")

2.3.2.3. Application: piping connected to rotating equipment piping connected to rotating equipment to reduce the transmission of noise and vibration, and to eliminate stresses in piping systems due to misalignment and thermal movement of the piping, where fluid temperatures remain in the -10 deg. C to 90 deg. C (14 deg. F to 190 deg. F).

2.3.2.4. Standard of Acceptance: Kinetics Noise Control model FTC

2.4. **DUCTWORK CONNECTIONS**

2.4.1. Ductwork Flexible Connector

2.4.1.1. Fully welded match drilled carbon steel flanges equipped with backing bars fastened in place with zinc plated hardware and EPDM flex membrane material. Acoustically rated design shall be used where called for on the design documentation, with an absorptive acoustic fill and EPDM outer barrier.

2.4.1.2. EPDM Flexible material: 1/8" thick layered EPDM flex membrane with internal nylon scrim for superior tear strength. Resistant to ozone and UV exposure and cold cracking (suitable for outdoor use).

2.4.1.3. Aerodynamic protective metal flow liner for air streams in excess of 6,000 cfm.

2.4.1.4. Construction: flange to flange distance: 200 mm (8") static mode. Lateral and axial movement: +/- 12.5 mm (1/2 inch). Operating temperature: up to 100 deg. C (212 deg. F)

2.4.1.5. Application: between fans (intake and discharge) and ductwork.

2.4.1.6. *Exception: not required for air handling units where fans are internally isolated*

2.4.1.7. Standard of Acceptance: Kinetics Noise Control model Kineflex.

PART 3 - EXECUTION

3.1. **GENERAL**

- 3.1.1. Statically and dynamically balance all pumps, fans, compressors and drivers. Align shafts of pumps, fans, and drivers to limit noise and vibration to specified values. Level and anchor equipment as necessary to achieve and maintain alignment.
- 3.1.2. All equipment mounted on vibration isolators springs shall have a minimum operating clearance of 2 inches between the bottom of the equipment or inertia base (and height saving bracket) and the concrete housekeeping pad (or bolt heads) beneath the equipment.
- 3.1.3. Check the clearance to ensure that no scraps have been left to short circuit the vibration isolators.
- 3.1.4. Provide a minimum of 4 inches between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
- 3.1.5. Piping, ductwork, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes, or ductwork installed on vibration isolators.
- 3.1.6. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Equipment should be blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.
- 3.1.7. All mechanical equipment not specifically identified in this specification that contains rotating or vibration elements shall be installed on neoprene isolators as appropriate. Provide supporting steel structure between isolators and equipment if isolator does not readily connect to equipment.

3.2. FLOOR MOUNTED FANS AND AIR HANDLING EQUIPMENT

- 3.2.1. Neoprene isolation pads (less than 10,000 cfm), restrained springs (above 10,000 cfm) with or without inertia concrete pads, as specified or shown on the drawings. Secure springs to equipment and pads.

3.3. PIPING ISOLATION

- 3.3.1. Use flexible hoses or neoprene vibration isolators at all connections between piping and equipment containing rotating parts (pumps, air handlers, chillers, cooling towers, etc). Applicable to refrigerant piping as well. Do not use neoprene isolators outdoors or where fluid temperatures temperature not suitable.
- 3.3.2. Use restrained spring isolators for the first three piping supports upstream and downstream of each pump.

3.4. CEILING SUSPENDED EQUIPMENT

- 3.4.1. Restrained spring isolators or neoprene isolation pads, as indicated on the drawings

3.5. AIR COOLED CONDENSING UNITS

- 3.5.1. Neoprene pad or elastomeric mounts secured to the support structure and equipment base rails. Select based on equipment weight.

3.6. DUCT CONNECTORS

- 3.6.1. At all connections between fans and ductwork, where not provided by the manufacturer.
- 3.6.2. Exception: kitchen grease exhaust ductwork connection to exhaust fan.

3.7. ELECTRICAL CONNECTIONS

- 3.7.1. All wiring connections to mechanical equipment on vibration isolators (either spring or neoprene type) shall be made with a minimum 36-inch-long flexible liquid-tight conduit in a 360° loop. Coordinate wiring connections with the electrical sub-trade.

3.8. INSPECTION

- 3.8.1. Supplier shall inspect and approve the installation of the vibration isolators and shall submit a report to the Client which verifies that all of the isolation equipment has been properly installed and that the installation is in full conformance with the specification. The report shall record the vibration isolator identification and model or type.
- 3.8.2. For isolators containing steel springs the report shall also record the size and uncompressed height, design static deflection and measured static deflection of the isolators provided.

3.9. COMMISSIONING

- 3.9.1. Provide commissioning documentation in accordance with the requirements of Section: 23 08 00 Commissioning of HVAC for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- 3.9.2. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section: 23 08 00 Commissioning of HVAC and related sections for contractor responsibilities for system commissioning.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. RELATED DOCUMENTS 2

1.2. SUMMARY 2

1.3. SUBMITTAL 2

PART 2 - PRODUCTS 2

2.1. STANDARDS OF ACCEPTANCE 2

2.2. EQUIPMENT LABELS 2

2.3. WARNING SIGNS AND LABELS 3

2.4. PIPE LABELS 4

2.5. VALVE TAGS 5

2.6. DUCT LABELS 5

2.7. OTHER SPECIALIZED LABELING AND REQUIREMENTS 6

2.8. STENCILING 6

PART 3 - EXECUTION 6

3.1. PREPARATION 6

3.2. EQUIPMENT LABEL INSTALLATION 6

3.3. VALVE TAG INSTALLATION AND DOCUMENTATION 7

3.4. DUCT LABEL INSTALLATION 7

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

1.1.1. Drawings and general provisions of the Contract apply to this Section.

1.1.1.1. Section: 23 21 13 Hydronic Piping.

1.1.1.2. Section: 23 31 13 Metal Ducts.

1.2. SUMMARY

1.2.1. Section Includes:

1.2.1.1. Equipment labels.

1.2.1.2. Warning signs and labels.

1.2.1.3. Pipe labels.

1.2.1.4. Valve tags.

1.2.1.5. Duct labels.

1.2.2. For BAS identification, also refer to requirements of Section: 23 09 00 Instrumentation and Control for HVAC.

1.3. SUBMITTAL

1.3.1. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1. STANDARDS OF ACCEPTANCE

2.1.1.1. Brady, Kolbi, or Panduit.

2.2. EQUIPMENT LABELS

2.2.1.1. Metal Labels for Equipment:

2.2.1.1.1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having pre-drilled or stamped holes for attachment hardware.

2.2.1.1.2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

2.2.1.1.3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

2.2.2. Fasteners: Stainless-steel rivets or self-tapping screws.

2.2.3. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.2.4. Plastic Labels for Equipment:

- 2.2.4.1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- 2.2.4.2. Letter Color: White.
- 2.2.4.3. Background Color: Black.
- 2.2.4.4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- 2.2.4.5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 2.2.4.6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

2.2.5. Fasteners: Stainless-steel rivets or self-tapping screws.

2.2.6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.2.7. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2.8. Label is to also indicate area and type of service being provided.

- 2.2.8.1. For Example, AHU - 3 - floors 1-4
- 2.2.8.2. P3 HW Hot Water Pump - building perimeter

2.2.9. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3. **WARNING SIGNS AND LABELS**

- 2.3.1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- 2.3.2. Letter Color: White.
- 2.3.3. Background Color: Red.
- 2.3.4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- 2.3.5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- 2.3.6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 2.3.7. Fasteners: Stainless-steel rivets or self-tapping screws.
- 2.3.8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- 2.3.9. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4. PIPE LABELS

- 2.4.1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, showing flow direction, and area served (i.e. perimeter heating hot water).
- 2.4.2. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- 2.4.3. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
- 2.4.4. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction, and visible all around pipe.
- 2.4.5. Lettering Size: At least 1-1/2 inches high.
- 2.4.6. All piping, except that piping which is within inaccessible chases, shall be identified.
- 2.4.7. Each marker background shall be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ASME A13.1-1981).
- 2.4.8. Set mark snap-around markers shall be used for overall diameters up to 6" and strap around markers shall be used above 6" overall diameters.
- 2.4.9. Markers shall be located:
 - 2.4.9.1. Adjacent to each valve
 - 2.4.9.2. At each branch
 - 2.4.9.3. At each cap for future
 - 2.4.9.4. At each riser takeoff,
 - 2.4.9.5. At each pipe passage through wall (each side)

- 2.4.9.6. At each pipe passage at 20' – 0" intervals maximum.
- 2.4.9.7. At each piece of equipment.
- 2.4.9.8. At all access doors.
- 2.4.9.9. A minimum of one (1) marker shall be provided at each room.

2.5. VALVE TAGS

- 2.5.1. Valve tags shall be according to project valve specification section(s). Unless required differently in project valve specification section(s), valve tags to be minimum 1.5" round brass, attached with metallic chains.

2.6. DUCT LABELS

- 2.6.1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2.6.1.1. Letter Color: White.
 - 2.6.1.2. Background Color: Red.
 - 2.6.1.3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 2.6.1.4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 2.6.1.5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 2.6.2. Fasteners: Stainless-steel rivets or self-tapping screws.
- 2.6.3. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- 2.6.4. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
- 2.6.5. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
- 2.6.6. Lettering Size: At least 1-1/2 inches high.
- 2.6.7. Markers shall be located:
 - 2.6.7.1. Adjacent to each air handling equipment
 - 2.6.7.2. At each branch
 - 2.6.7.3. At each cap for future
 - 2.6.7.4. At each riser takeoff,
 - 2.6.7.5. At each duct passage through wall (each side)

- 2.6.7.6. On each duct straight run at 20' – 0" intervals maximum.
- 2.6.7.7. At all access doors.
- 2.6.7.8. A minimum of one (1) marker shall be provided at each room.

2.7. OTHER SPECIALIZED LABELING AND REQUIREMENTS

- 2.7.1. Fire damper access panels shall be permanently identified on the exterior by labels not less than 2" in height reading "FIRE DAMPER".
- 2.7.2. Smoke damper access panels shall be permanently identified on the exterior by labels not less than 2" in height reading "SMOKE DAMPER".
- 2.7.3. Combination fire/smoke damper access panels shall be permanently identified on the exterior by labels not less than 2" in height reading "RESETTABLE FIRE/SMOKE DAMPER". Mark the other access panels "FIRE/SMOKE DAMPER."
- 2.7.4. Items listed in items 1-3 above, will also be listed on a full size, laminated print and left in the main mechanical room as indicated above.
- 2.7.5. Duct static pressure sensors shall be permanently identified on the exterior by labels not less than 2" in height reading "STATIC PRESSURE SENSOR".
- 2.7.6. Humidity sensors in ductwork shall be permanently identified on the exterior by labels not less than 2" in height reading "HUMIDITY SENSOR".
- 2.7.7. Abbreviations: No abbreviations to be used.
- 2.7.8. All smoke and fire damper locations are to be posted as a pdf on the DDC system per fan system. This information is also to be located in the fire command center for the building. Coordinate with other trades to make sure this happens, and support as required via that coordination.

2.8. STENCILING

- 2.8.1. Not allowed.

PART 3 - EXECUTION

3.1. PREPARATION

- 3.1.1. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2. EQUIPMENT LABEL INSTALLATION

- 3.2.1. Install or permanently fasten labels on each major item of mechanical equipment.

3.2.2. Locate equipment labels where accessible and visible.

3.3. VALVE TAG INSTALLATION AND DOCUMENTATION

- 3.3.1. Tag valves according to project valve specification section(s), and provide typed list (loose and framed under glass) per same specification section(s).
- 3.3.2. A valve tag schedule is to be mounted in each mechanical room and on every floor (for that respective floor) in a location to be determined by the Consultant
- 3.3.3. Each valve tag schedule will have an associated architectural print showing each valve location.
- 3.3.4. At project completion two additional hard copies are to be provided in addition to an electronic copy.
- 3.3.5. Two copies of the mechanical piping flow diagram will be supplied. All prints that are supplied that are located in mechanical rooms are to be laminated.
- 3.3.6. Pipe tags that are the first isolation for a utility in a mechanical room or building need to have indicated where the next upstream valve is located and the associated valve number indicated on the valve tag.
- 3.3.7. This is applicable for all utility isolation valves for each mechanical room space.

3.4. DUCT LABEL INSTALLATION

- 3.4.1. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 3.4.1.1. Blue: For cold-air supply ducts.
 - 3.4.1.2. Yellow: For hot-air supply ducts.
 - 3.4.1.3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 - 3.4.1.4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- 3.4.2. Locate labels at maximum intervals of 10 feet, at every change in direction, and within 3' of wall and floor penetrations on both sides of same.
- 3.4.3. Along with all other ducting on the job, label toxic exhaust.

TABLE OF CONTENTS

PART 1 - GENERAL	2
1.1. DESCRIPTION	2
1.2. RELATED WORK	2
1.3. QUALITY ASSURANCE	2
1.4. SUBMITTALS	4
1.5. APPLICABLE PUBLICATIONS	5
PART 2 - PRODUCTS	5
2.1. PLUGS	5
2.2. INSULATION REPAIR MATERIAL	5
PART 3 - EXECUTION	5
3.1. GENERAL	5
3.2. DESIGN REVIEW REPORT	6
3.3. SYSTEMS INSPECTION REPORT	6
3.4. DUCT AIR LEAKAGE TEST REPORT	6
3.5. SYSTEM READINESS REPORT	6
3.6. TAB REPORTS	7
3.7. TAB PROCEDURES	7
3.8. LOCATION OF MEASUREMENTS AND MEASURED PARAMETERS	8
3.9. MARKING OF SETTINGS	8
3.10. IDENTIFICATION OF TEST PORTS	9
3.11. COMMISSIONING	9

PART 1 - GENERAL

1.1. DESCRIPTION

1.1.1. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

- 1.1.1.1. Planning systematic TAB procedures.
- 1.1.1.2. Design Review Report.
- 1.1.1.3. Systems Inspection report.
- 1.1.1.4. Duct Air Leakage test report.
- 1.1.1.5. Systems Readiness Report.
- 1.1.1.6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
- 1.1.1.7. Recording and reporting results.

1.1.2. Definitions:

- 1.1.2.1. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
- 1.1.2.2. AABC: Associated Air Balance Council.
- 1.1.2.3. NEBB: National Environmental Balancing Bureau.

1.1.3. Hydronic Systems: Includes chilled water, condenser water, heating hot water and glycol water systems as applicable to the project.

1.1.4. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems, as applicable to the project.

1.1.5. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

1.2. RELATED WORK

- 1.2.1. Section: 23 05 00 Common Work Results for HVAC.
- 1.2.2. Section: 23 31 13 Metal Ducts.
- 1.2.3. Section: 23 34 00 HVAC Fans.
- 1.2.4. Section: 23 37 00 Air Outlets and Inlets.
- 1.2.5. Section: 23 21 13 Hydronic Piping.

1.3. QUALITY ASSURANCE

1.3.1. Qualifications:

- 1.3.1.1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
- 1.3.1.2. The TAB agency shall be required to adhere to all guidelines set forth by the AABC or NEBB when completing the balancing of the new equipment.

1.3.2. TAB Specialist: The TAB specialist shall follow and abide all regulations and guidelines indicated by the AABC or NEBB.

1.3.3. TAB Specialist shall be identified by the General Contractor within 10 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Consultant. The responsibilities would specifically include:

- 1.3.3.1. Shall directly supervise all TAB work.
- 1.3.3.2. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
- 1.3.3.3. Would follow all TAB work through its satisfactory completion.
- 1.3.3.4. Shall provide final markings of settings of all HVAC adjustment devices.
- 1.3.3.5. Permanently mark location of duct test ports.

1.3.4. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Consultant is to ensure that the Tab Technicians are qualified before work is performed. The lead technician shall be certified by AABC or NEBB

1.3.5. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.

1.3.6. Tab Criteria:

- 1.3.6.1. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
- 1.3.6.2. Tolerances:
 - 1.3.6.2.1. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): +/-5% of design values noted in the equipment schedules.

- 1.3.6.2.2. Air terminal units (maximum values): +/-5% of the design values noted on the equipment schedules.
 - 1.3.6.2.3. Exhaust hoods/cabinets: 0% to +10% of the design values noted on the equipment schedules
 - 1.3.6.2.4. Minimum outside air: 0% to +10% of the design values noted on the equipment schedules
 - 1.3.6.2.5. Individual room air outlets and inlets, and air flow rates not mentioned above: +/-5% of the design values noted on the equipment schedules.
 - 1.3.6.2.6. Heating hot water pumps and hot water coils: +/-5% of the design values noted on the equipment schedules.
 - 1.3.6.2.7. Chilled water and condenser water pumps: 0% to +5% of the design values noted on the equipment schedules
 - 1.3.6.2.8. Chilled water coils: 0% to +5% of the design values noted on the equipment schedules.
 - 1.3.6.2.9. Heat output capacities: 0% to +10% of the design values noted on the equipment schedules
 - 1.3.6.2.10. Cooling output capacities: +/-5% of the design values noted on the equipment schedules
- 1.3.7. Typical TAB procedures and results shall be demonstrated to the Consultant for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the Consultant) and one hydronic system (pumps and three coils) as follows:
- 1.3.7.1. When field TAB work begins.
 - 1.3.7.2. During each partial final inspection and the final inspection for the project if requested by the Board

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Submit names and qualifications of TAB agency and TAB specialists within 10 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- 1.4.3. Submit Following for Review and Approval:
 - 1.4.3.1. Design Review Report within 10 days after the award of contract from the General Contractor.
 - 1.4.3.2. Systems inspection report on equipment and installation for conformance with design.
 - 1.4.3.3. Duct Air Leakage Test Report.
 - 1.4.3.4. Systems Readiness Report.

- 1.4.4. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
- 1.4.5. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- 1.4.6. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.

1.5. APPLICABLE PUBLICATIONS

- 1.5.1. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
 - 1.5.1.1. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 - 1.5.1.2. 2007 HVAC Applications ASHRAE Handbook, Chapter 37, Testing, Adjusting, and Balancing and Chapter 47, Sound and Vibration Control
 - 1.5.1.3. Associated Air Balance Council (AABC):
 - 1.5.1.3.1. AABC National Standards for Total System Balance
 - 1.5.1.3.2. National Environmental Balancing Bureau (NEBB):
 - 1.5.1.3.3. 7th Edition 2005 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
 - 1.5.1.3.4. 2nd Edition 2006 Procedural Standards for the Measurement of Sound and Vibration
 - 1.5.1.3.5. 3rd Edition 2009 Procedural Standards for Whole Building Systems Commissioning of New Construction
 - 1.5.1.4. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 1.5.1.4.1. 3rd Edition 2002 HVAC SYSTEMS Testing, Adjusting and Balancing

PART 2 - PRODUCTS

2.1. PLUGS

- 2.1.1. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.2. INSULATION REPAIR MATERIAL

- 2.2.1. See Section: 23 07 00 HVAC Insulation.
- 2.2.2. Provide for repair of insulation removed or damaged for TAB work.

PART 3 - EXECUTION

3.1. GENERAL

- 3.1.1. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.
- 3.1.2. *Coordinate all balancing work with the BAS vendor. Where balancing variable flow systems, fine tune the pressure differential sensor settings to ensure that all end users receive adequate water and air flows.*

3.2. DESIGN REVIEW REPORT

- 3.2.1. The TAB Specialist shall review the Contract Plans and specifications and advise the Consultant of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3.3. SYSTEMS INSPECTION REPORT

- 3.3.1. Inspect equipment and installation for conformance with design.
- 3.3.2. The inspection and report are to be done after piping and air distribution equipment is on site and piping/duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
- 3.3.3. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

3.4. DUCT AIR LEAKAGE TEST REPORT

- 3.4.1. TAB Agency shall perform the leakage test as outlined in "Duct leakage Tests and Repairs" in Section: 23 31 13 Metal Ducts.

3.5. SYSTEM READINESS REPORT

- 3.5.1. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated on drawings. Submit report of findings to Consultant.
- 3.5.2. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to Consultant in standard format and forms prepared and or approved by the Commissioning Agent, as applicable to the project.

- 3.5.3. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Consultant.

3.6. TAB REPORTS

- 3.6.1. The TAB contractor shall provide raw data immediately in writing to the Consultant if there is a problem in achieving intended results before submitting a formal report.
- 3.6.2. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval at no additional cost to the Board.
- 3.6.3. Do not proceed with the remaining systems until intermediate reports are reviewed by the Consultant.

3.7. TAB PROCEDURES

- 3.7.1. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.
- 3.7.2. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.
- 3.7.3. For air handling systems, perform balancing work when the building envelope is substantially completed (windows and doors installed, ceilings completed, transfer grilles installed)
- 3.7.4. For air handling systems equipped with hydronic components, make air and hydronic balancing at the same time.
- 3.7.5. Air Balance and Equipment Test: Include air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets, computer room AC units, and laboratory fume hoods and biological safety cabinets.
- 3.7.6. Artificially load air filters by partial blanking to produce air pressure drop of manufacturer's recommended pressure drop.
- 3.7.7. Adjust fan speeds to provide design air flow.
- 3.7.8. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.

3.7.9. Variable air volume (VAV) systems:

3.7.9.1. Not applicable to this project

3.7.10. Water Balance and Equipment Test: Include convectors, coils, coolers and condensers

3.7.10.1. Adjust flow rates for equipment.

3.7.10.2. Primary secondary (variable volume) systems: Balance systems at design water flow and then verify that variable flow controls function as required.

3.7.10.3. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convectors. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

3.8. LOCATION OF MEASUREMENTS AND MEASURED PARAMETERS

3.8.1. Perform hydronic measurements at each:

3.8.1.1. Boiler

3.8.1.2. Coil

3.8.1.3. Control Valve

3.8.1.4. Balancing Valve

3.8.2. Perform air measurements at each:

3.8.2.1. Fan/Air Handling System discharge

3.8.2.2. Exhaust fan

3.8.2.3. Coil

3.8.2.4. Fresh air/Exhaust damper

3.8.2.5. Terminal unit

3.8.2.6. Air distribution equipment

3.8.3. Measured parameters

3.8.3.1. Air flows

3.8.3.2. Hydronic flows

3.8.3.3. Temperatures entering/leaving coils (hydronic and air)

3.8.3.4. Pressure drops at each measured equipment/device (hydronic and air)

3.8.3.5. Electric Power drawn by electrical equipment

3.9. MARKING OF SETTINGS

3.9.1. Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist

so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Consultant.

3.10. IDENTIFICATION OF TEST PORTS

- 3.10.1. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

3.11. COMMISSIONING

- 3.11.1. Provide commissioning documentation in accordance with the requirements of Section: 23 08 00 Commissioning of HVAC for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- 3.11.2. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section: 23 08 00 Commissioning of HVAC related sections for contractor responsibilities for system commissioning.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 3

1.5. STORAGE AND HANDLING OF MATERIAL 3

1.6. APPLICABLE PUBLICATIONS 3

1.7. STANDARDS OF ACCEPTANCE 4

PART 2 - PRODUCTS 4

2.1. HVAC PIPING INSULATION..... 4

2.2. FITTINGS, FLANGE AND VALVE INSULATION – HOT AND COLD PIPING 7

2.3. EQUIPMENT INSULATION 7

2.4. DUCTWORK INSULATION..... 7

PART 3 - EXECUTION 10

3.1. GENERAL REQUIREMENTS..... 10

3.2. INSULATION INSTALLATION..... 12

3.3. INSULATION JOINTS..... 14

3.4. INSULATION AT DUCT SUPPORTS..... 14

3.5. FIELD-APPLIED JACKET APPLICATION 14

3.6. OUTDOOR DUCTWORK – RECTANGULAR..... 14

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. Field applied insulation for thermal efficiency and condensation control for HVAC piping, ductwork and equipment.
- 1.1.2. Re-insulation of HVAC piping, ductwork and equipment after asbestos abatement.
- 1.1.3. Definitions
 - 1.1.3.1. ASJ: All service jacket, white finish facing or jacket.
 - 1.1.3.2. Air-conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
 - 1.1.3.3. Cold: Equipment or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
 - 1.1.3.4. Concealed: Piping above ceilings and in chases, interstitial space, and pipe chases.
 - 1.1.3.5. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
 - 1.1.3.6. Hot: Hot water equipment or piping handling media above 41 degrees C (105 degrees F).
 - 1.1.3.7. Thermal conductance: Heat flow rate through materials.
 - 1.1.3.8. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
 - 1.1.3.9. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). or the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.

1.2. RELATED WORK

- 1.2.1. Section: 23 05 00 Common Work Results for HVAC.
- 1.2.2. Section: 23 31 13 Metal Ducts.
- 1.2.3. Section: 23 21 13 Hydronic Piping.

1.3. QUALITY ASSURANCE

- 1.3.1. Comply with OBC requirements for flame spread and smoke development rates.

- 1.3.2. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
- 1.3.3. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- 1.3.4. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Shop Drawings:
 - 1.4.2.1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
 - 1.4.2.2. Insulation materials: Specify each type used and state surface burning characteristics.
 - 1.4.2.3. Insulation facings and jackets: Each type used.
 - 1.4.2.4. Insulation accessory materials: Each type used.
 - 1.4.2.5. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
 - 1.4.2.6. Make reference to applicable specification paragraph numbers for coordination.

1.5. STORAGE AND HANDLING OF MATERIAL

- 1.5.1. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6. APPLICABLE PUBLICATIONS

- 1.6.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- 1.6.2. National Fire Protection Association (NFPA):
 - 1.6.2.1. 101-09 Life Safety Code

- 1.6.2.2. 251-06 Standard methods of Tests of Fire Endurance of Building Construction Materials
- 1.6.2.3. 255-06 Standard Method of tests of Surface Burning Characteristics of Building Materials
- 1.6.3. Underwriters Laboratories, Inc (UL):
 - 1.6.3.1. 723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 08/03
- 1.6.4. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):
 - 1.6.4.1. SP58-2002 Pipe Hangers and Supports Materials, Design, and Manufacture

1.7. STANDARDS OF ACCEPTANCE

- 1.7.1. Owens/Corning, Knauf, Johns Mansville

PART 2 - PRODUCTS

2.1. HVAC PIPING INSULATION

- 2.1.1. Application (as applicable to the project)
 - 2.1.1.1. All hot water heating/glycol
 - 2.1.1.2. All chilled water/glycol
 - 2.1.1.3. All steam piping
 - 2.1.1.4. All condensate piping
 - 2.1.1.5. All piping conveying water and located in spaces where the temperature can drop below freezing. Also refer to heat tracing specifications
 - 2.1.1.6. All other piping conveying fluids warmer than 30°C or colder than 18°C
- 2.1.2. Mineral Fiber or Fiber Glass
 - 2.1.2.1. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), class 1, k = 0.037 (0.26) at 24 degrees C (75 deg. F), for use at temperatures from -20 deg. C (-4 deg. F) and up to 230 deg.C (450 deg. F) with an all-service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
 - 2.1.2.2. Thickness:
 - 2.1.2.2.1. Piping larger than 75mm (3"): 38 mm thickness
 - 2.1.2.2.2. Piping nominal 25mm-75mm (1-3"): 25 mm thickness
 - 2.1.2.2.3. Piping nominal 19mm (3/4") and less: 12 mm thickness
 - 2.1.2.2.4. Outdoor insulation (any size): increase insulation thickness by 12 mm (½")
 - 2.1.2.3. At fittings and flanges (including water meter and body of roof drains), insulate with wrapped fiberglass insulation of same thickness as adjacent pipe, and cover

with pre-molded PVC jackets. Seal edge of jacket with self-sealing vapor barrier tape.

2.1.3. Insulation Facings And Jackets

2.1.3.1. Vapor Retarder, higher strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on pipe insulation jackets.

2.1.3.2. Facings and jackets

2.1.3.2.1. Concealed indoor areas:

- Shall be all service type (ASJ) in concealed spaces and PVC Vapor Retarder jacketing in all exposed areas, including mechanical rooms and service areas.
- All service Jacket (ASJ) shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- Standard of Acceptance: Zeston, Ceeco, Proto

2.1.3.2.2. Exposed indoor areas:

- Shall be heavy PVC fitting covers (0.75 mm thickness. Overlap PVC covers on pipe insulation jackets as least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

2.1.3.2.3. Indoor Fittings Jackets

- Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
- Adhesive: Compatible with PVC jacket, and recommended by insulation material manufacturer.
- Standard of Acceptance: Zeston, Ceeco, Proto

2.1.3.2.4. Aluminum Jackets – Outdoor Piping and Fittings

- Aluminum Jacket-Piping systems: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel

bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

- Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping as well as on interior piping exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- Neither rivets, screws, staples nor any other fastener capable of penetrating the underlying vapor retarder shall be used to secure the aluminum jacketing.
- Standards of Acceptance: Childers-Lock-on and Pabco-Surfeit.

2.1.4. Pipe Covering Protection Saddles

- 2.1.4.1. Cold pipe support - indoors: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).
- 2.1.4.2. Warm or hot pipe supports - indoors: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).
- 2.1.4.3. All piping – outdoors: Metallic shield shall be made of galvanized steel painted on both sides with a minimum two coats of aluminum paint. 180 degree for clevises and roller type hangers and 360 degree for clamp type hangers and supports. Shield and insert length and gauge shall be 400 mm (16") long and min. 2.75 mm (12ga) thickness.

2.1.5. Adhesive, Mastic, Cement

- 2.1.5.1. Insulation manufacturers' published recommendations.

2.1.6. Mechanical Fasteners

- 2.1.6.1. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.

- 2.1.6.2. Bands: 13 mm (1/2 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.1.7. Flame And Smoke

- 2.1.7.1. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

2.2. **FITTINGS, FLANGE AND VALVE INSULATION – HOT AND COLD PIPING**

- 2.2.1. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place.
- 2.2.2. For hot piping finish with a smoothing coat of finishing cement.
- 2.2.3. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
- 2.2.4. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
- 2.2.5. Nominal thickness: same as piping of same size.

2.3. **EQUIPMENT INSULATION**

- 2.3.1. Applications: all heat exchangers, chilled water pumps, chilled water expansion tanks, chiller headers or evaporator vessels
- 2.3.2. Flexible Elastomeric Cellular Thermal insulation, ASTM C177, C518, k = 0.039 (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

2.4. **DUCTWORK INSULATION**

2.4.1. Application

- 2.4.1.1. All concealed ductwork, or exposed in mechanical rooms conveying air at temperatures above 30°C or below 18°C and running through heated spaces.
- 2.4.1.2. All ductwork running through unheated spaces (attics)
- 2.4.1.3. All exhaust air ductwork 3m upstream of the point of discharge to the outdoors
- 2.4.1.4. All fresh air supply ductwork
- 2.4.1.5. All ductwork mounted outdoors
- 2.4.1.6. All combustion air ductwork

2.4.2. Round Ductwork or Rectangular Ductwork – any side less than 750 mm (30")

- 2.4.2.1. Insulate ductwork with 40 mm (1½") thick, blanket-type, fiberglass insulation with factory-applied vapor barrier, and 2" stapling and taping flange along one edge. Insulation: ASTM C553, density of 0.75, conductivity of 0.32. Vapor barrier: aluminum foil, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.
- 2.4.2.2. Apply insulation from outlet of air handling equipment to air distribution equipment
- 2.4.2.3. Jacket
 - 2.4.2.3.1. Apply for exposed ductwork a zero permeability, all weather, multi-layered laminate coated with a cold weather acrylic adhesive, superior resistance to weathering, mold, UV and extreme environmental conditions. Designed for use as a vapour barrier for insulation cladding and jacketing applications.
 - 2.4.2.3.2. Zero permeability vapour barrier for insulation cladding and jacketing applications
 - 2.4.2.3.3. Cold weather acrylic adhesive applies easily at temperatures as cold as -23°C (-10°F)
 - 2.4.2.3.4. Puncture and Tear resistant
 - 2.4.2.3.5. Self-Adhesive material installs easily with no offsite fabrication required
 - 2.4.2.3.6. Cuts and installs easily on-site, no special tools required
 - 2.4.2.3.7. Flexible, strong, reinforced insulation cladding
 - 2.4.2.3.8. Standard Acceptance: 3M™ VentureClad™ Insulation Jacketing

2.4.3. Round Ductwork - Outdoor

- 2.4.3.1. Insulate ductwork with 50 mm (2") thick, blanket-type, fiberglass insulation with factory-applied vapor barrier, and 2" stapling and taping flange along one edge. Insulation: ASTM C553, density of 0.75, conductivity of 0.32. Vapor barrier: aluminum foil, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.
- 2.4.3.2. Jacket
 - 2.4.3.2.1. A zero permeability, all weather, multi-layered laminate coated with a cold weather acrylic adhesive, superior resistance to weathering, mold, UV and extreme environmental conditions. Designed for use as a vapour barrier for insulation cladding and jacketing applications.
 - 2.4.3.2.2. Zero permeability vapour barrier for insulation cladding and jacketing applications
 - 2.4.3.2.3. Cold weather acrylic adhesive applies easily at temperatures as cold as -23°C (-10°F)
 - 2.4.3.2.4. Puncture and Tear resistant
 - 2.4.3.2.5. Self-Adhesive material installs easily with no offsite fabrication required

- 2.4.3.2.6. Cuts and installs easily on-site, no special tools required
- 2.4.3.2.7. Flexible, strong, reinforced insulation cladding
- 2.4.3.2.8. Standard Acceptance: 3M™ VentureClad™ Insulation Jacketing

2.4.4. Rectangular Ductwork – any side larger than 750 mm (30")

- 2.4.4.1. In mechanical equipment rooms and all other areas where visible without removing ceilings or opening access panels, insulate ductwork with 40 mm (1 ½" thick) rigid, fiberglass insulation board ASTM C612 Class 2, conductivity of 0.26, density of 3.0. with factory-applied vapor barrier. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.
- 2.4.4.2. In ceiling spaces, building shafts, and other locations where not visible, insulate ductwork with 1-1/2" thick, blanket-type, fiberglass insulation with factory-applied vapor barrier, and 2" stapling and taping flange along one edge. Insulation: ASTM C553, density of 0.75, conductivity of 0.23 @75F. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.
- 2.4.4.3. Jacket
 - 2.4.4.3.1. Apply on exposed ductwork a zero permeability, all weather, multi-layered laminate coated with a cold weather acrylic adhesive, superior resistance to weathering, mold, UV and extreme environmental conditions. Designed for use as a vapour barrier for insulation cladding and jacketing applications.
 - 2.4.4.3.2. Zero permeability vapour barrier for insulation cladding and jacketing applications
 - 2.4.4.3.3. Cold weather acrylic adhesive applies easily at temperatures as cold as -23°C (-10°F)
 - 2.4.4.3.4. Puncture and Tear resistant
 - 2.4.4.3.5. Self-Adhesive material installs easily with no offsite fabrication required
 - 2.4.4.3.6. Cuts and installs easily on-site, no special tools required
 - 2.4.4.3.7. Flexible, strong, reinforced insulation cladding
 - 2.4.4.3.8. Standard Acceptance: 3M™ VentureClad™ Insulation Jacketing

2.4.5. Outdoor Rectangular Ductwork – any size

- 2.4.5.1. Insulate ductwork with 50 mm (2" thick) rigid, fiberglass insulation board with factory-applied vapor barrier. Insulation: ASTM C612 Class 2, conductivity of 0.26, density of 3.0.
- 2.4.5.2. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.

2.4.5.3. Jacket

- 2.4.5.3.1. A zero permeability, all weather, multi-layered laminate coated with a cold weather acrylic adhesive, superior resistance to weathering, mold, UV and extreme environmental conditions. Designed for use as a vapour barrier for insulation cladding and jacketing applications.
- 2.4.5.3.2. Zero permeability vapour barrier for insulation cladding and jacketing applications
- 2.4.5.3.3. Cold weather acrylic adhesive applies easily at temperatures as cold as -23°C (-10°F)
- 2.4.5.3.4. Puncture and Tear resistant
- 2.4.5.3.5. Self Adhesive material installs easily with no offsite fabrication required
- 2.4.5.3.6. Cuts and installs easily on-site, no special tools required
- 2.4.5.3.7. Flexible, strong, reinforced insulation cladding
- 2.4.5.3.8. Standard Acceptance: 3M™ VentureClad™ Insulation Jacketing

2.4.6. Kitchen Exhaust Ductwork listed under NFPA-96

- 2.4.6.1. Fire Rated Grease Duct Insulation (High Temperature Flexible Blanket); 1½ inch thick refractory grade fibrous fire barrier material with minimum service temperature design of 2,000 degrees F; aluminum foil laminated on both sides; with a minimum 'k' value of 0.25 and a minimum density of 6 lbs/cu ft; containing no asbestos. Listed by a nationally recognized testing laboratory (NRTL) UL to meet ASTM E 2336, ASTM E119, and with flame spread/smoke minimum rating of 25 / 50 when tested as per ASTM E84/UL 723.

2.4.7. Accessories

- 2.4.7.1. Closure Materials: Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
- 2.4.7.2. Support Materials: Hanger straps, hanger rods, saddles, support rings.
- 2.4.7.3. Contact adhesive: quick-setting, non-flammable fire resistive adhesive to adhere fibrous glass to ducts. Flame spread 15 smoke development 0.

PART 3 - EXECUTION

3.1. GENERAL REQUIREMENTS

- 3.1.1. Required pressure tests of piping and ductwork joints and connections shall be completed and the work approved by the Consultant for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- 3.1.2. Except for specific exceptions, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full-length section will fit.

- 3.1.3. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- 3.1.4. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- 3.1.5. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- 3.1.6. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- 3.1.7. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- 3.1.8. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights.
- 3.1.9. Hot piping work not to be insulated:
 - 3.1.9.1. Factory pre-insulated components.
 - 3.1.9.2. Over equipment nameplates.
 - 3.1.9.3. Vibration control devices
 - 3.1.9.4. Air chambers, unions, strainers, check valves, flow regulators.
 - 3.1.9.5. Pot feeders, filtration cartridges
- 3.1.10. Ductwork not to be insulated:
 - 3.1.10.1. Indoor return ductwork
 - 3.1.10.2. Exhaust air ductwork up to 3 m (10 ft) prior to existing the building
- 3.1.11. Firestop Pipe insulation:

- 3.1.11.1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed.
- 3.1.11.2. Pipe penetrations requiring fire stop insulation including, but not limited to the following:
 - 3.1.11.2.1. Pipe risers through floors
 - 3.1.11.2.2. Pipe chase walls and floors
 - 3.1.11.2.3. Smoke partitions
 - 3.1.11.2.4. Fire partitions
 - 3.1.11.2.5. Freeze protection of above grade outdoor piping (over heat tracing tape): 20 mm (0.75) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide where indicated on the drawings
- 3.1.12. Provide vapor barrier jackets over insulation as follows:
 - 3.1.12.1. All piping and ductwork exposed to outdoor weather.
 - 3.1.12.2. All interior piping and ductwork conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.
- 3.1.13. Provide metal jackets over insulation as follows:
 - 3.1.13.1. All HVAC piping and ductwork exposed to outdoor weather.

3.2. INSULATION INSTALLATION

3.2.1. Molded Mineral Fiber Pipe and Tubing Covering:

- 3.2.1.1. Fit insulation to pipe, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.

3.2.2. Flexible Mineral Fiber Blanket - Ductwork:

- 3.2.2.1. Adhere insulation to metal with 75 mm (3 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.

- 3.2.2.2. Blanket insulation shall be tightly sealed at all joints and seams. Insulation shall be cut longer than ductwork perimeter to allow maximum thickness on all areas and avoid excessive compression. All joints shall be over lapped at least 2" and stapled in place. The stapled seams shall be sealed with a minimum 3" wide pressure sensitive tape designed for use with the duct insulation. All breaks in the vapor barrier facing shall also be sealed with the tape. The underside of ductwork 18" or greater in width, and vertical surfaces 48" or greater shall have the insulation additionally secured with mechanical fasteners and speed clips spaced approximately 12" on center. The protruding ends of the fasteners shall be cut off flush after the speed clips are installed, and then sealed with the same tape as specified above.
- 3.2.2.3. Finished installation shall provide a continuous and effective vapor barrier.
- 3.2.2.4. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation, insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.

3.2.3. Rigid Board Mineral Fiber Insulation - Ductwork

- 3.2.3.1. Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
- 3.2.3.2. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
- 3.2.3.3. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
- 3.2.3.4. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.

3.2.4. Duct Wrap for Kitchen Hood Grease Ducts:

- 3.2.4.1. Not Applicable.

3.2.5. Flexible Elastomeric Cellular Thermal Insulation:

3.2.5.1. Not applicable

3.3. INSULATION JOINTS

- 3.3.1. All insulation joints should be sealed with pressure-sensitive joint sealing tape to match the insulation facing. Rub hard with a plastic sealing tool to affect a tight bond.
- 3.3.2. Recommended practice: 3" (76mm) wide tape on flat surfaces or where edges are ship-lapped and stapled. Use 5" (102mm) wide tape in lieu of ship-lapping.
- 3.3.3. All sheet metal joints must be sealed prior to insulating.

3.4. INSULATION AT DUCT SUPPORTS

- 3.4.1. Refer to and conform strictly to insulation and protection jacket manufacturers' instructions.
- 3.4.2. To properly insulate through a roof top duct support; lift duct off of support, insulate duct through the support, install protection jacket through the support and add an additional layer of protection jacket 6" wide on the bottom and both sides at the point of contact with the support system.
- 3.4.3. When it is not possible to lift a duct off the rooftop supports, it is necessary to incorporate the support system into the insulation system by encapsulating the supports with insulation. This same system must be used if duct supports are screwed onto the ductwork

3.5. FIELD-APPLIED JACKET APPLICATION

- 3.5.1. Apply PVC jacket on piping insulation where indicated, with 1 inch (25 mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
- 3.5.2. Apply aluminum jacket where indicated (piping and ductwork) and on all piping/ductwork located outdoors, with 2-inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel band 12 inches (300 mm) o.c. and at end joints. Provide vapor-barrier jackets. Aluminum jackets shall have seams located below the horizontal plane of the horizontal piping route. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and cover with aluminum jackets.

3.6. OUTDOOR DUCTWORK – RECTANGULAR

- 3.6.1. All roof-top ductwork to must be designed and built with adequate slope (watershed) to prevent ponding water. Ponding water is defined as water that stays in place for greater than 24 hours.

Table of Contents

PART 1 - GENERAL	3
1.1. GENERAL	3
1.2. APPROVED CONTROL SYSTEMS	3
1.3. SCOPE OF WORK	4
1.4. QUALITY ASSURANCE	5
1.5. CODES AND STANDARDS	5
1.6. APPROVED CONTROL SYSTEM MANUFACTURERS	6
1.7. EQUIPMENT INSTALLED BY OTHERS (WHERE APPLICABLE TO PROJECT)	6
1.8. SUBMITTALS	7
1.9. PROJECT RECORD DOCUMENTS	9
1.10. WARRANTY	10
1.11. BOARD OWNERSHIP OF PROPRIETARY MATERIAL	10
1.12. FACILITIES WITH EXISTING BUILDING AUTOMATION SYSTEM	10
1.13. CRITICAL ALARM CONTROL SEQUENCES	11
PART 2 - PRODUCTS	12
2.1. CONTROLLERS	12
2.2. COMMUNICATION	13
2.3. CONNECTION TO THE BOARD SERVER	14
2.4. BOARD CENTRAL SERVER	14
2.5. LOCAL SERVICE PORTS	14
2.6. COMMUNICATION	14
2.7. INPUT AND OUTPUT INTERFACE	16
2.8. POWER SUPPLIES AND LINE FILTERING	17
2.9. AUXILIARY CONTROL DEVICES	18
2.10. FAIL STATE POSITION OF OUTPUTS	26
2.11. LAN CABLING	27
2.12. WIRING AND RACEWAYS	28
PART 3 - EXECUTION	28
3.1. EXAMINATION	28
3.2. PROTECTION	29

3.3.	COORDINATION	29
3.4.	GENERAL WORKMANSHIP	30
3.5.	FIELD QUALITY CONTROL	30
3.6.	EXISTING EQUIPMENT	30
3.7.	WIRING	31
3.8.	COMMUNICATION WIRING	32
3.9.	FIBER OPTIC CABLE	33
3.10.	INSTALLATION OF SENSORS	33
3.11.	FLOW SWITCH INSTALLATION	35
3.12.	ACTUATORS	35
3.13.	WARNING LABELS.....	35
3.14.	IDENTIFICATION OF HARDWARE AND WIRING	36
3.15.	PROGRAMMING	36
3.16.	SEQUENCES OF OPERATION	37
3.17.	EQUIPMENT ENCLOSURES AND LOCATIONS.....	37
3.18.	IDENTIFICATION AND LABELING OF CONTROL EQUIPMENT.....	38
3.19.	SYSTEM HARDWARE COMMISSIONING	39
3.20.	SUBSTANTIAL COMPLETION INSPECTION	41
3.21.	CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE.....	42
3.22.	CLEANING	43
3.23.	TRAINING.....	43

PART 1 - GENERAL

1.1. GENERAL

- 1.1.1. This section of the specification shall be read in conjunction with and shall be governed by the requirements outlined in Section: 23 05 00 Common Work Results for HVAC.
- 1.1.2. The Building Automation System (BAS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection. The BAS shall be the latest generation system available from the installation contractor that has been previously reviewed and accepted by the Board.
- 1.1.3. Perform an in-depth review of all existing control components associated with the work scope (e.g. controllers, control valves, control dampers, linkages, actuators, pipe and duct sensors, flow switches, etc.).
- 1.1.4. Immediately report any defective or inoperative components to the Consultant.
- 1.1.5. Co-ordinate and supervise the work of all sub-contractors required to complete the scope of work as specified in the contract documents.
- 1.1.6. The Controls Contractor and all sub-contractors shall employ only certified trades persons to carry out all applicable work.
- 1.1.7. Provide all necessary control wiring and hardware to complete the entire project, including but not limited to, wiring, fittings, connectors, conduits, hangers/supports, box covers, and all other accessories required to ensure complete, safe and fully operational systems.
- 1.1.8. The BAS at minimum, shall incorporate the following integrated features, functions, and services:
 - 1.1.8.1. Operator information, alarm management and control function.
 - 1.1.8.2. As-built drawings in a separate PDF file, to be retrievable by the Operator at any given time using the BAS interface.
 - 1.1.8.3. Control access
 - 1.1.8.4. Information management, including monitoring, transmission, archiving, retrieval and reporting functions
 - 1.1.8.5. Diagnostic monitoring and reporting of BAS functions
 - 1.1.8.6. Offsite monitoring and management access
 - 1.1.8.7. Energy Management

1.2. APPROVED CONTROL SYSTEMS

1.2.1. Delta Controls (Viridian)

1.3. SCOPE OF WORK

1.3.1. The general outline of the scope of work includes but is not limited to the following:

- 1.3.1.1. Remove all electric and pneumatic control devices, sensors, valves, operators and controllers serving the existing wall-fin convectors and existing mini split system equipment (refer to drawings for scope). Work includes removal of all indicated control valves and thermostats, and any associated wiring and pneumatic wiring.
- 1.3.1.2. Supply and install all the new BAS components (sensors, actuators, valves, operators, wiring, relays, controllers, panels, etc) required to make the new ERV, fancoil and mini split system operate in accordance with the sequences indicated on the drawings.
- 1.3.1.3. Remove any redundant timers and associated wiring and devices controlling the demolished equipment.
- 1.3.1.4. Update existing programming and user interface as required to match the sequence of operation indicated on the drawings; c/w graphical displays on the Board main server to match the new equipment layout and configuration.
- 1.3.1.5. Provide all necessary power wiring and hardware to complete the entire project, including but not limited to, wiring, fittings, connectors, conduits, hangers/supports, box covers, BAS control panels, and all other accessories required to ensure complete, safe and fully operational systems. This shall include the power wiring for all the equipment.
- 1.3.1.6. Make good all surfaces affected by the work.
- 1.3.1.7. All removed control valves to be returned to the Board. Coordinate with the Board for confirmation.
- 1.3.1.8. Arrange for Electrical Authority inspection of all electrical work done by the Control Sub- Contractor. Submit the Certificate of Inspection and Product Approval Certificate with the as built documentation.
- 1.3.1.9. Provide new wiring.
- 1.3.1.10. Update software and graphical interface as required.
- 1.3.1.11. All line and low voltage wiring shall be run in EMT metal conduit.
- 1.3.1.12. Control wiring installed in exposed areas (common areas, mechanical rooms, outdoors) shall be run in IMC rigid metal conduit
- 1.3.1.13. Control wiring installed in the ceiling space shall be plenum rated and does not require rigid conduit. Any controls wiring in ceiling spaces is to be run in a cable management tray, and transitions from the tray shall neatly follow the building structure and any wall penetrations must be sleeved in conduit with nylon bushings.
- 1.3.1.14. Include all wiring, conduit, piping, installation, materials, supervision and labor including calibration, commissioning software programming and data base

generation, and additional work necessary to provide a complete and fully operating system to the approval of the Consultant.

- 1.3.1.15. Controls sub-contractor shall coordinate with the electrical sub-contractor for the location of breakers and junction boxes from which power to the control's equipment will be provided. The over-all responsibility for providing and coordinating power supply to the controls equipment rests with the mechanical contractor in his capacity as general contractor.
- 1.3.1.16. The BAS shall be completed in all details not necessarily defined or shown on the drawings but as may be reasonably inferred as necessary to complete each system and provide operating service in an acceptable manner.
- 1.3.1.17. Upon completion of the installation, all control equipment supplied under this control shall be adjusted to place the system in complete operating condition subject to the Owner's approval. All adjustments shall be made in co-ordination with the TAB sub-contractor responsible for balancing the air and water systems where required.
- 1.3.1.18. For variable flow systems (air or hydronic), coordinate the final settings of pressure differential setpoints with the TAB contractor, to achieve the design flows noted in the equipment schedules.
- 1.3.1.19. When removing existing equipment, it is the responsibility of the contractor to ensure the integrity of the BAS communication line that must remain intact to ensure the proper function of the remainder of the school BAS system.
- 1.3.1.20. The BAS shall modulate the electric duct heaters as noted in the control diagrams.
- 1.3.1.21. All new mechanical equipment to be on BAS. Refer to control diagrams in issued drawings.
- 1.3.1.22. The existing VRF system consists of one outdoor heat pump unit located on the roof serving 3 indoor evaporator units in rooms 201, 203, 204. The control points for these units are to be transferred to the new BAS system. Each evaporator unit has 3 binary outputs (G-Fan, Y- cooling, W- Heating) for a total of 9 binary outputs.
- 1.3.1.23. The new BAS control panel and controller to be located in new Copy Room 202A.

1.4. QUALITY ASSURANCE

- 1.4.1. Base bid basis of design products referenced under this Section establish the minimum acceptable standards of product quality, features and performance.
- 1.4.2. Work of this Section shall be provided by a recognized contractor regularly employed in the installation and wiring of BAS and temperature control system and equipment. The Board will provide a list of acceptable Contractors to bid the work (see Boards list of Pre-Qualified contractors).

1.5. CODES AND STANDARDS

1.5.1. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

- 1.5.1.1. National Electric Code (NEC)
- 1.5.1.2. International Building Code (IBC)
 - 1.5.1.2.1. Section 719 Ducts and Air Transfer Openings
 - 1.5.1.2.2. Section 907 Fire Alarm and Detection Systems
 - 1.5.1.2.3. Section 909 Smoke Control Systems
- 1.5.1.3. Division 23 Mechanical
- 1.5.1.4. International Mechanical Code (IMC)
- 1.5.1.5. ANSI/ASHRAE 135-2004: Data Communication Protocol for Building Automation and Control Systems (BACNET)

1.6. APPROVED CONTROL SYSTEM MANUFACTURERS

1.6.1. Only approved building automation systems will be accepted.

1.7. EQUIPMENT INSTALLED BY OTHERS (WHERE APPLICABLE TO PROJECT)

1.7.1. As required, the following equipment shall be supplied as noted and installed by qualified sub trades as part of this contract:

1.7.2. Supply by Mechanical Contractor/Power wiring by Electrical Contractor/Controls wiring by Controls Contractor:

- 1.7.2.1. Variable Speed Drives, where not integral part of mechanical equipment

1.7.3. Supply Mechanical Contractor / Install – Mechanical Contractor

- 1.7.3.1. Automatic control dampers (not supplied with packaged equipment)

1.7.4. Supply Mech. Contractor/ install Control Contractor / wired by Control Contractor (not supplied with packaged equipment)

- 1.7.4.1. Damper Actuators

1.7.5. Supply by Control Contractor / install by Mech. Contractor/ wired by Control Contractor

- 1.7.5.1. Automatic Controls Valves & Actuators
- 1.7.5.2. Space temperature sensors

1.7.6. Supply and wired by Control Contractor/ installed by Mechanical Contractor

- 1.7.6.1. Temperature Sensing Wells

1.7.7. Supply by Mech. Contractor/ installed by Mech. Contractor/ wired by Control, Contractor

1.7.7.1. Air and Hydronic Flow and Pressure sensors

1.7.8. The final completeness of all required components to make equipment operational as indicated on the sequences of operation including wiring, setting and adjustment remains as the final the responsibility of the mechanical contractor acting as the general contractor.

1.8. SUBMITTALS

1.8.1. Provide three copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Drawings should be 11" x 17" prints.

1.8.2. Provide submittals within 6 weeks of contract award.

1.8.3. Begin no work until submittals have been approved for conformity with design intent.

1.8.4. Provide drawings using AutoCAD 2007 (or newer) in following formats: original, pdf and print.

1.8.5. Submittal approval does not relieve Contractor of responsibility to supply sufficient materials to complete work.

1.8.6. Provide submittals on the following:

1.8.6.1. Product Submittals. Clearly indicate applicable data on manufacturer's cut sheets by highlighting or by other means. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work.

1.8.6.2. Network Architecture. Riser diagrams showing control network layout, connections to all network devices, communication protocols, network speeds and wire types. Include schematic diagrams of control, communication, and power wiring for central system installation. Show interface wiring to control system.

1.8.6.3. Schematics. Schematic diagram of each controlled system. Label all control points with point names.

1.8.6.4. Wiring diagrams including complete power system, interlocks, control and data communications.

1.8.6.5. Programming code listing for all controllers

1.8.6.6. Manufacturers' data/specification sheets and catalogue cuts for all material and equipment supplied.

1.8.6.7. Floor plan schematic diagrams indicating field sensor and controller locations.

1.8.6.8. Valve Schedule. Indicate system and device designation, product name, manufacturer, and model numbers (both valve and actuator), quantities, sizes, Cv

(design and actual), pressure drop, close-off pressure, configuration, ports, and line sizes of each supplied valve and existing control valve.

- 1.8.6.9. Damper Schedule. Indicate system and device designation, product name, manufacturer, size, and model numbers (both damper and actuator) of each supplied damper/actuator and existing control damper/actuator.
 - 1.8.6.10. Room and Equipment Schedules. Indicate controller type, address, model number, object names, setpoints, and room location.
 - 1.8.6.11. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - 1.8.6.12. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 - 1.8.6.12.1. Direct digital controllers (controller panels)
 - 1.8.6.12.2. Transducers and transmitters
 - 1.8.6.12.3. Sensors (include accuracy data)
 - 1.8.6.12.4. Actuators
 - 1.8.6.12.5. Valves
 - 1.8.6.12.6. Dampers
 - 1.8.6.12.7. Relays and switches
 - 1.8.6.12.8. Control panels
 - 1.8.6.12.9. Power supplies
 - 1.8.6.12.10. Batteries
 - 1.8.6.12.11. Operator interface equipment
 - 1.8.6.12.12. Wiring
 - 1.8.6.13. Complete description of control system operation including sequences of operation and points-lists for each control system. Include and reference schematic diagram of controlled system. List I/O points and software points specified in this section. Indicate alarmed and trended points.
 - 1.8.6.14. Wiring diagrams and layouts for each control panel. Show termination numbers.
 - 1.8.6.15. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - 1.8.6.16. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.
- 1.8.7. Schedules
- 1.8.7.1. Construction Schedule of work provided within one month of contract award, indicating:
 - 1.8.7.1.1. Intended sequence of work items
 - 1.8.7.1.2. Start date of each work item

- 1.8.7.1.3. Duration of each work item
 - 1.8.7.1.4. Planned delivery dates for ordered material and equipment and expected lead times.
 - 1.8.7.1.5. Milestones indicating possible restraints on work by other trades or situations.
- 1.8.8. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

1.9. PROJECT RECORD DOCUMENTS

- 1.9.1. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:
- 1.9.1.1. As-built versions of submittal shop drawings should be 11" x 17" prints. Provide drawings using AutoCAD 2007 (or newer) in following formats: original, pdf and print.
 - 1.9.1.2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of this section (Control System Demonstration and Acceptance).
 - 1.9.1.3. An Information sheet that contains:
 - 1.9.1.3.1. School name and address
 - 1.9.1.3.2. A brief description of the control details. i.e. total # of points, list of equipment controls and which panels they are connected to.
 - 1.9.1.3.3. Panel's information i.e. part numbers for panels used and their serial numbers and revision # (if applicable)
 - 1.9.1.3.4. Software version
 - 1.9.1.3.5. Modem telephone number
 - 1.9.1.3.6. Warranty start date and duration
 - 1.9.1.3.7. BAS contractor Name, address, and Phone number
 - 1.9.1.4. Detailed sequence of operation for each controlled system.
 - 1.9.1.5. Control schematics for each system. Including a System Architecture indicating the type and model number for all BAS components, the proposed interconnection and location of all panels, network connection and key peripheral devices (workstations, modems, printers, repeaters, etc)
 - 1.9.1.6. BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e. AO/DO/AI/DI), end device fail position, end device manufacture and model number and wire tag ID.
 - 1.9.1.7. Floor plan with the location of all field mounted control devices.
 - 1.9.1.8. Programming code for all DDC controllers.
 - 1.9.1.9. Wiring diagrams including complete power system, interlocks, control and data communications.

- 1.9.1.10. Manufacturers' data/specification sheets and catalogue cuts for all material and equipment supplied. This section shall include a summary sheet that indicates all BAS Device, Manufacturers', model number, and quantity of each used on this job.
- 1.9.1.11. Automatic control valves and dampers where required.
- 1.9.1.12. Commissioning list including the name of the commissioning agent of the BAS Contractor, his signature and the date of commissioning.
- 1.9.1.13. Licensed BAS workstation software.
- 1.9.1.14. BAS programming database stored on a USB memory stick.

1.10. WARRANTY

1.10.1. Warrant work as follows:

- 1.10.1.1. All labour and material (hardware and software) supplied under this contract shall be warranted free from defects for a period of two (2) years after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost to the Board. The Contractor shall respond to Board request for warranty service within one (1) business day.
- 1.10.1.2. The final completion and substantial performance date shall be the date of the project turnover meeting.
- 1.10.1.3. All work shall have a single warranty date, even when the Board has received beneficial use of part of the system in advance of the final completion date.
- 1.10.1.4. The contractor shall be responsible for correcting any deficiencies, errors or omissions in operating strategies, programming code, system functionality or parameters and operator workstation graphics during the warranty period.

1.11. BOARD OWNERSHIP OF PROPRIETARY MATERIAL

1.11.1. Project-specific software and documentation shall become Board's property. This includes, but is not limited to:

- 1.11.1.1. Record drawings / Documentation
- 1.11.1.2. Database
- 1.11.1.3. Application programming code (Two copies and two licenses of Engineering (Program) Tool)
- 1.11.1.4. All documentation.

1.12. FACILITIES WITH EXISTING BUILDING AUTOMATION SYSTEM

- 1.12.1. Where a facility has an existing BAS that is to be replaced, modified or upgraded, the Controls Contractor shall be responsible for ensuring that the entire system (hardware, programming and system graphics) and all integral parts (new and re-used) are in conformance with all requirements of the specifications outlined herein.

- 1.12.2. Ensure complete interoperability and compatibility between new and existing DDC systems and components. Provide system firmware and/or hardware upgrades to existing DDC panels/modules where required to ensure a complete working system to the satisfaction of the Consultant.
- 1.12.3. Where an existing DDC panel is re-used, ensure that sufficient controller memory is present to provide for all specified control functions. Provide memory and/or panel upgrades where required to meet system memory requirements.
- 1.12.4. Provide new network communication wiring for interconnection between all DDC panels and interfaces.
- 1.12.5. Existing control wiring and conduits may be re-used only where they comply with the requirements of these specifications and where approved by the Consultant.
- 1.12.6. Ensure that all re-used DDC panels/modules are upgraded to the latest version of system firmware and system operating software.
- 1.12.7. Provide complete commissioning and verification of all re-used automation input/output points, end devices and components.
- 1.12.8. Provide new labeling for wiring, devices and equipment where existing labelling does not meet the requirements of these specifications.

1.13. CRITICAL ALARM CONTROL SEQUENCES

- 1.13.1. Critical alarms are displayed on the plant operator's PC. Critical alarms warn the building operators about critical control problems that require immediate attention.
- 1.13.2. Critical alarms shall be activated for the following reasons:
 - 1.13.2.1. a boiler or air handler status has not responded to control by the FMS for more than 5 minutes
 - 1.13.2.2. a VFD status has not responded to control by the FMS for more than 5 minutes
 - 1.13.2.3. a heating pump or boiler pump status has not responded to control by the FMS for more than 10 minutes
 - 1.13.2.4. a boiler flame ignition failed
 - 1.13.2.5. a boiler low water cut off has shut the boiler
 - 1.13.2.6. a boiler high limit temperature has shut the boiler
 - 1.13.2.7. FMS low limit temperature controller has tripped
 - 1.13.2.8. FMS supply fan and return fan status has been OFF
 - 1.13.2.9. a space temperature has read below 16OC for more than 10 minutes
 - 1.13.2.10. the radiation supply water temperature is more than 10OC below the supply water low limit for 1 hour during heating season (as determined by OAT)

1.13.2.11. return water temperature in the radiation and glycol loops has dropped 10OC below the low limit.

1.13.3. The remote alarm shall remain in effect until all of the critical alarm conditions are cleared.

1.13.4. The remote alarm shall be disabled when the outside air temperature is above 10OC.

PART 2 - PRODUCTS

2.1. CONTROLLERS

2.1.1. General.

2.1.1.1. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified herein.

2.1.1.2. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

2.1.2. BACNET.

2.1.2.1. Building Controllers (BCs): Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.

2.1.2.2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

2.1.2.3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

2.1.2.4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.

2.1.2.5. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

2.1.3. BACNET Communication.

- 2.1.3.1. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
- 2.1.3.2. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
- 2.1.3.3. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- 2.1.3.4. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- 2.1.3.5. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- 2.1.3.6. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

2.2. COMMUNICATION

- 2.2.1. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.
- 2.2.2. Install new wiring and network devices as required to provide a complete and workable control network.
- 2.2.3. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- 2.2.4. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
- 2.2.5. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
- 2.2.6. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in this section. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

- 2.2.7. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
- 2.2.8. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.3. CONNECTION TO THE BOARD SERVER

- 2.3.1. Advise the Board representative of the proposed location of the system router/gateway panel within the facility. The controls vendor shall provide a communication cable (RJ45) between the BAS Controller and the schools HUB under the Board supervision and comply with the Board standard and he shall connect the BAS to the Board server and WAN and confirm that network access to the BAS has been established.

2.4. BOARD CENTRAL SERVER

- 2.4.1. New site databases shall be installed on the designated central BOARD central server.
- 2.4.2. Provide written notification to the BOARD representative prior to installing new site databases to the BOARD server. Do not install software or make any changes to the server without the written consent of the BOARD representative.
- 2.4.3. Set up and configure the server software and area routers (where required) to allow for seamless access to the site BAS via the BOARD WAN.
- 2.4.4. Coordinate all activities related to the central server with the BOARD representatives. Provide the BOARD with detailed documentation related to any changes made to the server software, settings or protocols.

2.5. LOCAL SERVICE PORTS

- 2.5.1. Every DDC panel shall be provided with a local network access port to connect to laptop computer. A user connected to the local access port shall have the same level of system access and functionality as being connected to the site workstation PC.
- 2.5.2. Where BAS points (4 or more) are located in a mechanical room that does not have a local BAS panel installed, a remote network access port shall be provided. The access port shall be installed in a hinged metal enclosure with key-lock set and Iamaco ID label.

2.6. COMMUNICATION

- 2.6.1. Service Port

- 2.6.1.1. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.

2.6.2. Signal Management

- 2.6.2.1. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.

2.6.3. Data Sharing

- 2.6.3.1. Each BC and AAC shall share data as required with each networked BC and AAC.

2.6.4. Stand-Alone Operation

- 2.6.4.1. Each piece of equipment specified in this section Appendix A shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

2.6.5. Environment

- 2.6.5.1. Controller hardware shall be suitable for anticipated ambient conditions.
- 2.6.5.2. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
- 2.6.5.3. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

2.6.6. Keypad

- 2.6.6.1. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

2.6.7. Real-Time Clock

- 2.6.7.1. Controllers that perform scheduling shall have a real-time clock

2.6.8. Serviceability

- 2.6.8.1. Controllers shall have diagnostic LEDs for power, communication, and processor.
- 2.6.8.2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
- 2.6.8.3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- 2.6.9. Memory
 - 2.6.9.1. Controller memory shall support operating system, database, and programming requirements.
 - 2.6.9.2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 - 2.6.9.3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
 - 2.6.9.4. Each controller shall have a min. 25% spare memory to allow for future expansion.
 - 2.6.9.5. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- 2.6.10. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.7. INPUT AND OUTPUT INTERFACE

- 2.7.1. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- 2.7.2. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
- 2.7.3. Digital Inputs. Digital inputs shall monitor the on and off signal from a remote device. Digital inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Digital inputs shall sense dry contact closure without application of power external to the controller.
- 2.7.4. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

- 2.7.5. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- 2.7.6. Digital Outputs. Digital outputs shall send an on-or-off signal for on and off control. Building Controller Digital outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- 2.7.7. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Analog outputs shall not drift more than 0.4% of range annually.
- 2.7.8. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- 2.7.9. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.8. POWER SUPPLIES AND LINE FILTERING

- 2.8.1. All electronic equipment shall be complete with all necessary devices to safeguard against voltage spikes, fluctuations, or any other power line anomalies, which might damage the equipment.
- 2.8.2. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
- 2.8.3. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
- 2.8.4. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
- 2.8.5. Line voltage units shall be UL recognized and CSA listed.

2.8.6. Power Line Filtering.

2.8.6.1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:

- 2.8.6.1.1. Dielectric strength of 1000 V minimum
- 2.8.6.1.2. Response time of 10 nanoseconds or less
- 2.8.6.1.3. Transverse mode noise attenuation of 65 dB or greater
- 2.8.6.1.4. Common mode noise attenuation of 150 dB or greater at 40-100 Hz

2.9. AUXILIARY CONTROL DEVICES

2.9.1. Automatic Control Valves

- 2.9.1.1. Automatic control valves, shall be globe type valves. Valves and actuators shall be ordered as one factory-assembled and tested unit. Control ball valves will not be accepted.
- 2.9.1.2. Submit to the Consultant for review the following information for each valve:
 - 2.9.1.2.1. Valve type and size
 - 2.9.1.2.2. Connection type
 - 2.9.1.2.3. Line size
 - 2.9.1.2.4. Valve manufacturer and model number
 - 2.9.1.2.5. Valve flow coefficient
 - 2.9.1.2.6. Design flow
 - 2.9.1.2.7. Pressure drop across valve.
 - 2.9.1.2.8. Maximum close-off pressure
 - 2.9.1.2.9. Actuator manufacturer and model number
 - 2.9.1.2.10. Actuator maximum torque
- 2.9.1.3. Valves 2" (50mm) and smaller shall be constructed of bronze. Valves 2½" (65mm) and larger shall have iron bodies and bronze mountings.
- 2.9.1.4. All control valves shall have stainless steel stems. The bronze in bodies and bonnets of all bronze valves shall conform to ASTM B62 for valves rated up to 150psig (1035 Kpa) working pressure and to ASTM B61 for valves rated at 200 psig (1380 Kpa) working pressure. The bodies and bonnets of iron body valves shall conform to ASTM A126, Class B.
- 2.9.1.5. Control valve discs and seats shall be of bronze for 100 °C or less fluid temperature and of stainless steel for fluid temperatures above 100 °C.
- 2.9.1.6. The control valves shall have tight shut-off. Flat disk valves are not acceptable.
- 2.9.1.7. Control valves 2" (50mm) and smaller shall be complete with screwed ends type, except for bronze valves installed in soldered copper piping which shall be complete with soldering ends. Control valves larger than 2" (50mm) shall be complete with flanged end type and proper flanged adapters to copper shall be provided where flanged valves are installed in copper piping.

- 2.9.1.8. The water control valves shall be sized for a pressure drop of 6 ft. water column or as indicated on mechanical drawings.
- 2.9.1.9. Each automatic control valve must provide the design output and flow rates at pressure drops compatible with equipment selected.
- 2.9.1.10. Each automatic control valve must be suitable for the particular system working pressure.
- 2.9.1.11. Each automatic control valve shall be fitted with a position indicator.
- 2.9.1.12. All the same type control valves shall be the products of a single manufacturer and have the manufacturer's name, pressure rating and size clearly marked on the outside of the body.
- 2.9.1.13. All heating valves: default position shall be fully open to the coil.
- 2.9.1.14. Valves providing two-position service shall be quick opening. Two-way valves shall have replaceable disc or ball.
- 2.9.1.15. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.
 - 2.9.1.16. Two-way: 150% of total system (pump) head.
 - 2.9.1.17. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
- 2.9.1.18. Ports. Valves providing modulating service shall have equal percentage ports.
- 2.9.1.19. Sizing.
 - 2.9.1.19.1. Two-position service: line size.
 - 2.9.1.19.2. Two-way modulating service: select pressure drop equal to the greatest of twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa (5 psi).
 - 2.9.1.19.3. Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 35 kPa (5 psi).
- 2.9.1.20. Standard of Acceptance: Belimo
- 2.9.2. Electric Damper and Valve Actuators.
 - 2.9.2.1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
 - 2.9.2.2. Spring-return Mechanism. Actuators used for power-failure, heating and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS), unless otherwise specified
 - 2.9.2.3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
 - 2.9.2.4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
 - 2.9.2.5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an

external manual gear release. Spring-return actuators with more than 7 N•m (60 in.-lb) torque capacity shall have a manual crank.

2.9.2.6. Standard of Acceptance: Belimo

2.9.3. Positive positioning Relays.

- 2.9.3.1. Whenever a controller has to proportion more than one motor on a single damper, a positive positioning relay must be used. Whenever a controller has to sequence two or more devices, such as valves or dampers, and for all damper operators on modulating dampers, positive positioning relays must be used. Sequencing by spring ranges alone will not be acceptable. Positive positioning relays have positive mechanical feedback of the controlled device, ratio relays are not acceptable.

2.9.4. Switches

- 2.9.4.1. Pressure electric switches have diaphragm operated D.P.D.T. snap acting contacts with electrical rating suitable for applications as specified. Pressure electric switches withstand up to 25 psig. And are provided with adjustable cut-in and cutout settings between 3 and 20 psig.
- 2.9.4.2. Water flow switches are general purpose with a paddle actuated snap acting D.P.D.T. switch rated at 16 amp 120/1/60 A.C.
- 2.9.4.3. Air proving (differential pressure) switches utilize a differential pressure activated, diaphragm actuated, snap acting D.P.D.T. switch rated at 9.8 amp 120/1/60 A.C. full load. Select differential pressure range to suit the application and setpoint is adjustable. Mount switches with diaphragm in a vertical plane. Switches are CSA approved.
- 2.9.4.4. Install minimum positioning switches inside local cabinets and lock switches after system balancing.
- 2.9.4.5. Damper end switches are DPDT, lever operated, activated by damper blade movement and mounted securely on damper frame. Switches have contact ratings of 5A at 120 VAC and are CSA approved.

2.9.5. Electronic Temperature Sensors

- 2.9.5.1. All mixed air sensors are 1000 ohm nickel, resistance temperature detector (RTD) type with a twenty-five foot averaging element. Accuracy of the RTD sensor shall be $\pm 0.6^{\circ}\text{C}$ over a range of -7°C to 49°C (19°F to 120°F).
- 2.9.5.2. All supply and return air sensors are 1000 ohm nickel RTD type temperature detectors. The sensor probe has a minimum length of 450mm (18"). The accuracy of the sensor is $\pm 0.6^{\circ}\text{C}$ over a range of 4°C to 66°C (39°F to 151°F).
- 2.9.5.3. All space sensors (unless noted differently on drawings) are 1000 ohm nickel RTD type temperature detectors. All space sensors are provided with vented

protective covers, local temperature adjustment of $\pm 1^{\circ}\text{C}$ from setpoint, built in occupancy sensor. There shall be no temperature display.

- 2.9.5.4. Local temperature adjustment is by two cap touch buttons and LED scale (no actual temperature gradients will be accepted). The accuracy of the sensor is $\pm 0.6^{\circ}\text{C}$ over a range of 4°C to 49°C (39°F to 120°F).
- 2.9.5.5. All space sensors for vestibules, corridors and other high traffic areas shall be nickel RTD stainless steel plate temperature sensor 100 ohm. Equal to Enercorp.
- 2.9.5.6. All liquid immersed sensors are 1000 ohm nickel RTD type temperature detectors. Each sensor is provided with a stainless steel well, suitable for the working temperature and pressure of the fluid. The accuracy of the sensor is $\pm 0.6^{\circ}\text{C}$ over a range of -7°C to 49°C (19°F to 120°F).
- 2.9.5.7. Outdoor air sensor is the 1000 ohm nickel RTD type temperature detector. The RTD sensor is mounted in a weatherproof enclosure. The accuracy of the sensor is $\pm 0.6^{\circ}\text{C}$ over a range of -40°C to 40°C (-40°F to 120°F).
- 2.9.5.8. All sensor elements other than those for space sensors shall be housed in a factory-made stainless-steel sheath.
- 2.9.5.9. All sensors shall be calibrated and linearized. Include a written documentation of individual sensors for records.

2.9.6. Duct Averaging Temperature Sensors

- 2.9.6.1. Provide plenum mounted mixed air temperature averaging type sensors with the following minimum characteristics:
 - 2.9.6.1.1. Constructed of FT6 plenum rated cable incorporating a minimum of 9 temperature sensors encapsulated at equal distances along the 24 foot length of the element. The assembly acts as a single sensor reporting the average temperature from all individual sensors.
 - 2.9.6.1.2. End-to-end accuracy $\pm 0.3^{\circ}\text{C}$.
 - 2.9.6.1.3. Mount in a zigzag manner to provide continuous coverage of the entire duct cross-sectional area.
 - 2.9.6.1.4. The use of thermistor type sensors is required.
- 2.9.6.2. Standard of Acceptance: Greystone

2.9.7. Outdoor Air Temperature Sensors

- 2.9.7.1. Provide outdoor air temperature sensors with the following minimum characteristics:
 - 2.9.7.1.1. Each sensor shall be 10Kohm thermistor probe
 - 2.9.7.1.2. Provide two sensors for each site.
 - 2.9.7.1.3. Both sensors shall be mounted inside a heavy-duty (blow-proof) solar shield.
 - 2.9.7.1.4. Provide a heavy-duty, metal, wire guard.
- 2.9.7.2. Standard of Acceptance: Greystone

2.9.8. CO₂ Sensor

- 2.9.8.1. Provide CO₂ sensors for either wall or duct mounting applications as specified. Provide a heavy duty metal guard to protect the sensor when mounted on walls. Provide the factory-supplied duct mounting kit for all duct mount applications.
- 2.9.8.2. The sensor shall be microprocessor controlled, fully digital, non-dispersive dual wavelength infrared technology with temperature compensation. The device output shall be 4 to 20mA.
- 2.9.8.3. The sensor shall have a measurement range of 0 to 3000ppm with an accuracy of +/-25ppm in the 15-30C range. Long term stability shall be no greater than 20 ppm per year. The user selectable range shall be 0 to 1500ppm.
- 2.9.8.4. Install the sensor in accordance with all manufacturer's instructions. Wall mounted sensors shall be installed at a minimum height of 72" above the finished floor. Sensors shall not be mounted on an outside wall, close to a window, door or in draft areas with direct airflow.
- 2.9.8.5. The standard of acceptance shall be Greystone

2.9.9. Air Differential Pressure Transmitters

- 2.9.9.1. Provide differential pressure transmitters to sense differential pressure and convert to a proportional electrical output in applications such as pressure independent Variable Air Volume terminals, S/A duct static pressure, etc. The differential pressure range is selected to match the applications. Select materials suitable for the measured variable, i.e. water and air, and to withstand a minimum of twice the normal working pressure.
- 2.9.9.2. Each sensor is provided with an industry standard 4-20 mA transmitter, mounted at the sensor not the SCU or panel unless in a finished area. The transmitter and sensor have a combined accuracy of 0.5% of the differential pressure range.
- 2.9.9.3. Static pressure pickups within finished areas are in blank thermostat cases. Outside static pressure reference heads are complete with a wind baffle cap to eliminate wind pressure effects. The static pressure controller is of the slack diaphragm type with a minimum setpoint range of .01 inches to 6.0 inches W.G.

2.9.10. Liquid Pressure Differential Transmitters

- 2.9.10.1. The differential pressure transmitter is designed with dual remote sensors that enable it to accept high pressure in ranges up to 500 PSI. All models are rated for overload pressure 2X the maximum fully scale range and burst pressure is 5X the maximum full scaled range. Features include field selectable pressure ranges and output signal types, output reversal and slow damping, port swapping and bidirectional measurements for the most flexible applications. The output signal is factory calibrated and temperature compensated for the highest start-up accuracy.

- 2.9.10.2. Provide a 3-valve manifold assembly (optional kit to be ordered with sensor) to facilitate sensor servicing and maintenance.
- 2.9.10.3. Coordinate with the mechanical contractor to provide a pressure tap complete with shut-off valve and "pig tail" tubing (primed with water) for each sensor used to monitor steam pressure.
- 2.9.10.4. Specifications:
 - 2.9.10.4.1. Power Supply: 24 Vac/dc $\pm$ 10% (non-isolated half-wave rectified)
 - 2.9.10.4.2. Output Signal: 4-20 mA sourcing, 0-5/0-10 Vdc (switch selectable)
 - 2.9.10.4.3. LCD: 35 x 15 mm (1.4 x 0.6"), 2-line x 8-character
 - 2.9.10.4.4. Accuracy: $\pm$ 1% full scale of selected range (range 4 is $\pm$ 2%)
 - 2.9.10.4.5. Stability: $\pm$ 0.25% FS typical (1 year)
 - 2.9.10.4.6. Pressure Ranges: 4 per model (menu selectable)
 - 2.9.10.4.7. Media Compatibility: 17-4 PH stainless steel
 - 2.9.10.4.8. Proof Pressure: 2X highest range per model
 - 2.9.10.4.9. Burst Pressure: 20X highest range per model
 - 2.9.10.4.10. Pressure Cycles: > 100 million
 - 2.9.10.4.11. Sensor Operating Range: -40 to 105°C (-40 to 221°F)
 - 2.9.10.4.12. Operating Environment: 0 to 50°C (32 to 122°F), 10 to 90 %RH non-condensing
 - 2.9.10.4.13. Pressure Connection: 1/4" NPT male
 - 2.9.10.4.14. Sensor Housing: IP67
 - 2.9.10.4.15. Remote Sensor Cable: S: FT-6 plenum rated, A: Armored Flexible S/S
 - 2.9.10.4.16. Wiring Connection: 14-22 AWG screw terminal block
 - 2.9.10.4.17. Enclosure: Polycarbonate, UL94-V0, IP65 (NEMA 4X)
- 2.9.10.5. Standard of Acceptance: Schneider EPW series or equivalent
- 2.9.11. Control Relays
 - 2.9.11.1. Control relays are DPDT for control of electrical starters and equipment where shown on the Point Schedule.
 - 2.9.11.2. Coil voltage matches the Unit Controller. Contacts are rated at 5A at 120 VAC.
- 2.9.12. Time Delay Relays
 - 2.9.12.1. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm$ 100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
 - 2.9.12.2. Standard of Acceptance: Enercorp
- 2.9.13. Override Timers

- 2.9.13.1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

2.9.14. Current Transmitters

- 2.9.14.1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
- 2.9.14.2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
- 2.9.14.3. Unit shall be split-core type for clamp-on installation on existing wiring.

2.9.15. Current Transformers

- 2.9.15.1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
- 2.9.15.2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
- 2.9.15.3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

2.9.16. Voltage Transmitters

- 2.9.16.1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
- 2.9.16.2. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
- 2.9.16.3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

2.9.17. Voltage Transformers

- 2.9.17.1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
- 2.9.17.2. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
- 2.9.17.3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

2.9.18. Power Monitors

- 2.9.18.1. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
- 2.9.18.2. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.

2.9.19. Current Switches

- 2.9.19.1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

2.9.20. Current Sensors (Analog)

- 2.9.20.1. Current sensors (CT) shall be used for status monitoring of all motor-driven equipment, where specified.
- 2.9.20.2. Technical Performance – Output should be only 4-20mA only. Voltage output will not be accepted. End-to-end accuracy $\pm 1\%$ of full scale at each range.
- 2.9.20.3. The current sensors shall be mounted inside the starter cabinets whenever possible. If this is not possible due to space limitation, provide an enclosure to house the sensor.
- 2.9.20.4. Standard of Acceptance: Enercorp

2.9.21. Status Relays (Solid State)

- 2.9.21.1. The status relays shall be mounted inside newly provided enclosures mounted near the respective equipment starter cabinets.
- 2.9.21.2. Standard of Acceptance: Omron Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

2.9.22. Variable Speed Drives

- 2.9.22.1. Refer to Section: 26 29 23 Variable-Frequency Motor Controllers.

2.9.23. Fire stopping and Smoke Seal Materials

- 2.9.23.1. Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN4-S115-M85, for installation in U.L.C. designated firestopping and smoke seal Systems. These Systems shall provide a positive fire,

water and smoke seal and a fire- resistance rating (flame, smoke hose stream and temperature) not less than the fire resistance rating of surrounding construction.

2.9.23.2. Materials shall form ULC listed or UL classified assemblies and be compatible with abutting dissimilar materials and finishes.

2.9.23.3. Standard of Acceptance:

2.9.23.3.1. 3M Canada Limited

2.9.23.3.2. A/D Fire Protection System Ltd.

2.9.23.3.3. Fire Stop System

2.9.24. Wall Opening Covering Plates

2.9.24.1. All hole covering plates used on this project shall be stainless steel 18-8 chrome metal alloy, type 302, non-magnetic type for finished areas and pressed steel for unfinished areas. Finish brush marks shall be run in a vertical direction.

2.9.25. Access Doors

2.9.25.1. Access doors installed in unfinished areas shall be constructed of 12 ga prime coated steel and of stainless steel for all areas finished with tile or marble surfaces.

2.9.25.2. Access doors shall be complete with 180° opening door, round safety corners, concealed hinges, screwdriver latches, plaster lock and anchor straps.

2.9.25.3. Access doors shall be 24'x 24' or 12'x 18' as per site condition.

2.9.25.4. Access doors in fire rated construction shall be ULC listed and labeled and of a rating to maintain the fire separation integrity.

2.9.25.5. Standard of Acceptance:

2.9.25.5.1. Zurn Industries Canada Limited

2.9.25.5.2. LeHage Industries Limited

2.9.25.5.3. Acudor Acorn Limited.

2.9.26. Local Control Panels

2.9.26.1. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.

2.9.26.2. Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.

2.9.26.3. Each local panel shall have a control power source power switch (on-off) with over current protection.

2.10. FAIL STATE POSITION OF OUTPUTS

2.10.1. Unless specified otherwise, configure BAS output points for the following fail state (e.g. device position upon panel failure):

2.10.1.1.	All Fans	OFF
2.10.1.2.	Heating Valves	Full heat to terminal device
2.10.1.3.	Mixing Dampers	Full recirculation air
2.10.1.4.	Face/Bypass Dampers	Full to face
2.10.1.5.	Zone Dampers	Full heat
2.10.1.6.	Heating Pumps	ON (except boiler belly pumps)
2.10.1.7.	Boiler Belly Pumps	OFF
2.10.1.8.	Variable Frequency Drives	ON, minimum programmed speed
2.10.1.9.	Lighting Relays	Last State
2.10.1.10.	Boilers (1 stage)	ON
2.10.1.11.	Boilers (Multi-stage)	LOW ON, HIGH OFF
2.10.1.12.	Cooling Equipment	OFF
2.10.1.13.	Electric Heating	OFF
2.10.1.14.	Domestic Hot Water Pumps	OFF
2.10.1.15.	Roof-top Gas Burners	OFF

2.11. LAN CABLING

- 2.11.1. All LAN cabling shall be Category V as defined by EIA/TIA 568A. The contractor shall test all cabling to verify that 100Mb bandwidth is supported. See commissioning requirements.
- 2.11.2. Cabling shall be 4 pair, 100 ohm UTP, #24 AWG solid copper conductor PVC insulated, with blue or grey colour coded jacket. FT6 rated cable shall be used unless otherwise required to meet building codes or by-laws.
- 2.11.3. Data outlets shall be RJ45, 8 pin connectors, with 50 microns of hard gold over nickel, minimum durability of 750 mating cycles and contact pressure of 100 grams per contact. Transmission characteristics shall meet TSB-40 Category V.
- 2.11.4. Provide one RJ45 data outlet adjacent to each device to be terminated (e.g. workstation PC, DDC panel, hub, etc.) Use a flexible patch cable to connect from the data outlet to the end device. For Delta Controls installations, provide a duplex data outlet at the workstation PC to accommodate the remote security key wiring. LAN cabling shall not be directly terminated to any device.
- 2.11.5. Provide protection from EMI sources in accordance with CSA-T530 article 4
- 2.11.6. The contractor shall test all cabling to verify conformance with TIA /EIA TSB-67 - Basic Link Test using a Level 2, bi-directional tester. See commissioning requirements.

- 2.11.7. Where there are more than 2-90 degree in a conduit run, provide a pull box between sections so that there are two bends or less in any one section.
- 2.11.8. Where a conduit run requires a reverse bend, between 100 degrees and 180 degrees, insert a pull box at each bend having an angle from 100 degrees to 180 degrees.
- 2.11.9. Ream all conduit ends and install insulated bushings on each end.
- 2.11.10. Terminate all conduits that protrude through the structural floor 2" above the concrete base.
- 2.11.11. Do not use a pull box in lieu of a conduit bend. Align conduits that enter a pull box from opposite ends with each other.
- 2.11.12. FIBER OPTIC CABLE SYSTEM
- 2.11.13. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
- 2.11.14. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

2.12. WIRING AND RACEWAYS

- 2.12.1. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- 2.12.2. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

PART 3 - EXECUTION

3.1. EXAMINATION

- 3.1.1. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Consultant for resolution before starting rough-in work.
- 3.1.2. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Consultant for resolution before starting rough-in work.
- 3.1.3. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Consultant and obtain written instructions for changes necessary to accommodate this Section's work with work of others. Controls

Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2. PROTECTION

- 3.2.1. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.
- 3.2.2. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3. COORDINATION

3.3.1. Site.

- 3.3.1.1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
- 3.3.1.2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

3.3.2. Life Safety.

- 3.3.2.1. Duct smoke detectors required for air handler shutdown are provided under Division 16 and/or are existing. Interlock smoke detectors to air handlers for shutdown.
- 3.3.2.2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23 and/or are existing. Interlock smoke dampers to air handlers
- 3.3.2.3. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.
- 3.3.2.4. Communication media and equipment shall be provided as specified herein
- 3.3.2.5. Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation described herein regardless of where within the contract documents those products are described.
- 3.3.2.6. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
- 3.3.2.7. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.

- 3.3.2.8. Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.4. GENERAL WORKMANSHIP

- 3.4.1. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- 3.4.2. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- 3.4.3. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
- 3.4.4. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- 3.4.5. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.5. FIELD QUALITY CONTROL

- 3.5.1. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in this section (Codes and Standards).
- 3.5.2. Continually monitor field installation for code compliance and workmanship quality.
- 3.5.3. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.6. EXISTING EQUIPMENT

- 3.6.1. Wiring. Interconnecting control wiring shall be removed and shall become Contractor's property unless specifically noted or shown to be reused.
- 3.6.2. Local Control Panels. Remove and deliver existing control panels to Board.
- 3.6.3. Repair. Unless otherwise directed, Contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Notify Consultant in writing immediately of existing equipment that requires maintenance.
- 3.6.4. Indicator Gauges. Ensure operation of and recalibrate for reasonable accuracy or replace existing gauges.
- 3.6.5. Room Thermostats. Remove and deliver existing room thermostats to Board unless otherwise noted. Patch and finish holes and marks left by removal to match existing walls.

- 3.6.6. Electronic Sensors and Transmitters. Remove and deliver existing sensors and transmitters to Board.
- 3.6.7. Controllers and Auxiliary Electronic Devices. Remove and deliver existing controllers and auxiliary electronic devices to Board.
- 3.6.8. Damper Actuators, Linkages, and Appurtenances: Remove and deliver existing damper actuators, linkages and appurtenances to Board.
- 3.6.9. Control Valves. Replace existing control valves with new. Deliver removed control valves to Board.
- 3.6.10. Existing System Operating Schedule. Existing mechanical system may be disabled during this work.
- 3.6.11. Maintain fan scheduling using existing or temporary time clocks or control systems throughout the control system installation.
- 3.6.12. Modify existing starter control circuits if necessary to provide hand-off-auto control of each controlled starter. Furnish new starters or starter control packages as required.
- 3.6.13. Patch holes and finish to match existing walls.
- 3.6.14. At Board's request, items to be delivered to Board shall instead be properly disposed of. Hazardous materials shall be disposed in accordance with current regulations and applicable by-laws.

3.7. WIRING

- 3.7.1. Control and interlock wiring and installation shall comply with national and local electrical codes, and manufacturer's recommendations.
- 3.7.2. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC.
- 3.7.3. All wiring shall be installed in EMT conduit unless specified otherwise. Exposed wiring in finished areas (e.g. corridors, classrooms, gymnasiums, etc.) shall be installed in wiremold (colour to match surrounding area)
- 3.7.4. Wiring from DDC controllers to sensors and actuators and control system network and low voltage wiring running in accessible ceilings may be installed using LVT cable. Where the ceiling is used as a return air plenum, plenum rated cable shall be used in lieu of LVT cable.
- 3.7.5. Install EMT and cable at right angles to building lines, securely fastened, and in accordance with current electrical codes and standards.

- 3.7.6. Power and control wiring shall be copper conductor (RW90). For power wiring, provide #12 AWG (minimum) with a 3% maximum voltage drop in accordance with CEC requirements. Control wiring shall be a minimum of #14 AWG, unless otherwise specified.
- 3.7.7. The wires smaller than 18 gauge shall not be used and will not be accepted on the project except for: wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.
- 3.7.8. The wiring from panels to devices shall be installed without splices. The use of crimp connectors is not allowed when connecting field wiring to sensor or device leads. The use of wire nuts is acceptable in this application.
- 3.7.9. Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently switched off. Only dedicated circuit(s) shall power the control system. Provide additional breakers or electrical panels as required.
- 3.7.10. Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line-side breakers/fuses for each transformer.
- 3.7.11. All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.
- 3.7.12. A dedicated power circuit may be used to power DDC panels and equipment within the same or adjoining mechanical rooms. The use of one power circuit to power DDC panels distributed throughout the building is not acceptable.
- 3.7.13. The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, rooftop unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status.
- 3.7.14. Provide all required code gauge boxes, connectors and other wiring accessories.
- 3.7.15. For all DC wiring, positive conductors shall be WHITE or RED in colour while negative conductors shall be BLACK in colour.

3.8. COMMUNICATION WIRING

- 3.8.1. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).
- 3.8.2. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

- 3.8.3. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- 3.8.4. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- 3.8.5. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- 3.8.6. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- 3.8.7. Label communication wiring to indicate origination and destination.
- 3.8.8. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- 3.8.9. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 3.8.9.1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - 3.8.9.2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - 3.8.9.3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - 3.8.9.4. An MS/TP EIA-485 network shall have no T connections.

3.9. FIBER OPTIC CABLE

- 3.9.1. During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- 3.9.2. Install cabling and associated components according to manufacturers' instructions. Do not exceed minimum cable and unjacketed fiber bend radii specified by cable manufacturer.

3.10. INSTALLATION OF SENSORS

- 3.10.1. Install sensors according to manufacturer's recommendations.
- 3.10.2. Mount sensors rigidly and adequately for operating environment.

- 3.10.3. Install room temperature sensors on concealed junction boxes properly supported by wall framing.
- 3.10.4. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- 3.10.5. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
- 3.10.6. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m² (1 ft²) of coil area.
- 3.10.7. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- 3.10.8. Install outdoor air temperature sensors on north wall at designated location with sun shield complete with metal cover cage.
- 3.10.9. Differential Air Static Pressure.
 - 3.10.9.1. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - 3.10.9.2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - 3.10.9.3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
 - 3.10.9.4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
 - 3.10.9.5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
 - 3.10.9.6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.
 - 3.10.9.7. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
 - 3.10.9.8. Install humidity sensors for duct mounted humidifiers at least 3 m (10 ft) downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.11. FLOW SWITCH INSTALLATION

- 3.11.1. Use correct paddle for pipe diameter.
- 3.11.2. Adjust flow switch according to manufacturer's instructions.

3.12. ACTUATORS

- 3.12.1. General. Mount actuators and adapters according to manufacturer's recommendations.
- 3.12.2. Electric and Electronic
 - 3.12.2.1. Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
 - 3.12.2.2. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
 - 3.12.2.3. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
 - 3.12.2.4. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3.12.2.5. Provide necessary mounting hardware and linkages for actuator installation.
 - 3.12.2.6. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.13. WARNING LABELS

- 3.13.1. Affix permanent warning labels to equipment that can be automatically started by the control system.
- 3.13.2. Labels shall use white lettering (12-point type or larger) on a red background.
 - 3.13.2.1. Warning labels shall read as follows.

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.
 - 3.13.2.2. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
 - 3.13.2.3. Labels shall use white lettering (12-point type or larger) on a red background.
 - 3.13.2.4. Warning labels shall read as follows.

CAUTION

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.14. IDENTIFICATION OF HARDWARE AND WIRING

- 3.14.1. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.
- 3.14.2. Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- 3.14.3. Permanently label or code each point of field terminal strips to show instrument or item served.
- 3.14.4. Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- 3.14.5. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.
- 3.14.6. Label room sensors related to terminal boxes or valves with nameplates.
- 3.14.7. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- 3.14.8. Label identifiers shall match record documents.
- 3.14.9. Controllers
 - 3.14.9.1. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
 - 3.14.9.2. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in Appendix A (Sequences of Operation).

3.15. PROGRAMMING

- 3.15.1. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See drawings. If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix C may be used. Where multiple points with the same name reside in the same controller, each point

name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.

3.15.2. Software Programming. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.

3.15.3. Application Programming. Provide application programming that adheres to sequences of operation specified in in this section. Program documentation or comment statements shall reflect language used in sequences of operation.

3.15.4. System Programming. Provide system programming necessary for system operation.

3.15.5. Operator Interface.

3.15.5.1. Standard Graphics. Provide graphics as specified in this section. Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List in this section and on the drawings. Point information on graphics shall dynamically update.

3.15.5.2. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in this section.

3.16. SEQUENCES OF OPERATION

3.16.1. As noted on the drawings, together with the list of control points.

3.17. EQUIPMENT ENCLOSURES AND LOCATIONS

3.17.1. Provide new enclosures for all field equipment (e.g. DDC panels, transducers, relays, etc.). Enclosures shall be equipped with a hinged door and latch. Provide a BOARD-standard key/lock set for each enclosure.

3.17.2. Mount all enclosures in serviceable areas of mechanical rooms, storage rooms or janitor closets. Obtain written approval of the Consultant prior to mounting any enclosure in ceiling spaces or more than 5'-6" above the finished floor.

3.17.3. All transformers and power supplies for control equipment shall be installed in new dedicated metal cabinets with hinged, lockable covers located in the proximity of their dedicated controller cabinets.

3.17.4. Include within a DDC panel enclosure one 120 VAC duplex receptacle for portable PC power, if the controller cabinet is located further than 5'-0" from the nearest wall receptacle.

3.17.5. Ensure that enclosures are sized to allow for ease of servicing of all equipment contained within. Enclosures containing DDC panels shall be sized to allow for the installation of the maximum allowable number of expansion panels/boards. Do not mount other equipment in a manner that may interfere with the future installation of expansion panels/boards.

3.17.6. For enclosures containing pneumatic transducers or devices, provide one pressure gauge (1½" dial, 0-30psi) for the main air line supply.

3.18. IDENTIFICATION AND LABELING OF CONTROL EQUIPMENT

3.18.1. All panels must have a lamicoid tag (min. 3"x1") affixed to the front face indicating panel designation and function (i.e. "BAS Panel 1" or "Relay Panel 3").

3.18.2. All field sensors or devices must have a lamicoid tag (min. 3"x1") attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. AHU1-MAT, 2.IP4). Tags must be secured by screws where mounted outside of the building, in unheated spaces, in high humidity areas or where subject to vibration.

3.18.3. Room sensors or other sensors in finished areas must have a lamicoid tag affixed to the front cover. This tag shall be minimum 1"x ½" and indicate the point software name and hardware address.

3.18.4. All devices within a field enclosure shall be identified via a label or tag.

3.18.5. All BAS panel power sources must be identified by a label (min. 3"x1") indicating the source power panel designation and circuit number (i.e. "120vac fed from LP-2A cct #1).

3.18.6. All field control equipment panels fed from more than one power source must have a warning label on the front cover.

3.18.7. All wires shall be identified with the hardware address with a band-type self-adhesive strips or clip-on plastic wire markers at both ends.

3.18.8. All rotating equipment controlled by the BAS shall have a tag or label affixed indicating that the equipment may start without warning.

3.18.9. The location of the phone line manager shall be indicated via a label affixed to the inside cover of the modem enclosure or BAS panel.

3.18.10. All BAS panels will be supplied with a point's list sheet (within a plastic sleeve) attached to the inside door.

3.18.11. The points list shall identify the following for each point:

3.18.11.1. Panel number.

- 3.18.11.2. Panel location.
- 3.18.11.3. Hardware address.
- 3.18.11.4. Software name.
- 3.18.11.5. Point description.
- 3.18.11.6. Field device type.
- 3.18.11.7. Point type (i.e. AI or DO).
- 3.18.11.8. Device fail position.
- 3.18.11.9. Device manufacturer.
- 3.18.11.10. Model number or reference.
- 3.18.11.11. Wire tag reference.
- 3.18.12. Provide laminated wiring diagrams for all field mounted relay enclosures. Securely attach to the inside door. Identify power panels and circuit numbers of the equipment being controlled.
- 3.18.13. Provide laminated wiring diagrams or modify existing equipment wiring diagrams wherever the BAS interfaces to other equipment. (e.g. boilers, chillers, etc.). Securely attach to the inside of the respective control cabinet.
- 3.18.14. Provide lamacoid labels indicating the required operating sequences, on the boilers and valves, where the boiler plants have manual or automatic isolating valves. Submit actual wording to the Consultant for approval prior to fabrication and installation.
- 3.18.15. Provide lamacoid or machine labels (as outlined above) for all interposing relays or contactors used in control circuits. The labels shall include the related point software name and hardware address
- 3.18.16. Provide a lamacoid label to identify the location of concealed devices above the ceiling space. Mount the label on the ceiling grid T-bar or a permanent surface adjacent to the devices. The label shall contain the wording "BAS Devices Above".
- 3.18.17. Provide lamacoid labels for all auxiliary HVAC equipment (e.g. force flow cabinets, unit ventilators, unit heater, window AC units, etc.) controlled by the BAS. Mount the labels in the vicinity of the existing thermostat or power switch for the unit. The label shall contain the wording "Under BAS Control".
- 3.18.18. Where directed by the Consultant, provide any and all additional labelling, diagrams, schematics or instructions as may be required to facilitate the correct operation and maintenance of controlled building systems.

3.19. SYSTEM HARDWARE COMMISSIONING

- 3.19.1. This contractor shall be responsible for the "end to end" commissioning, testing, verification and start-up of the complete control system hardware including panels,

sensors, transducers, end devices, relays and wiring. Where applicable, this shall include any points from an existing and/or re-used automation system in the building.

- 3.19.2. The contractor shall conduct the hardware commissioning at the facility.
- 3.19.3. When the site hardware installation is 100% completed (including all labeling and documentation), the contractor shall provide written notification to the Board to schedule the hardware commissioning dates for each facility.
- 3.19.4. Board reserves the right, at its sole discretion, to discontinue site commissioning at any time if any part of the site hardware installation is found to be incomplete on the date of commissioning. If this occurs, the Contractor shall assume responsibility for any additional costs related to rescheduling of the site commissioning.
- 3.19.5. The Contractor shall prepare a hardware commissioning report containing the following information and test results:
 - 3.19.5.1. Analog inputs (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual temperature readings should be with +/- 1C of the readings observed at the workstation. Record calibration adjustments and settings.
 - 3.19.5.2. Analog outputs shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0-100% range from a minimum control range of 10-90%. Record the actual output scale range (channel output voltage versus controller command) for each analogue end device
 - 3.19.5.3. Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.
 - 3.19.5.4. Digital inputs shall be verified by witnessing the status of the input point as the equipment is manually cycled on and off.
 - 3.19.5.5. Identify any existing equipment (valves, dampers, fan starters, etc..) that are inoperative or require maintenance or repair.
 - 3.19.5.6. The BAS field panel power source shall be toggled on and off to ensure reboot functionality and power down memory retention of all parameters. During the power down test, all controlled system outputs shall go to their fail-safe position.
 - 3.19.5.7. The hardware commissioning report must be signed and dated by the Contractor's technician performing the tests and participating Board representative.
 - 3.19.5.8. Include with the hardware commissioning report a site floor plan indicating the location of all equipment installed in concealed or recessed locations (e.g. interposing relays in ceiling spaces).
 - 3.19.5.9. Provide testing of all LAN cabling to ensure that 100Mb bandwidth is supported.

- 3.19.5.10. Verify conformance with TIA /EIA TSB-67 - Basic Link Test using a Level 2, bi-directional tester. Provide all equipment necessary to carry out the required tests.
- 3.19.5.11. The Contractor shall prepare a software commissioning report containing the following information and test results:
- 3.19.6. Alarms and Interlocks.
 - 3.19.6.1. Check each alarm with an appropriate signal at a value that will trip the alarm.
 - 3.19.6.2. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
 - 3.19.6.3. Tests interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.
- 3.19.7. Record all out-of-season or unverified points in the commissioning report as “non-commissioned”.
- 3.19.8. Verify PID loop tuning parameters by applying a step change to the current setpoint and observing the response of the controlled device. Setpoint should be reached in an acceptable period of time without excessive cycling or hunting of the controlled device. Provide a graph of the trend response to setpoint change for important controlled devices (e.g. valves 1-inch or larger, dampers on major air handlers, etc.)
- 3.19.9. Provide confirmation that a series of test alarms has been successfully received at a designated remote monitoring workstations.
- 3.19.10. The software commissioning report must be signed and dated by the Contractor’s technician performing the tests and participating Board representative.
- 3.19.11. At the completion of site commissioning, submit four (4) copies of each the hardware and software commissioning reports to the Board.

3.20. SUBSTANTIAL COMPLETION INSPECTION

- 3.20.1.1. At the completion of the site hardware inspection, the Contractor shall test and verify that the system programming, graphics and alarm software is operating correctly and is in compliance all requirements of the specifications.
- 3.20.1.2. The Contractor shall provide written notification to the Board that the site is ready for the Substantial Completion Inspection by the Consultant.
- 3.20.1.3. At the conclusion of the Substantial Completion Inspection, the Consultant shall issue a comprehensive site deficiency report to the Contractor for his immediate action.
- 3.20.1.4. The Contractor shall correct all items noted in the site deficiency report within ten (10) business days of receipt.

- 3.20.1.5. The Contractor shall provide written notification to the Board that all items on the Consultant's site deficiency report have been corrected.

3.21. CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- 3.21.1. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified above. Provide Consultant with log documenting completion of Substantial Completion Inspection.
- 3.21.2. Consultant and Board Representative will be present to observe and review system demonstration. Notify Consultant and Board Representative at least 10 days before system demonstration begins.
- 3.21.3. Demonstration shall follow process submitted and approved. Complete approved checklists and forms for each system as part of system demonstration.
- 3.21.4. Demonstrate actual field operation of each sequence of operation as specified herein. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Consultant. Provide and operate test equipment required to prove proper system operation.
- 3.21.5. Demonstrate compliance with sequences of operation through each operational mode.
- 3.21.6. Demonstrate complete operation of operator interface.
- 3.21.7. Demonstrate each of the following.
- 3.21.7.1. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Consultant will require further tuning of each loop that displays unreasonably under- or over-damped control.
 - 3.21.7.2. Building fire alarm system interface.
 - 3.21.7.3. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.
- 3.21.8. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

3.21.9. Acceptance.

3.21.9.1. After tests described in this specification are performed to the satisfaction of both Consultant and Board, Consultant will accept control system as meeting completion requirements. Consultant may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Consultant will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

3.21.10. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required.

3.22. CLEANING

3.22.1. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.

3.22.2. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

3.22.3. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

3.23. TRAINING

3.23.1. Provide training for a designated staff of Board's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

3.23.2. Training shall enable students to accomplish the following objectives.

- 3.23.2.1. Proficiently operate system.
- 3.23.2.2. Understand control system architecture and configuration.
- 3.23.2.3. Understand DDC system components.
- 3.23.2.4. Understand system operation, including DDC system control and optimizing routines (algorithms)
- 3.23.2.5. Operate workstation and peripherals
- 3.23.2.6. Log on and off system
- 3.23.2.7. Access graphics, point reports, and logs
- 3.23.2.8. Adjust and change system set-points, time schedules, and holiday schedules
- 3.23.2.9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
- 3.23.2.10. Understand system drawings and Operation and Maintenance manual
- 3.23.2.11. Understand job layout and location of control components

- 3.23.2.12. Access data from DDC controllers
 - 3.23.2.13. Operate portable operator's terminals
 - 3.23.2.14. Create and change system graphics
 - 3.23.2.15. Create, delete, and modify alarms, including configuring alarm reactions
 - 3.23.2.16. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
 - 3.23.2.17. Configure and run reports
 - 3.23.2.18. Add, remove, and modify system's physical points
 - 3.23.2.19. Create, modify, and delete application programming
 - 3.23.2.20. Add operator interface stations
 - 3.23.2.21. Add a new controller to system
 - 3.23.2.22. Download firmware and advanced applications programming to a controller
 - 3.23.2.23. Configure and calibrate I/O points
 - 3.23.2.24. Maintain software and prepare backups
 - 3.23.2.25. Interface with job-specific, third-party operator software
 - 3.23.2.26. Add new users and understand password security procedures
- 3.23.3. Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.
- 3.23.3.1. Day-to-day Operators (objectives 1-13)
 - 3.23.3.2. Advanced Operators (objectives 1-13 and 14-23)
 - 3.23.3.3. System Managers and Administrators (objectives 1-13 and 14-26)
 - 3.23.3.4. Provide course outline and materials Provide one copy of training material per student.
 - 3.23.3.5. Instructors shall be factory-trained and experienced in presenting this material.
 - 3.23.3.6. Perform classroom training using a network of working controllers representative of installed hardware.

TABLE OF CONTENTS

PART 1 - GENERAL	3
1.1. DESCRIPTION	3
1.2. RELATED WORK	3
1.3. QUALITY ASSURANCE	3
1.4. SUBMITTALS	3
1.5. APPLICABLE PUBLICATIONS	4
1.6. SPARE PARTS.....	5
PART 2 - PRODUCTS	5
2.1. PIPE AND TUBING	5
2.2. FITTINGS FOR COPPER TUBING	6
2.3. FITTINGS FOR STEEL PIPE.....	6
2.4. DIELECTRIC FITTINGS	7
2.5. UNION.....	7
2.6. FLANGES	7
2.7. GASKETS AND BOLTS	7
2.8. PLUGS	7
2.9. SCREWED JOINTS.....	8
2.10. VALVES.....	8
2.11. STRAINERS	11
2.12. FLEXIBLE CONNECTORS FOR WATER SERVICE.....	11
2.13. HYDRONIC SYSTEM COMPONENTS	11
2.14. PRESSURE/TEMPERATURE TEST PROVISIONS	12
2.15. FIRESTOPPING MATERIAL.....	12
PART 3 - EXECUTION	12
3.1. GENERAL.....	12
3.2. PIPE JOINTS.....	13
3.3. BRAZING	14
3.4. LEAK TESTING ABOVEGROUND PIPING	14
3.5. FLUSHING AND CLEANING PIPING SYSTEMS.....	14
3.6. WATER TREATMENT	15

3.7. OPERATING AND PERFORMANCE TEST AND INSTRUCTION..... 15

PART 1 - GENERAL

1.1. DESCRIPTION

1.1.1. Water piping to connect HVAC equipment, including the following:

- 1.1.1.1. Condenser water, heating hot water and drain piping.
- 1.1.1.2. Extension of domestic water make up piping.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 23 05 00 Common Work Results for HVAC.

1.3. QUALITY ASSURANCE

- 1.3.1. Section: 23 05 00 Common Work Results for HVAC, which includes welding qualifications.
- 1.3.2. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.
- 1.3.3. All joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer.
- 1.3.4. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Manufacturer's Literature and Data:
 - 1.4.2.1. Pipe and equipment supports.
 - 1.4.2.2. Pipe and tubing, with specification, class or type, and schedule.
 - 1.4.2.3. Pipe fittings, including miscellaneous adapters and special fittings.
 - 1.4.2.4. Flanges, gaskets and bolting.
 - 1.4.2.5. Valves of all types.
 - 1.4.2.6. Strainers.
 - 1.4.2.7. Flexible connectors for water service.
 - 1.4.2.8. Pipe alignment guides.
 - 1.4.2.9. Expansion joints.
 - 1.4.2.10. All specified hydronic system components.
 - 1.4.2.11. Water flow measuring devices.
 - 1.4.2.12. Gages.

- 1.4.2.13. Thermometers and test wells.
- 1.4.2.14. Submit the welder's qualifications in the form of a current (less than one year old) and formal certificate.
- 1.4.2.15. As Built Piping Diagrams: Provide drawing as follows for water, and heating hot water system and other piping systems and equipment in electronic Autocad and pdf format.

1.5. APPLICABLE PUBLICATIONS

- 1.5.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. American National Standards Institute, Inc.

- 1.5.2. American Society of Mechanical Engineers/American National Standards Institute, Inc. (ASME/ANSI):

- 1.5.2.1. B1.20.1-83(R2006) Pipe Threads, General Purpose (Inch)
- 1.5.2.2. B16.4 06 Gray Iron Threaded Fittings
- 1.5.2.3. B16.18-01 Cast Copper Alloy Solder joint Pressure fittings
- 1.5.2.4. B16.23-02 Cast Copper Alloy Solder joint Drainage fittings
- 1.5.2.5. B40.100-05 Pressure Gauges and Gauge Attachments

- 1.5.3. American National Standards Institute, Inc./Fluid Controls Institute (ANSI/FCI):

- 1.5.3.1. 70-2-2006 Control Valve Seat Leakage

- 1.5.4. American Society of Mechanical Engineers (ASME):

- 1.5.4.1. B16.1-98 Cast Iron Pipe Flanges and Flanged Fittings
- 1.5.4.2. B16.3-2006 Malleable Iron Threaded Fittings: Class 150 and 300
- 1.5.4.3. B16.4 2006 Gray Iron Threaded Fittings: (Class 125 and 250)
- 1.5.4.4. B16.5-2003 Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard
- 1.5.4.5. B16.9-07 Factory Made Wrought Butt Welding Fittings
- 1.5.4.6. B16.11-05 Forged Fittings, Socket Welding and Threaded
- 1.5.4.7. B16.18-01 Cast Copper Alloy Solder Joint Pressure Fittings
- 1.5.4.8. B16.22-01 Wrought Copper and Bronze Solder Joint Pressure Fittings.
- 1.5.4.9. B16.24 06 Cast Copper Alloy Pipe Flanges and Flanged Fittings
- 1.5.4.10. B16.39 06 Malleable Iron Threaded Pipe Unions
- 1.5.4.11. B16.42-06 Ductile Iron Pipe Flanges and Flanged Fittings
- 1.5.4.12. B31.1 08 Power Piping

- 1.5.5. American Society for Testing and Materials (ASTM):

- 1.5.5.1. A47/A47M-99 (2004) Ferritic Malleable Iron Castings

- 1.5.5.2. A53/A53M-07 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- 1.5.5.3. A106/A106M-08 Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service
- 1.5.5.4. A126 04 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
- 1.5.5.5. A183 03 Standard Specification for Carbon Steel Track Bolts and Nuts
- 1.5.5.6. A216/A216M-08 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
- 1.5.5.7. A234/A234M-07 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- 1.5.5.8. A307 07 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
- 1.5.5.9. A536 84 (2004) Standard Specification for Ductile Iron Castings
- 1.5.5.10. A615/A615M-08 Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
- 1.5.5.11. B32 08 Standard Specification for Solder Metal
- 1.5.5.12. B62 02 Standard Specification for Composition Bronze or Ounce Metal Castings
- 1.5.5.13. B88 03 Standard Specification for Seamless Copper Water Tube
- 1.5.6. American Water Works Association (AWWA):
 - 1.5.6.1. C110-08 Ductile Iron and Grey Iron Fittings for Water
 - 1.5.6.2. C203-02 Coal Tar Protective Coatings and Linings for Steel Water Pipe Lines Enamel and Tape Hot Applied

1.6. SPARE PARTS

- 1.6.1. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

PART 2 - PRODUCTS

2.1. PIPE AND TUBING

- 2.1.1. Condenser Water Piping, Heating Hot Water/Glycol Piping as applicable to the project:
 - 2.1.1.1. 50 mm (2") diam and smaller:
 - 2.1.1.1.1. Schedule 40 continuous weld or electric resistance welded black carbon steel conforming to ASTM A53 84a Grade B, with threaded ends.
 - 2.1.1.1.2. Type "L" hard drawn copper tubing conforming to ASTM B88. Type "L" soft annealed copper tubing may be used within convector enclosures.
 - 2.1.1.2. 65 mm (2½") diam and larger

- 2.1.1.2.1. Schedule 40 continuous weld or electric resistance welded black carbon steel conforming to ASTM A53 84a Grade B, with beveled ends.

2.1.2. Cooling Coil Condensate Drain Piping:

- 2.1.2.1. From air handling/ERV units: Copper water tube, ASTM B88, Type M
- 2.1.2.2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.

- 2.1.3. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.2. FITTINGS FOR COPPER TUBING

2.2.1. Joints 50 mm (2") and smaller:

- 2.2.1.1. *Solder Joints:* Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
- 2.2.1.2. *Screwed Joints:* Pipe Thread: ANSI B1.20. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.2.2. Joints 65 mm (2½") and larger:

- 2.2.2.1. Bronze Flanges and Flanged Fittings: ASME B16.24.
- 2.2.2.2. Fittings: ASME B16.18 cast copper or ASME B16.22 solder wrought copper.

2.3. FITTINGS FOR STEEL PIPE

2.3.1. 50 mm (2 inches) and Smaller: Screwed or welded joints.

- 2.3.1.1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
- 2.3.1.2. Forged steel, socket welding or threaded: ASME B16.11.
- 2.3.1.3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.

2.3.2. 65 mm (2 1/2 inches) and Larger: Welded or flanged joints.

- 2.3.2.1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
- 2.3.2.2. Welding flanges and bolting: ASME B16.5:
- 2.3.2.3. Weld neck or slip on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
- 2.3.2.4. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

2.4. DIELECTRIC FITTINGS

- 2.4.1. Provide where copper tubing and ferrous metal pipe are joined.
- 2.4.2. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- 2.4.3. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- 2.4.4. Temperature Rating, 99 degrees C (210 degrees F).

2.5. UNION

- 2.5.1. 50 mm (2") diam and smaller:
 - 2.5.1.1. All brass construction with ground joint and either solder joint or screwed ends as required.
 - 2.5.1.2. Class 150 black malleable iron construction with brass to iron ground joint and screwed ends, conforming to ASTM A197 and ANSI/ASME B1.20.1.
 - 2.5.1.3. Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping or equipment.

2.6. FLANGES

- 2.6.1. Class 150 forged steel slip-on or weld-neck raised face type conforming to ASTM A181 Grade 1 and ANSI/ASME B16.5. Remove raised face where flanges connect to Class 125 cast iron valves.
- 2.6.2. Hinged, two piece, shouldered or keyed cast malleable iron
- 2.6.3. Conforming to ASTM A47 Grade 32510 with elastomeric gasket suitable for service and lock bolt.

2.7. GASKETS AND BOLTS

- 2.7.1. Gaskets
 - 2.7.1.1. 1.6 mm (1/16") Garlock 3200 with SBR binder or equivalent asbestos free material.
- 2.7.2. Bolts
 - 2.7.2.1. Semi finished hex head machine bolts and semi finished hex nuts, both of carbon steel conforming. to ASTM A307 Class A.

2.8. PLUGS

2.8.1. 50 mm (2") diam and smaller

2.8.2. Class 3000 screwed, square head, machined from solid steel or forging to ASTM A105 Grade 2.

2.9. SCREWED JOINTS

2.9.1. Pipe Thread: ANSI B1.20.

2.9.2. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.10. VALVES

2.10.1. Asbestos packing is not acceptable.

2.10.2. All valves of the same type shall be products of a single manufacturer.

2.10.3. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.

2.10.4. Standard of Acceptance: Crane, Toyo, Kitz, RWV

2.10.5. Shut-Off Valves

2.10.5.1. Ball Valves (Pipe sizes 50 mm [2"] and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.

2.10.5.2. Butterfly Valves (Pipe Sizes 65 mm [2-1/2"] and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS SP 67, flange lug type end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.

2.10.5.2.1. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65 45 12 electro-plated.

2.10.5.2.2. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.

2.10.5.2.3. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.

2.10.5.2.4. Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.

2.10.5.2.5. Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain wheel operator.

2.10.5.3. Globe and Angle Valves

2.10.5.3.1. Globe Valves

- 50 mm (2 inches) and smaller: MSS SP 80, bronze, 1034 kPa (150 lb.)
Globe valves shall be union bonnet with metal plug type disc.
- 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP 85 for globe valves.

2.10.5.3.2. Angle Valves:

- 50 mm (2 inches) and smaller: MSS SP 80, bronze, 1034 kPa (150 lb.)
Angle valves shall be union bonnet with metal plug type disc.
- 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP 85 for angle.

2.10.5.3.3. Check Valves

- Swing Check Valves:
- 50 mm (2 inches) and smaller: MSS SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.
- 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP 71 for check valves.
- Non Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
- Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
- Seat, disc and spring: 18 8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

2.10.5.3.4. Water Flow Balancing Valves: For flow regulation and shut off. Valves shall be line size rather than reduced to control valve size.

- Standard of Acceptance: Crane, Toyo, Kitz, RWV, Armstrong
- General

Globe style valve.

Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.

Standard of Acceptance: Armstrong CBV series, Taco, Tour and Anderson

- Valves ½" to 2" diam:

Valves are to be of the 'Y' pattern, equal percentage globe-style and provide three functions: 1) Precise flow measurement, 2) Precision flow balancing, 3) Positive drip-tight shut-off.

Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.

Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 1/4" threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin.

- Valves 2-1/2" to 12" diam:

Valves are to be of the 'Y' pattern, equal percentage globe-style and provide three functions: 1) Precise flow measurement, 2) Precision flow balancing, 3) Positive drip-tight shut-off.

Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.

Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 1/4" threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin.

2.10.5.3.5. Automatic Balancing Control Valves:

- Use only where specifically approved by the consultant
- Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:

- Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
- Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self cleaning piston/spring assembly that is easily removable for inspection or replacement.
- Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.
- Standard of Acceptance: Kitz, RWV

2.10.5.3.6. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

2.11. STRAINERS

2.11.1. Basket or Y Type.

- 2.11.1.1. Screens: Bronze, monel metal or 18 8 stainless steel, free area not less than 2 1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations.

2.12. FLEXIBLE CONNECTORS FOR WATER SERVICE

2.12.1. Refer to Section: 23 05 48 Vibration and Seismic Controls for HVAC.

2.13. HYDRONIC SYSTEM COMPONENTS

2.13.1. Radiator/Convactor Automatic Air Vent: provide automatic air venting for hot or cold water distribution systems at terminal equipment (convectors/radiators). The vent valve utilizes a float to actuate the valve plug which is located at the top of the valve. Once the air is displaced and the system pressure is sustained, the valve plug seals and prevents any water from escaping from the system. The float vent can also operate as an anti-vacuum device since it will permit air to enter the system when it must be drained. It can also be installed to permit the separation and dispersal of air while fluid is actually circulating in the system.

2.13.1.1. Features

- 2.13.1.1.1. Body and cover are brass construction
- 2.13.1.1.2. Air vent with silicone rubber seal
- 2.13.1.1.3. Impurities do not usually affect function as maximum float line of water is always lower than the valve seal
- 2.13.1.1.4. Float is high temperature resistant polyethylene
- 2.13.1.1.5. Suitable for use with glycol systems
- 2.13.1.1.6. Can be disassembled for inspection and cleaning

2.13.1.2. Pressure – Temperature

- 2.13.1.2.1. Minimum working pressure: 1.45psi (10 kPa)
- 2.13.1.2.2. Maximum working pressure: 150psi (10 bar)
- 2.13.1.2.3. Temperature Range: 33°F – 240°F (5°C – 116°C)
- 2.13.1.3. Standard of Acceptance: Watts Series FV-4M1

2.14. PRESSURE/TEMPERATURE TEST PROVISIONS

- 2.14.1. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordelself closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

2.15. FIRESTOPPING MATERIAL

- 2.15.1. Refer to Section: 23 05 00 Common Work Results for HVAC.

PART 3 - EXECUTION

3.1. GENERAL

- 3.1.1. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- 3.1.2. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- 3.1.3. Support piping securely. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- 3.1.4. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- 3.1.5. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly

valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

- 3.1.6. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take offs with 3 elbow swing joints where noted on the drawings.
- 3.1.7. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- 3.1.8. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.
- 3.1.9. Connect piping to equipment as shown on the drawings and as recommended by the manufacturer.
- 3.1.10. Install components furnished by others such as:
 - 3.1.10.1. Water treatment pot feeders and condenser water treatment systems.
 - 3.1.10.2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
 - 3.1.10.3. Thermometer Wells: In pipes 65 mm (2 1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- 3.1.11. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section: 23 07 00 HVAC Insulation.
- 3.1.12. Where copper piping is connected to steel piping, provide dielectric connections.

3.2. PIPE JOINTS

- 3.2.1. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- 3.2.2. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- 3.2.3. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.
- 3.2.4. Solvent Welded Joints: As recommended by the manufacturer.

3.3. BRAZING

- 3.3.1. Flux shall not be allowed to penetrate to the inside of the pipe. The outside of the tube and fittings shall be cleaned by washing with hot water in order to remove any residual flux.
- 3.3.2. During the brazing of the pipe connections, except when performing final connections and emergency repairs, the interior of the pipe shall be maintained with a nitrogen atmosphere. This shall be done by purging the pipe a sufficient number of times to remove all air and oxygen and by maintaining a small purge flow to prevent reentry of

3.4. LEAK TESTING ABOVEGROUND PIPING

- 3.4.1. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.
- 3.4.2. An operating test at design pressure, and for hot systems, design maximum temperature.
- 3.4.3. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

3.5. FLUSHING AND CLEANING PIPING SYSTEMS

- 3.5.1. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section: 23 25 13 Water Treatment for Closed-Loop Hydronic Systems and/or Section: 23 25 16 Water Treatment for Open Hydronic Systems.
- 3.5.2. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/S (6 feet per second), if possible. Connect dead end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and

permanent piping and Contractor's booster pumps. Flush until clean as approved by the Resident Engineer.

- 3.5.3. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
- 3.5.4. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

3.6. WATER TREATMENT

- 3.6.1. Install water treatment equipment and provide water treatment system piping.
- 3.6.2. Close and fill system as soon as possible after final flushing to minimize corrosion.
- 3.6.3. Charge systems with chemicals specified in Section: 23 25 13 Water Treatment for Closed-Loop Hydronic Systems and/or Section: 23 25 16 Water Treatment for Open Hydronic Systems.
- 3.6.4. Utilize this activity, by arrangement with the Resident Engineer, for instructing VA operating personnel.

3.7. OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- 3.7.1. Refer to PART 3 of Section: 23 05 00 Common Work Results for HVAC.
- 3.7.2. Adjust red set hand on pressure gages to normal working pressure.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 2

1.5. APPLICABLE PUBLICATIONS..... 3

PART 2 - PRODUCTS 4

2.1. PIPING AND FITTINGS 4

2.2. REFRIGERATION VALVES:..... 5

2.3. GAGES 7

2.4. PIPE SUPPORTS..... 7

2.5. REFRIGERANTS AND OIL 8

2.6. PIPE INSULATION FOR DX HVAC SYSTEMS 8

PART 3 - EXECUTION 10

3.1. INSTALLATION..... 10

3.2. PIPE AND TUBING INSULATION 11

3.3. SIGNS AND IDENTIFICATION 11

3.4. VALVE INSTALLATION 12

3.5. FIELD QUALITY CONTROL 12

3.6. SYSTEM TEST AND CHARGING..... 13

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. Refrigerating system: Combination of interconnected refrigerant containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.
- 1.1.2. Low side means the parts of a refrigerating system subjected to evaporator pressure.
- 1.1.3. High side means the parts of a refrigerating system subjected to condenser pressure.
- 1.1.4. Brazed joint: A gas tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 449 degrees C (840 degrees F) but less than the melting temperatures of the joined parts.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 22 05 00 Common Work Results for Plumbing.

1.3. QUALITY ASSURANCE

- 1.3.1. Refer to specification Section: 23 05 00 Common Work Results for HVAC.
- 1.3.2. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.
- 1.3.3. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.
- 1.3.4. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with specification Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Shop Drawings:
 - 1.4.2.1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for components noted below:
 - 1.4.2.1.1. Tubing and fittings

- 1.4.2.1.2. Valves
 - 1.4.2.1.3. Strainers
 - 1.4.2.1.4. Moisture liquid indicators
 - 1.4.2.1.5. Filter driers
 - 1.4.2.1.6. Flexible metal hose
 - 1.4.2.1.7. Liquid suction interchanges
 - 1.4.2.1.8. Oil separators (when specified)
 - 1.4.2.1.9. Gages
 - 1.4.2.1.10. Pipe and equipment supports
 - 1.4.2.1.11. Refrigerant and oil
 - 1.4.2.1.12. Pipe/conduit roof penetration cover
 - 1.4.2.1.13. Soldering and brazing materials
- 1.4.3. Layout of refrigerant piping and accessories, including flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
- 1.4.4. Refrigerant piping shall be sized, selected, and designed either by the equipment manufacturer or in strict accordance with the manufacturer's published instructions. The schematic piping diagram shall show all accessories such as, stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators and driers to make a complete installation.
- 1.4.5. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

1.5. APPLICABLE PUBLICATIONS

- 1.5.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.5.2. Air Conditioning, Heating, and Refrigeration Institute (ARI/AHRI):
- 1.5.2.1. 495-1999 (R2002) Standard for Refrigerant Liquid Receivers
 - 1.5.2.2. 730-2005 Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers
 - 1.5.2.3. 750-2007 Thermostatic Refrigerant Expansion Valves
 - 1.5.2.4. 760 2007 Performance Rating of Solenoid Valves for Use with Volatile Refrigerants
- 1.5.3. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):
- 1.5.3.1. ANSI/ASHRAE 15 2007 Safety Standard for Refrigeration Systems (ANSI)
 - 1.5.3.2. ANSI/ASHRAE 17 2008 Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves (ANSI)

- 1.5.3.3. 63.1-95 (RA 01) Method of Testing Liquid Line Refrigerant Driers (ANSI)
- 1.5.4. American National Standards Institute (ANSI):
 - 1.5.4.1. ASME (ANSI)A13.1-2007 Scheme for Identification of Piping Systems
 - 1.5.4.2. Z535.1-2006 Safety Color Code
- 1.5.5. American Society of Mechanical Engineers (ASME):
 - 1.5.5.1. ANSI/ASME B16.22 2001 (R2005)
 - 1.5.5.2. Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)
 - 1.5.5.3. ANSI/ASME B16.24 2006 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500 (ANSI)
 - 1.5.5.4. ANSI/ASME B31.5-2006 Refrigeration Piping and Heat Transfer Components (ANSI)
 - 1.5.5.5. ANSI/ASME B40.100-2005 Pressure Gauges and Gauge Attachments
 - 1.5.5.6. ANSI/ASME B40.200-2008 Thermometers, Direct Reading and Remote Reading
- 1.5.6. American Society for Testing and Materials (ASTM)
 - 1.5.6.1. B88 03 Standard Specification for Seamless Copper Water Tube
 - 1.5.6.2. B88M-05 Standard Specification for Seamless Copper Water Tube (Metric)
 - 1.5.6.3. B280 08 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
 - 1.5.6.4. Underwriters Laboratories (U.L.):
 - 1.5.6.5. U.L.207-2009 Standard for Refrigerant-Containing Components and Accessories, Nonelectrical
 - 1.5.6.6. U.L.429-99 (Rev.2006) Standard for Electrically Operated Valves

PART 2 - PRODUCTS

2.1. PIPING AND FITTINGS

- 2.1.1. Refrigerant Piping: For piping up to 100 mm (4 inch) use Copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer. For piping over 100 mm (4 inch) use A53 Black SML steel.
- 2.1.2. Pre-Insulated refrigerant piping/lines shall not be accepted.
- 2.1.3. Fittings, Valves and Accessories:
 - 2.1.3.1. Copper fittings: Wrought copper fittings, ASME B16.22.

- 2.1.3.2. Brazed Joints, refrigerant tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.
- 2.1.3.3. Solder Joints, water and drain: 95 5 tin antimony, ASTM B32 (95TA).
- 2.1.3.4. Refrigerant piping – Welded Joints.
- 2.1.3.5. Flanges and flanged fittings: ASME B16.24.
- 2.1.4. Flexible connectors
 - 2.1.4.1. Install at all locations where refrigerant piping is connected to equipment containing moving or rotating parts (compressors, supply fans, condenser fans, etc)
 - 2.1.4.2. Also refer to Section: 23 05 48 Vibration and Seismic Controls for HVAC.
- 2.2. **REFRIGERATION VALVES:**
 - 2.2.1. Stop Valves:
 - 2.2.1.1. Brass or bronze alloy, packless, or packed type with gas tight cap, frost proof, back seating.
 - 2.2.2. Pressure Relief Valves:
 - 2.2.2.1. Comply with ASME Boiler and Pressure Vessel Code; UL listed. Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.
 - 2.2.3. Solenoid Valves:
 - 2.2.3.1. UL-listed, 250 deg. F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with ½ inch conduit adapter, holding coil, voltage to meet controls requirements.
 - 2.2.3.2. Comply with ARI 760 and UL 429, UL-listed, two-position, direct acting or pilot-operated, moisture and vapor proof type of corrosion resisting materials, designed for intended service, and solder-end connections. Fitted with suitable NEMA 250 enclosure of type required by location and normally open or closed holding coil (as specified)
 - 2.2.4. Thermostatic Expansion Valves:
 - 2.2.4.1. Comply with ARI 750. Brass body with stainless-steel or non-corrosive non ferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and

external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.

2.2.5. Check Valves:

- 2.2.5.1. Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.

2.2.6. Strainers:

- 2.2.6.1. Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines DN 25 (NPS 1) and smaller, 60 mesh in liquid lines larger than DN 25 (NPS 1), and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.

2.2.7. Refrigerant Moisture/Liquid Indicators:

- 2.2.7.1. Double ported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.

2.2.8. Refrigerant Filter Dryers:

- 2.2.8.1. UL listed, angle or in line type, as shown on drawings. Conform to ARI Standard 730 and ASHRAE Standard 63.1. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for service and capacity of system with connection not less than the line size in which installed. Filter driers with replaceable filters shall be furnished with one spare element of each type and size.

2.2.9. Flexible Metal Hose:

- 2.2.9.1. Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each compressor and connections to air handling equipment. As manufactured by Anaconda or equal

2.2.10. Oil Separators:

2.2.10.1. Provide for condensing units, as shown. All welded steel construction with capacity to eliminate a minimum of 95 percent of the oil from the hot gas flowing through it. Provide manufacturer's published ratings for minimum and maximum refrigeration tonnage corresponding to this oil separating efficiency. Separator shall be equipped with a float valve to prevent return of the hot gas to crankcase, and shall have isolating stop valves so it can be opened and services without pumping out any other part of the system. ASME construction or UL listed.

2.2.11. Receivers:

2.2.11.1. Conform to AHRI 495, steel construction, equipped with tappings for liquid inlet and outlet valves, pressure relief valve and liquid level indicator.

2.2.12. Standards of Acceptance for Refrigerant Valves and Specialties:

2.2.12.1. Emerson Electric, Danfoss, Henry Industries

2.3. **GAGES**

2.3.1. Temperature Gages: Comply with ASME B40.200. Industrial duty type and in required temperature range for service in which installed. Gages shall have Celsius scale in 1-degree (Fahrenheit scale in 2-degree) graduations and with black number on a white face. The pointer shall be adjustable. Rigid stem type temperature gages shall be provided in thermal wells located within 1525 mm (5 feet) of the finished floor. Universal adjustable angle type or remote element type temperature gages shall be provided in thermal wells located 1525 to 2135 mm (5 to 7 feet) above the finished floor. Remote element type temperature gages shall be provided in thermal wells located 2135 mm (7 feet) above the finished floor.

2.3.2. Vacuum and Pressure Gages: Comply with ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Gage shall be a minimum of 90 mm (3-1/2 inches) in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gage range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.3.3. Suction: 101 kPa (30 inches Hg) vacuum to 1723 kPa (gage) (250 psig).

2.3.4. Discharge: 0 to 3445 kPa (gage) (0 to 500 psig).

2.4. **PIPE SUPPORTS**

2.4.1. Indoor supports

2.4.1.1. Refer to specification Section: 23 05 00 Common Work Results for HVAC.

2.4.2. Outdoor supports

- 2.4.2.1. The roof block is an assembled product comprised of two major components including the support shell which is a one piece, UV resistant, thermoplastic injection molded Polypropylene Impact Copolymer and the Type 3, 20 psi extruded polystyrene non-marring base. The support shell is designed with an interior web creating eight symmetrical cavities. Design maximizes support strength while substantially reducing the overall weight. Interior cavities allow for expansion and contraction under extreme temperature conditions over its lifetime. The lower portion of the one piece support shell incorporates a $\frac{3}{4}$ " high wall which reduces UV exposure to the extruded polystyrene base.
- 2.4.2.2. Straps: install 2-hole galvanized pipe straps, mounted to the roof block using fasteners available locally. Ensure that there is no direct contact between the copper refrigerant piping and the galvanized straps.
- 2.4.2.3. Standard of Acceptance: Miro Industries, Block-Ease, Portable Pipe Hangers. Min. height above roof: 150 mm.

2.5. REFRIGERANTS AND OIL

- 2.5.1. Provide EPA approved refrigerant and oil for proper system operation.

2.6. PIPE INSULATION FOR DX HVAC SYSTEMS

- 2.6.1. Application: all refrigerant suction lines, all hot gas discharge lines.
- 2.6.2. Insulation materials shall have a closed cell structure to prevent moisture from wicking which makes it an efficient insulation.
- 2.6.3. Insulation materials shall be manufactured without the use of CFC's, HFC's or HCFC's. It is also formaldehyde free, low VOCs, fiber free, dust free and resists mold and mildew.
- 2.6.4. Insulation materials shall have a flame-spread index of less than 25 and a smoke-developed index of less than 50 as tested in accordance with ASTM E 84. In addition, the products, when tested, shall not melt or drip flaming particles, and the flame shall not be progressive.
- 2.6.5. Insulation materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft²-°F at a 75°F mean temperature as tested in accordance with ASTM C 177 or ASTM C 518.
- 2.6.6. Insulation materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A.
- 2.6.7. Standard of Acceptance: Armaflex
- 2.6.8. Insulation shall be a flexible, closed-cell elastomeric pipe insulation: AP Armaflex, AC Accoflex. Adhesive shall be Armaflex 520, 520 Black or 520 BLV Adhesive. The insulation must conform to ASTM C534 Grade 1, Type I.

2.6.9. Sizes

- 2.6.9.1. Wall Thickness (nominal): 3/8", 1/2", 3/4", 1", 1-1/2", 2" (10, 13, 19, 25, 38, 50mm)
- 2.6.9.2. Inside Diameter, Tubular: 3/8" ID to 10"ID (10mm ID to 250mm)

2.6.10. Specifications Compliance:

- 2.6.10.1. ASTM C 534, Type I — Grade 1
- 2.6.10.2. ASTM D 1056, 2B1
- 2.6.10.3. ASTM E 84, NFPA 255, UL723
- 2.6.10.4. ASTM G21/C1338
- 2.6.10.5. ASTM G22
- 2.6.10.6. CAN/ULC S102

2.6.11. Outdoor protection:

2.6.11.1.1. Aluminum Jackets – Outdoor Piping and Fittings

- Aluminum Jacket-Piping systems: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
- Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping as well as on interior piping exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- Neither rivets, screws, staples nor any other fastener capable of penetrating the underlying vapor retarder shall be used to secure the aluminum jacketing.
- Standards of Acceptance: Childers-Lock-on, Pabco-Surfeit, Johns Mansville.

2.6.12. Accessories

- 2.6.12.1. ArmaFlex 520 and 520 Black Adhesive – Air-drying, solvent-based contact adhesive for strong bonds and tight seams.
- 2.6.12.2. ArmaFlex BLV – Black Low VOC Air-drying, solvent-based contact adhesive
- 2.6.12.3. ArmaFlex Insulation Tape – black foam, pressure-sensitive seam tape
- 2.6.12.4. Armacell Fabricated Fittings – Made to order pre-fabricated fittings in Tees, Elbows, P-Traps and more
- 2.6.12.5. ArmaFix Insulation Pipe Hangers – Easy-to-use insulated pipe hanger supports that protect against compression, up to 1" wall thickness.

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5
- 3.1.2. Install piping as short as possible, with a minimum number of joints, elbow and fittings.
 - 3.1.2.1. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
 - 3.1.2.2. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
 - 3.1.2.3. Install hangers and supports per ASME B31.5 and the refrigerant piping manufacturer's recommendations.
 - 3.1.2.4. Slope refrigerant piping as follows:
 - 3.1.2.4.1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.
 - 3.1.2.4.2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
 - 3.1.2.4.3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
 - 3.1.2.4.4. Liquid lines may be installed level.
 - 3.1.2.5. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

- 3.1.2.6. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver (where applicable).
- 3.1.2.7. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.
- 3.1.2.8. Joint Construction:
 - 3.1.2.8.1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
 - 3.1.2.8.2. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
 - 3.1.2.8.3. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
 - 3.1.2.8.4. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.
 - 3.1.2.8.5. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.
 - 3.1.2.8.6. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.
 - 3.1.2.8.7. Pipe relief valve discharge to outdoors for systems containing more than 45 kg (100 lbs) of refrigerant.
- 3.1.2.9. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material.

3.2. PIPE AND TUBING INSULATION

- 3.2.1. Insulate all suction piping, including traps
- 3.2.2. Outdoors: Apply two coats of weather resistant finish as recommended by the manufacturer to insulation exposed to outdoor weather.
- 3.2.3. Protect insulation at all support points; use galvanized metallic saddles.

3.3. SIGNS AND IDENTIFICATION

- 3.3.1. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.

- 3.3.2. Systems containing more than 50 kg (110 lb) of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI Z535.1, having letters not less than 13 mm (1/2 inch) in height designating:
- 3.3.3. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
- 3.3.4. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."

3.4. VALVE INSTALLATION

- 3.4.1. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.
- 3.4.2. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.
- 3.4.3. Install a full sized, 3-valve bypass around each drier.
- 3.4.4. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.
- 3.4.5. Coordinate electrical requirements and connections.
- 3.4.6. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.
- 3.4.7. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
- 3.4.8. Install the valve in such a location so that the diaphragm case is warmer than the bulb. Verify proper location for bulb with valve manufacturer.
- 3.4.9. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.
- 3.4.10. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.
- 3.4.11. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

3.5. FIELD QUALITY CONTROL

- 3.5.1. Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of

defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.

- 3.5.2. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of Resident Engineer. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
- 3.5.3. Every refrigerant-containing parts of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.
- 3.5.4. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.
- 3.5.5. Test Medium: A suitable dry gas such as nitrogen or shall be used for pressure testing. The means used to build up test pressure shall have either a pressure limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system components.

3.6. SYSTEM TEST AND CHARGING

- 3.6.1. Provide a full charge of refrigerant and oil, to suit the capacity of the system, including lengths of refrigerant piping and receivers. System Test and Charging: As recommended by the equipment manufacturer or as follows:
- 3.6.2. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 70 kPa (10 psi) gage. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.
- 3.6.3. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Test entire system again for leaks.
- 3.6.4. Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in mPa (microns). Pull the system down to 665 mPa (500 microns) 665 mPa (2245.6 inches of mercury at 60 degrees F) and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the

evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. RELATED DOCUMENTS 2

1.2. SUMMARY 2

1.3. SUBMITTALS 3

1.4. QUALITY ASSURANCE 3

1.5. DELIVERY, STORAGE, AND HANDLING 4

1.6. WARRANTY 4

1.7. STANDARDS OF ACCEPTANCE - CHEMICAL SERVICE PROVIDERS (CSPS)..... 4

1.8. STANDARDS OF ACCEPTANCE - CHEMICAL TREATMENT HARDWARE 5

PART 2 - PRODUCTS 5

2.1. PERFORMANCE REQUIREMENTS 5

2.2. FLUSHING OF NEW AND REUSED PIPING 5

2.3. TREATMENT PROGRAM – CHEMICAL TREATMENT AND PASSIVATION 7

PART 3 - EXECUTION 7

3.1. CHEMICAL SERVICE PROVIDER (CSP) SERVICES 7

3.2. INSTALLATION AND TREATMENT 9

3.3. FIELD QUALITY CONTROL 9

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

- 1.1.1.1. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, and other applicable Specification Sections.

1.2. SUMMARY

- 1.2.1. Products specified in this section include the following:

- 1.2.1.1. Chemical Inhibitors for Water and Glycol
- 1.2.1.2. Chemicals for Inhibitors and cleaning
- 1.2.1.3. Pot Feeder and Accessories
- 1.2.1.4. Filtration cartridge housing
- 1.2.1.5. Piping, fittings and Accessories
- 1.2.1.6. Glycol Feed System (where applicable to the project)

- 1.2.2. Provide a Chemical Services Provider (CSP) to perform the services described below.

- 1.2.3. Provide water treatment products and services including:

- 1.2.3.1. Chemicals for cleaning, passivation, and treatment of each system.
- 1.2.3.2. On-going treatment, chemicals, testing, certification, and reports to demonstrate effective water treatment is maintained at all times.
- 1.2.3.3. Start-up and operation of chemical treatment equipment.

- 1.2.4. Provide a complete chemical water treatment program during construction for all new and reused piping networks. This program shall begin from the point each system is filled during construction and extend until Substantial Completion or final Client acceptance of each system, whichever occurs later. The program shall include water analysis chemicals, testing equipment, consulting and service for the following systems:

- 1.2.4.1. Heating Hot Water System
- 1.2.4.2. Chilled Water System
- 1.2.4.3. Dual Temperature Water System
- 1.2.4.4. Glycol System
- 1.2.4.5. All other closed loop systems

- 1.2.5. Attend project meetings as required to plan, schedule and coordinate above activities with other project contractors and the Client.

- 1.2.6. Provide recommended testing procedures and chemical treatment schedule for Client's personnel. This information shall be submitted to the Client in a Program Administration Manual.

1.3. SUBMITTALS

1.3.1. Product Data:

- 1.3.1.1. Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and complete data on furnished products listed below:
 - 1.3.1.1.1. Pot Feeders
 - 1.3.1.1.2. Filtration cartridges and housing
 - 1.3.1.1.3. Glycol Feed System
 - 1.3.1.1.4. Flow Indicators
 - 1.3.1.1.5. Valves
 - 1.3.1.1.6. Product specifications and MSDS's for each chemical used
 - 1.3.1.1.7. Cleaning Procedures
 - 1.3.1.1.8. Passivation Procedures
 - 1.3.1.1.9. Chemical Treatment Procedures

1.3.2. Shop Drawings

- 1.3.2.1. Shop Drawings to include detailed equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and the location and size of each field connection as necessary to assist the mechanical contractor with proper system installations
- 1.3.2.2. Service Reports as indicated under Part 2 below.

1.4. QUALITY ASSURANCE

- 1.4.1. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work.
- 1.4.2. Subject to compliance with all requirements, provide specified products from the manufacturers indicated in the Standard of Acceptance
- 1.4.3. Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.
- 1.4.4. American Society for Testing and Materials (ASTM)
 - 1.4.4.1. D859 – Test Method for Silica in Water
 - 1.4.4.2. D1067 – Test Methods for Acidity/Alkalinity in Water
 - 1.4.4.3. D1068 – Test Methods for Iron in Water
 - 1.4.4.4. D1126 – Test Method for Hardness in Water
 - 1.4.4.5. D3370 – Practices for Sampling Water from Closed Conduits
 - 1.4.4.6. D4012 - Test Method for Adenosine Triphosphate (ATP)
 - 1.4.4.7. Content of Microorganisms in Water

1.4.4.8. D5465 - Practice for Determining Microbial Colony Counts from Waters Analyzed by Plating Methods

- 1.4.5. Conform to all applicable Codes, Regulations, and Municipal requirements for the use and disposal of chemicals (including cleaning compounds) and waste to public sewer systems.
- 1.4.6. Wastewater shall be discharged to the sanitary sewer only if it has a pH between 5.0 and 10.0 and meets the requirements of the locality where the work takes place. Glycols (of any type) shall not be discharged to the sanitary sewer.
- 1.4.7. Wastewater containing any chemical or sediment is prohibited from discharge to the storm water system. No chemical shall contain Chromates or Inorganic Phosphates.

1.5. DELIVERY, STORAGE, AND HANDLING

- 1.5.1. Package for delivery to best protect finished surfaces while using the least amount of single-use packaging as possible. Deliver equipment and components adequately packaged for lifting, skidding, or rolling into final position, according to manufacturer's instructions. If possible, package and ship products using reusable blankets and fabrics, or reusable cardboard and crate systems.
- 1.5.2. Store materials and equipment raised off the floor on pallets and protected with coverings to prevent damage due to weather and construction activities. Store in areas that prevent damage due to freezing and extreme temperatures or sunlight. Arrange coverings to provide air circulation to avoid damage from condensation or chemical build-up. Protect from damage, dirt and debris at all times.
- 1.5.3. Store chemicals in curb protected area. Such secondary containment areas must have the capacity to hold the volume of the largest container or 10% of the combined containers, whichever larger. If room has no floor drains, then the room itself may be considered sufficient secondary containment. If the room is considered the secondary containment ensure there is a lip at the door so no liquids can exit the room in the event of a leak. Verify field conditions before storing any chemicals
- 1.5.4. Provide temporary containment areas when permanent containment areas do not exist. Remove temporary containment at the end of construction.

1.6. WARRANTY

- 1.6.1. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion. This warranty does not include ongoing chemical treatment or monitoring.

1.7. STANDARDS OF ACCEPTANCE - CHEMICAL SERVICE PROVIDERS (CSPS)

- 1.7.1. Board approved CSPA

1.8. STANDARDS OF ACCEPTANCE - CHEMICAL TREATMENT HARDWARE

- 1.8.1. Neptune
- 1.8.2. Axiom
- 1.8.3. Griswald

PART 2 - PRODUCTS

2.1. PERFORMANCE REQUIREMENTS

- 2.1.1. Cleaning activities shall remove oil, grease, silt, and rust from system. Cleaned metal surfaces shall be well passivated.
- 2.1.2. The water treatment programs proposed by the CSP shall maintain corrosion rates below 0.5 mils per year for mild steel and 0.1 mils per year for copper and/or brass, with no pitting allowed.
- 2.1.3. Suspended solids: Nil. Total Iron Concentration: 0.5 mg/L Fe maximum. Total Copper Concentration: 0.2 mg/L Cu maximum.
- 2.1.4. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005
- 2.1.5. These rates shall be verified with corrosion coupons provided by the CSP. Coupons shall be analyzed in the CSP's analytical laboratory every three months, more often if required, to assure these levels are not exceeded.
- 2.1.6. Microbiological growth levels shall be maintained below 10,000 cfu's aerobic bacteria and 10 cfu's anaerobic bacteria. The CSP shall perform detailed microbiological culturing at the CSP's company's analytical laboratory monthly, more often if required, to assure these levels are not exceeded
- 2.1.7. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively.

2.2. FLUSHING OF NEW AND REUSED PIPING

- 2.2.1. Flush and clean all new and reused piping.
- 2.2.2. Before adding cleaning chemicals to the closed system and subsequent flushing, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves

and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils.

- 2.2.3. System is operated with a minimum pressure of 35 kPa at highest point and expansion tank level is maintained at 1/3 to ½ full.
- 2.2.4. Do not valve in or operate system pumps until after system has been cleaned.
- 2.2.5. Provide a copy of recommended cleaning procedures and chemicals for review by Consultant.
- 2.2.6. Prior to chemical cleaning, the systems shall be inspected to ensure removal of heavy debris and excessive dirt and oil. Temporary strainers shall be installed on the suction side of each pump.
- 2.2.7. Provisions shall be made for temporary connections between the supply and return mains in the system to permit circulation of the cleaner. A 1" pipe connection shall be provided on the suction side of the circulating pumps for introduction of the cleaning solution.
- 2.2.8. Each system shall be flushed to remove loose dirt and shall be hydrostatically tested to ensure that there are no leaks. Rotation of pumps shall be checked.
- 2.2.9. The contractor shall introduce a neutral pH cleaner and rust remover into each system at a dosage recommended by the water treatment supplier. The cleaner shall not attack carbon steel, copper, stainless steel, bronze, brass, aluminum, plastics or natural and synthetic rubbers. "Flash rusting" shall not occur after cleaning.
- 2.2.10. The cleaner shall be circulated at a temperature of 20°C to 80°C for a period of not less than 72 hours. PH adjustment shall be carried out by the water treatment supplier's representative.
- 2.2.11. Each system shall be drained, refilled with fresh water, recirculated for a period of 12 hours, drained a second time, and immediately refilled and treated with the recommended corrosion inhibitor.
- 2.2.12. The water treatment company shall provide the loan of a drum pump and dolly to facilitate the introduction of the cleaner into the system.
- 2.2.13. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.
- 2.2.14. Provide and later remove all temporary bypasses, drains, vents, etc. required to flush and clean the system. Temporary components for flushing and cleaning are not indicated on the drawings.

2.3. TREATMENT PROGRAM – CHEMICAL TREATMENT AND PASSIVATION

- 2.3.1. Provide passivation and chemical treatment per the approved chemical treatment procedures. Chemically treat new and reused piping networks using chemicals and treatment procedures compatible with the system being cleaned and the chemical treatment chemicals in existing piping systems being connected to. Test existing piping systems or otherwise determine chemical treatment in existing piping and validate compatibility. Note that existing systems may be silica based, adjust water treatment program accordingly.
- 2.3.2. When connecting into active existing systems, treat piping networks installed or reused by the project and verify by lab analysis that the treatment levels per the treatment plan have been attained prior to connecting into the existing active system. Submit validating report for approval.
- 2.3.3. Do not connect into existing active system until report is approved by Client.
- 2.3.4. Provide temporary valves, piping, and accessories as required to treat the project's piping prior to connection to the active system.
- 2.3.5. Provide passivation/chemical treatment at system startup or immediately upon operation of a system for temporary cooling and heating, whichever comes first.
- 2.3.6. Provide chemical treatment immediately after each system has been cleaned and flushed. Thereafter immediately begin the approved water treatment maintenance program to passivate and prevent corrosion, scale, and organic growth and to maintain treatment chemical levels. Note that systems or parts of systems will not typically be started at the same time; adjust treatment strategy accordingly.

PART 3 - EXECUTION

3.1. CHEMICAL SERVICE PROVIDER (CSP) SERVICES

- 3.1.1. The CSP shall provide all cleaning and treatment chemicals, basic services, testing, equipment and materials necessary for a complete water treatment program.
- 3.1.2. The CSP shall perform an analysis of the supply water to determine the type and quantities of chemical treatment needed to maintain the required water quality to prevent corrosion, scaling, and biological growth. The CSP will at minimum provide weekly site visits to verify proper water treatment for the first month after any system or part of a system is treated. Provide monthly visits thereafter, or more often if required to assure performance requirements are being met, to analyze water samples, inspect equipment, and add additional chemicals as required to maintain proper water treatment, until final written Client acceptance of the respective system.

3.1.3. At each site visit CSP shall analyze each system for corrosion inhibitors, pH, total iron, total copper, bacteria levels (provide monthly analytical laboratory analysis), and conductivity; inspect loss from corrosion (provide analytical laboratory analysis every three months), record make-up meter readings, and perform any other tests necessary to validate that corrosion, scale, and organic growth is being prevented.

3.1.4. Reports:

3.1.4.1. Submit a written startup test report for each system placed into service. A service report shall be prepared on site by the CSP, submitted at the time of each service visit (with copies immediately provided to the Client), which shall include all required test results and recommendations.

3.1.4.2. Additionally, provide final reports for approval to the Client regarding each site service visit, certified by a representative of the CSP, within one week of any water treatment activity. Such reports shall include the results of any field or lab tests. Reports shall clearly state if the required water quality and maximum corrosion rates are being achieved.

3.1.4.3. At a minimum, each report shall include the following information:

3.1.4.3.1. System Treated

3.1.4.3.2. Date

3.1.4.3.3. Conductivity

3.1.4.3.4. pH

3.1.4.3.5. Total Iron

3.1.4.3.6. Total Copper

3.1.4.3.7. Bacteria(cfu) (monthly analytical laboratory analysis)

3.1.4.3.8. Corrosion Rates (three month analytical laboratory analysis)

3.1.4.3.9. Make-up Water Quantity since Last Visit

3.1.4.3.10. Corrosion Inhibitor level (ppm)

3.1.4.3.11. Silica level (ppm)

3.1.5. Conduct final on-site system turn over meeting with Client and Consultant or Commissioning Agent (as applicable to the project). Present final validation report demonstrating that performance requirements have been achieved and that each system is currently properly treated.

3.1.6. Train Owner's maintenance personnel in water treatment procedures.

3.1.7. Program Administration Manual:

3.1.7.1. The CSP shall provide the Owner with two (2) Program Administration Manuals including sections covering program control, testing requirements, in plant logs, safety data and system information. Each section shall include the following:

- 3.1.7.1.1. *Program Control*: Include a complete program outline with chemical descriptions, control ranges, and required action for “out of range” situations. Also include complete ordering instructions with applicable account numbers and phone numbers.
- 3.1.7.1.2. *Testing Requirements*: This section will include basic testing practices as well as detailed test instructions for each test to be performed.
- 3.1.7.1.3. *In-Plant Logs*: Include detailed testing log sheets for each system to be tested including room to record one (1) month’s data on one (1) sheet and a section to log chemical inventory.
- 3.1.7.1.4. *Safety Data*: Include the CSP’s 24-hour toll free safety hotline number as well as MSDS sheets for each chemical used.
- 3.1.7.1.5. *System Information*: Include any equipment manuals and related information.

3.2. INSTALLATION AND TREATMENT

- 3.2.1. Install all required components, and chemically passivate/treat and maintain the system as described in Part 2.
- 3.2.2. Use and dispose of chemicals and wastewater (including from existing piping networks) per the Quality Assurance section of this specification. All costs of disposal shall be borne by the contractor.
- 3.2.3. Provide and install all chemicals and all incidental components.
- 3.2.4. Install equipment at locations shown on the Drawings. Follow the manufacturer’s installation and startup instructions.
- 3.2.5. Passivate and chemically treat each system immediately after it has been cleaned and flushed.
- 3.2.6. Install pot feeders and filtration cartridges with openings no higher than 1,200 mm (4 ft) above finished floor. Pipe pot feeder drain to nearest floor drain (where glycol is not present).
- 3.2.7. The treatment program shall begin at system start-up or immediately upon first operation of the system by the contractor for temporary heating and cooling, whichever comes first. Continue the program until Substantial Completion.

3.3. FIELD QUALITY CONTROL

- 3.3.1. The CSP shall:

- 3.3.1.1. Verify that systems and equipment have been properly cleaned, flushed, and filled with water, and are fully operational before introducing operational chemicals for water-treatment systems.
- 3.3.1.2. Introduce and maintain chemical treatment to achieve the specified performance requirements.
- 3.3.1.3. Submit a written startup test report for each system placed into service.
- 3.3.1.4. Provide validation testing and required reports.
- 3.3.1.5. Attend final on-site system turn over meeting with Client and Consultant or Commissioning agent (as applicable to the project). Present final validation report demonstrating that performance requirements have been achieved and that each system is currently properly treated.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. QUALITY ASSURANCE 2

1.3. SUBMITTALS 3

1.4. WARRANTY 4

PART 2 - PRODUCTS 4

2.1. GENERAL USE DUCTWORK 4

2.2. SEALING CLASSIFICATION 6

2.3. PRESSURE CLASSIFICATIONS..... 7

2.4. PLENUMS..... 7

2.5. FLEXIBLE AIR DUCT 7

2.6. DUCT ACCESS DOORS 8

2.7. VOLUME CONTROL DAMPERS (MANUAL ADJUSTMENT)..... 9

2.8. INSTRUMENT TEST FITTINGS..... 9

2.9. DUCTWORK HANGERS AND SUPPORTS..... 9

PART 3 - EXECUTION 11

3.1. INSTALLATION..... 11

3.2. DUCT LEAKAGE TESTS AND REPAIR 12

3.3. DUCT PAINTING 13

3.4. DUCTWORK EXPOSED TO WIND VELOCITY 14

PART 1 - GENERAL

1.1. DESCRIPTION

1.1.1. Ductwork and accessories for HVAC including the following:

- 1.1.1.1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
- 1.1.1.2. Exhaust ductwork for equipment.

1.1.2. Section Includes:

- 1.1.2.1. Ductwork materials, plenums, construction, fabrication, and support
- 1.1.2.2. Galvanized steel ductwork (rectangular, round)
- 1.1.2.3. Aluminum ductwork
- 1.1.2.4. Leak-proof ductwork
- 1.1.2.5. Reinforcing and supports.
- 1.1.2.6. Flexible duct.
- 1.1.2.7. Special ductwork construction including exhaust plenums;
- 1.1.2.8. Duct sealants.
- 1.1.2.9. Ductwork sealing, inspection, and leakage testing.
- 1.1.2.10. Ductwork accessories.

1.1.3. Section does not include:

- 1.1.3.1. *Dust or particle collection ductwork*

1.1.4. Definitions:

- 1.1.4.1. SMACNA standards as used in this specification means the HVAC Duct Construction Standards, Metal And Flexible.
- 1.1.4.2. Seal or sealing: use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
- 1.1.4.3. Duct pressure classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- 1.1.4.4. Exposed duct: exposed to view in a finished room
- 1.1.4.5. Outdoor duct: exposed to weather.

1.2. QUALITY ASSURANCE

- 1.2.1. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the following quality assurance standards; latest editions, unless noted otherwise.

- 1.2.2. Duct system construction and installation: referenced SMACNA standards are the minimum acceptable quality.
- 1.2.3. Duct sealing, air leakage criteria, and air leakage tests: ducts shall be sealed as per duct sealing requirements of SMACNA HVAC air duct leakage test manual for duct pressure classes shown on the drawings.
- 1.2.4. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.3. SUBMITTALS

- 1.3.1. Provide the following information and product data:

- 1.3.1.1. Sealants and gaskets
- 1.3.1.2. Access doors
- 1.3.1.3. Hangers and supports
- 1.3.1.4. Duct fittings
- 1.3.1.5. Turning vanes
- 1.3.1.6. Flexible duct
- 1.3.1.7. Volume control dampers
- 1.3.1.8. Fire and smoke dampers

- 1.3.2. Applicable Publications

- 1.3.2.1. American Society for Testing and Materials (ASTM):

- 1.3.2.1.1. A167 99(2009) Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip
- 1.3.2.1.2. A653-09 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
- 1.3.2.1.3. A1011-09a Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- 1.3.2.1.4. B209 07 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
- 1.3.2.1.5. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
- 1.3.2.1.6. E84-09a Standard Test Method for Surface Burning Characteristics of Building Materials

- 1.3.2.2. National Fire Protection Association (NFPA):

- 1.3.2.2.1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems

- 1.3.2.2.2. 96-08 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- 1.3.2.2.3. E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
- 1.3.2.2.4. 2nd Edition – 2005 HVAC Duct Construction Standards, Metal and Flexible
- 1.3.2.2.5. 1st Edition - 1985 HVAC Air Duct Leakage Test Manual
- 1.3.2.2.6. 6th Edition – 2003 Fibrous Glass Duct Construction Standards
- 1.3.2.3. Underwriters Laboratories, Inc. (UL):
- 1.3.2.3.1. 181 08 Factory Made Air Ducts and Air Connectors
- 1.3.2.3.2. 555 06 Standard for Fire Dampers
- 1.3.2.3.3. 555S 06 Standard for Smoke Dampers

1.4. WARRANTY

- 1.4.1. Provide a complete part and labor warranty for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1. GENERAL USE DUCTWORK

- 2.1.1. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel of lock-forming quality to ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- 2.1.2. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- 2.1.3. Approved factory made joints may be used.
- 2.1.4. Provide fittings, branches, inlets and outlets in such a manner that air turbulence is reduced to a minimum.
- 2.1.5. Rectangular Duct Construction
 - 2.1.5.1. Rectangular duct longitudinal seams shall be Pittsburgh lock 3/8 in. minimum pocket. Crossbreak or bead rectangular ductwork
 - 2.1.5.2. Thickness shall be the more restrictive between the SMACANA Standards and the following:
 - 2.1.5.2.1. Ducts through 12 in. wide: 24 Gage
 - 2.1.5.2.2. Ducts 13 in. through 30 in. wide: 22 Gage.
 - 2.1.5.2.3. Ducts 31 in. through 84 in. wide: 20 Gage.
 - 2.1.5.2.4. Ducts 84 in. and larger: 18 Gage

2.1.5.3. Elbows

2.1.5.3.1. Unless shown otherwise on the drawings, install a 1.5 times width to centerline radius elbow (full radius elbow). Where not possible, use lesser radii configurations, with 'radius-proportional' splitter vanes permanently installed within.

2.1.5.3.2. Only where shown specifically on the drawings, provide square elbows with double thickness vanes.

2.1.5.4. Transitions

2.1.5.4.1. Limit transition angles (for each side) to 15 degrees diverging and 30 degrees converging.

2.1.5.5. Offsets:

2.1.5.5.1. Radiused elbows, as indicated.

2.1.5.6. Take-Off Fittings:

2.1.5.6.1. For take-offs carrying more than 25 percent of duct main, provide an increasing branch elbow with an inside radius equal to branch duct width. Size branch and main at elbow for equal velocity.

2.1.5.6.2. For take-offs carrying 25 percent or less of duct main, provide flanged increased area branch take-off (45 degree entry, "shoe" type) or 45 degree lateral wye takeoffs. Conical fittings shall be used for spiral, round, and oval ductwork.

2.1.5.6.3. For take-offs directly to side outlet for register or grille, provide an increased area tap. For take-offs directly to diffusers see appropriate SMACNA figures.

2.1.5.7. Turning vanes

2.1.5.7.1. Install double wall, airfoil, 2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity less than 2000 fpm. Install double wall, airfoil, 4-1/2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity 2000 fpm or greater.

2.1.5.7.2. If duct size changes in a mitered elbow, use single wall type vanes with a trailing edge extension. If duct size changes in a radius elbow or if short radius elbows must be used, install sheet metal turning vanes in accordance with SMACNA Chart 4-1 and Figure 4-9.

2.1.6. Round Duct Construction

2.1.6.1. All round and oval duct shall be manufactured of spiral lock seams. Ductwork up to 12 in. diameter and 2 in. w.g. can be manufactured with longitudinal lock seams.

2.1.6.2. Minimum galvanized rectangular duct gage shall be the more restrictive between the SMACANA Standards and the following:

2.1.6.2.1. Ducts less than 10" diam: 26 ga spiro duct without ribs

2.1.6.2.2. Ducts 12" to 16" in. diam: 24 Gage

2.1.6.2.3. Ducts 18" through 24" diam: 22 Gage.

- 2.1.6.2.4. Ducts 26 in. through 30" diam: 20 Gage.
- 2.1.6.2.5. Ducts 32" diam and larger: 18 Gage
- 2.1.6.3. Tees shall be conical. Laterals shall be straight. Taps through 10 in. diameter in size shall have a machine drawn entrance and fittings shall have longitudinal seams, continuously welded. Both sides of welds shall be primed with zinc chromate. Tap entrances shall be free of weld build-up.
- 2.1.6.4. Elbows in diameters 2 in. through 10 in. shall be stamped or pleated. Elbows shall be 5 gore for 90 degrees and 3 gore for 45 degrees. Elbows shall have 1.5 times width to centerline radius (full radius elbow).
- 2.1.6.5. Flanges, access doors and taps into spiral ducts shall be factory fabricated.
- 2.1.6.6. Field joints in diameters through 48 in. shall be made with 2 in. long slip-fit, sleeve coupling, or flanges. Duct sealer to be applied on male end connectors before insertion and afterwards to cover the entire joint and sheet metal screws. Sheet metal screws shall be installed at a maximum 300 mm spacing, with a minimum of 3 screws per joint.
- 2.1.6.7. Ductwork 48 in. diameter and over, and for all sizes where disassembly or removal is required, shall be joined with flanges.

2.2. SEALING CLASSIFICATION

- 2.2.1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
- 2.2.2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
- 2.2.3. Gaskets in Flanged Joints: Soft neoprene.
- 2.2.4. Sealing classification as per the following table

SEAL CLASS	SEALING REQUIREMENTS	STATIC PRESSURE	ALLOWABLE LEAKAGE RATE
A	All traverse duct joints, all longitudinal duct seams and all duct wall penetrations	-4" to +4" w.g. (1,000 to +1,000 Pa)	1% of total design air flow at 4" w.g. (+1,000 Pa) operating pressure
B	All traverse duct joints, all longitudinal duct seams	-3" to +3" w.g. (-750 to +750 Pa)	1% of total design air flow at 3" w.g. (+750 Pa) operating pressure

C	All traverse duct joints	-2" to +2" w.g. (-500 to +500 Pa)	1.5% of total design air flow at 2" w.g. (+500 Pa) operating pressure
D	Not sealed	-1" to +1" w.g. (-250 to +250 Pa)	5% of total design air flow at 1" w.g. (+250 Pa) operating pressure

Note: Dust collection exhaust ductwork not included.

2.3. PRESSURE CLASSIFICATIONS

2.3.1. Ductwork material shall be constructed in accordance with SMACNA ratings for the following pressure classifications. Seal classifications shall be in accordance with the following table:

DUCTWORK	OPERATING PRESSURE	SEAL CLASS	REMARKS
All supply ductwork	-3" to +3" w.g. (-750 to +750 Pa)	B	
All return ductwork	-2" to +2" w.g. (-500 to +500 Pa)	C	
All exhaust ductwork	-2" to +2" w.g. (-500 to +500 Pa)	C	
All other ductwork not listed herein	-1" to +1" w.g. (-250 to +250 Pa)	D	

2.4. PLENUMS

2.4.1. Intake and Exhaust plenums shall be double wall with 2 in. thick duct liner, G-90 galvanized steel solid inner wall (gauge per specified duct minimum standards) and minimum 18 gauge, G-90 galvanized steel outer wall.

2.5. FLEXIBLE AIR DUCT

2.5.1. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 1.5 m (5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.

2.5.2. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 200 mm (8 inches) in diameter shall be Class 1. Ducts 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.

2.5.3. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than

50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm (foot) of straight duct, at 500 Hz, based on 150 mm (6 inch) duct, of 750 m/min (2500 fpm).

2.5.4. Application Criteria:

- 2.5.4.1. Temperature range: -18 to 93 degrees C (0 to 200 degrees F) internal.
- 2.5.4.2. Maximum working velocity: 1200 m/min (4000 feet per minute).
- 2.5.4.3. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.

2.5.5. Duct Clamps: 100 percent nylon strap, 80 kg (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

2.6. DUCT ACCESS DOORS

2.6.1. Provide access doors, sized and located for maintenance work, upstream, in the following locations:

- 2.6.1.1. Each in-duct coil (hydronic or DX)
- 2.6.1.2. Each duct mounted coil and humidifier.
- 2.6.1.3. Each fire damper (for link service), smoke damper and automatic control damper.
- 2.6.1.4. Each duct mounted smoke detector.

2.6.2. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.

2.6.3. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2 12).

2.6.4. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

2.6.5. Access doors to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be aluminum or steel full length continuous piano type. Doors in concealed spaces shall be secured in place with cam sash latches.

2.6.6. For both hinged and non-hinged doors provide sufficient number of camp sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access.

2.6.7. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep

double wall access door with frame that shall use materials of construction identical to adjacent ductwork.

- 2.6.8. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.

2.7. VOLUME CONTROL DAMPERS (MANUAL ADJUSTMENT)

- 2.7.1. Single or multi-blade in opposed arrangement, as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.

2.8. INSTRUMENT TEST FITTINGS

- 2.8.1. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.
- 2.8.2. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

2.9. DUCTWORK HANGERS AND SUPPORTS

- 2.9.1. Generally, hang and support ductwork per the latest edition of SMACNA. Additionally, adhere to the more specific requirements found in this specification section, the Related Sections, and as indicated on the project drawings.
- 2.9.2. Hanging duct, equipment, or accessories with cables or wires is prohibited.
- 2.9.3. Provide vibration isolation as specified in Related Section.
- 2.9.4. Ductwork shall be supported and anchored to structure so that horizontal ducts are without sag or sway, vertical ducts without buckle and all ducts are free from deformation, collapse or vibration
- 2.9.5. Upper hanger attachments:
 - 2.9.5.1. For concrete: manufactured concrete inserts.
 - 2.9.5.1.1. Standard of Acceptance: Myatt fig 485.
 - 2.9.5.2. For concrete after concrete pour:
 - 2.9.5.2.1. Expanded concrete anchors shall be made of steel.

- 2.9.5.3. Powder actuated fasteners shall only be utilized for slabs that are thicker than 100 mm (4") and shall not be utilized in lightweight aggregate concretes.
- 2.9.5.4. Holes for expanding fasteners shall be drilled either by a carbide bit or by the teeth on the fastener itself. Expansion shield shall be "set" by driving it into the hole and expanding it with a conical plug.
- 2.9.5.5. For steel joist: manufactured joist clamp or steel plate washer.
- 2.9.5.5.1. Standard of Acceptance: Grinnell fig 61 or 86 for joist clamps.
- 2.9.5.6. For steel beams: manufactured beam clamps:
- 2.9.5.6.1. Standard of Acceptance: Grinnell fig. 60
- 2.9.6. Support un-insulated rectangular ducts in sizes up to 600 mm (24 in.) by non-perforated galvanized steel strap or by trapeze hangers. Support insulated rectangular ducts and ducts larger than 36 in. with trapeze hangers. Straps shall be one gauge thicker than the duct material being supported.
- 2.9.7. Support rectangular ducts in sizes 350 mm (26 in) and larger by galvanized steel angle with black galvanized steel rods to ASHRAE and SMACNA. Space the angle supports in accordance with the following table:
- | DUCT SIZE | ANGLE SIZE (mm) | ROD SIZE (mm) |
|------------------------|-----------------|---------------|
| Up to 750 mm (30") | 25 x 25 x 3 | 6 |
| 800-1500 mm (32"-60") | 40 x 40 x 3 | 10 |
| 1500-2400 mm (60"-96") | 50 x 50 x 5 | 10 |
| > 2400 mm (96") | 50 x 50 x 6 | 10 |
- 2.9.8. For round ductwork the duct shall be supported as follows:
- 2.9.8.1.1. For duct dimensions 900 mm (36") single strap hangers are acceptable.
- 2.9.8.1.2. For duct dimensions over 900 mm (36") use trapeze hangers with rods provided on both sides of the duct.
- 2.9.8.2. Minimum hanger sizes shall be in accordance with Table 4-2 of SMACNA.
- 2.9.8.3. Loading on trapeze bars shall be in accordance with Table 4-3 of SMACNA
- 2.9.9. Install supports on both ends of duct turns, branch fittings and transitions.
- 2.9.10. Do not hang ductwork from piping, ducts, other trades hangers, existing hangers, or equipment.
- 2.9.11. Provide supports on each side of any duct mounted equipment or device, including fans, coils, dampers, etc, to permit removal of item without removal of adjacent duct sections.
- 2.9.12. Provide supplemental steel required to support ductwork in shafts, mechanical rooms or on the floor where structural steel is not properly positioned.

- 2.9.13. Beam clamps shall be double sided on ducts over 36 in. by 36 in. Use double sided or single sided beam clamps with retaining clips on all other sizes.
- 2.9.14. Do not modify existing structural steel without approval and a structural engineer's review.
- 2.9.15. Provide clamping systems that are compatible with the structural steel system of the building.
- 2.9.16. Use angle iron "V" construction supports or similarly rigid construction for vertical ducting that requires lateral support.
- 2.9.17. Ductwork mounted on roof or otherwise exposed to elements shall be supported with non-penetrating supports constructed of galvanized steel angles and channels, regardless of duct size. Standard of Acceptance: Portable Pipe Hangers (Canada)
- 2.9.18. Provide angle sway bracing and diagonal cross bracing to the structure to provide support against maximum lateral loads that may be imposed on the ductwork installed downstream of fan discharges and ductwork exposed to wind loads, and any other locations exposed to lateral loads.

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Comply with provisions of Section 23 05 00 Common Work Results for HVAC, particularly regarding coordination with other trades and work in existing buildings.
- 3.1.2. Comply with the provisions of Section 23 07 11 HVAC System Insulation.
- 3.1.3. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
- 3.1.4. Ductwork shall be installed to true alignment, parallel or perpendicular to adjacent building walls, floors and ceilings, to present a neat and workmanlike appearance.
- 3.1.5. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an

obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.

- 3.1.6. Provide bolted construction and tie rod reinforcement in accordance with SMACNA Standards.
- 3.1.7. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- 3.1.8. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- 3.1.9. For ductwork mounted outdoors, install duct with slight lateral pitch to prevent water ponding on top of duct.
- 3.1.10. Install special equipment items in ductwork systems including, but not limited to: control dampers, thermometers, airflow measuring devices and other related items, according to manufacturer's recommendations.
- 3.1.11. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- 3.1.12. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 1.5 m (5 feet) long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.
- 3.1.13. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- 3.1.14. Protection and Cleaning:
 - 3.1.14.1. Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by the Consultant. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

3.2. DUCT LEAKAGE TESTS AND REPAIR

- 3.2.1. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor. For maximum leakage rates, refer to pressure classifications and sealing classifications included in part 2 of these specifications
- 3.2.2. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections.
- 3.2.3. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- 3.2.4. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- 3.2.5. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- 3.2.6. Duct Leakage Testing Procedures:
 - 3.2.6.1. Prior to fabrication and installation, develop and submit for approval a ductwork testing plan, indicating locations of temporary caps, surface area of ductwork test sections, test pressure, leakage class and allowable leakage in cubic feet per minute.
 - 3.2.6.2. Notify the Client's Representative at least 2 days prior to each test.
 - 3.2.6.3. Provide all blank-off plates, flanges, and safing required to isolate each section of duct to be tested.
 - 3.2.6.4. Provide necessary testing apparatus.
 - 3.2.6.5. For all ducts, pressurize ductwork to the specified pressure class and inspect ductwork for visual and audible leaks, and leaks perceptible to a hand 2 in. from duct. Reseal all perceptible leaks until acceptable to Client's Representative.
 - 3.2.6.6. After completing visual and audible inspection, conduct measured ductwork leakage tests at the specified pressure class for the duct. Reseal and retest as required until successfully achieving the specified leakage class.
 - 3.2.6.7. Submit leakage test report for approval, using SMACNA or other approved form.
 - 3.2.6.8. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

3.3. DUCT PAINTING

- 3.3.1. Where the interior of duct is visible through grilles, registers, diffusers or other air diffusion devices, paint the interior flat black. Coordinate work with Architectural Trade.

- 3.3.2. For plenum returns, where equipment and structure above ceiling is visible through return air grilles, provide black sheet metal baffle with turned edges suspended from building construction. Size and position the baffle to prevent restriction of air flow. Where space above ceiling precludes use of a baffle, paint visible building surfaces flat black.

3.4. DUCTWORK EXPOSED TO WIND VELOCITY

- 3.4.1. Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building to withstand wind velocity of 145 km/h (90 mph).
- 3.4.2. All bracing to be stamped and sealed by a licensed Structural Professional Engineer and submitted for review. All engineering services required for additional strapping to be provided by the roof duct support manufacturer and paid for by the Contractor.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. MOTORIZED DAMPERS TYPE 2

1.3. SUBMITTALS 2

1.4. APPLICABLE PUBLICATIONS 3

PART 2 - PRODUCTS 3

2.1. THERMALLY INSULATED DAMPER 3

2.2. ENHANCED AIR-FOIL CONTROL DAMPER 5

2.3. FIRE DAMPERS 7

PART 3 - EXECUTION 8

3.1. GENERAL 8

3.2. MOTORIZED DAMPERS 8

3.3. FIRE AND SMOKE DAMPERS 9

3.4. TESTING 10

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. Motorized dampers not included as part of pre-manufactured air handling equipment
- 1.1.2. Fire dampers

1.2. MOTORIZED DAMPERS TYPE

- 1.2.1. All modulating motorized dampers shall be opposed-blades type
- 1.2.2. All two-position motorized dampers shall be parallel type
- 1.2.3. All motorized dampers for fresh air and/or exhaust air, and all other dampers in contact with outside are shall be thermally insulated type.

1.3. SUBMITTALS

- 1.3.1. Product Data: Submit performance data, rated capacities, furnished specialties, sound-power ratings, and accessories for each type of product.
- 1.3.2. Damper manufacturer's installation instructions.
- 1.3.3. Product Data for each type of product.
- 1.3.4. Shop Drawings:
 - 1.3.4.1. Indicate the location and rating of all dampers on shop drawings and submittals.
 - 1.3.4.2. Operation and maintenance data.
- 1.3.5. Damper Operators
 - 1.3.5.1. Refer to Section: 23 09 00 Instrumentation and Control for HVAC.
- 1.3.6. Record Documents:
 - 1.3.6.1. Fire Dampers: The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500D standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05-inch water gauge.
 - 1.3.6.2. Combination Fire/Smoke Dampers: Assign identification numbers for each damper with corresponding number noted on Drawings. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper. Provide manufacturer's data of damper and its accessories or options. At Owner's request, provide two (2) dampers (18-inch x 12 inch) for the purpose

of illustrating damper operation to Owner's operating and maintenance personnel.

- 1.3.7. Access Doors. Include type of material, installation guidelines, leakage rates and maximum pressure data.
- 1.3.8. Volume Control Dampers. Include type of material, installation guidelines, pressure drop and maximum pressure data.

1.4. APPLICABLE PUBLICATIONS

- 1.4.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.4.2. American Society for Testing and Materials (ASTM):
 - 1.4.2.1. A167 99 (2004) Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet and Strip
 - 1.4.2.2. B209 07 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
- 1.4.3. National Fire Protection Association (NFPA):
 - 1.4.3.1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems
- 1.4.4. Underwriters Laboratories, Inc. (UL):
 - 1.4.4.1. 181 08 UL Standard for Safety Factory Made Air Ducts and Connectors

PART 2 - PRODUCTS

2.1. THERMALLY INSULATED DAMPER

- 2.1.1. Extruded aluminum (6063-T5) damper frame shall not be less than 0.080" (2.03 mm) in thickness. Damper frame shall be 4" (101.6 mm) deep x 1" (25.4 mm), with duct mounting flanges on both sides of frame. Damper frame shall have a 2" (50.8 mm) mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners. Welded frames shall not be acceptable.
- 2.1.2. Blades shall be maximum 6" (152.4 mm) deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06" (1.52mm). Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29. All blades shall be symmetrically pivoted.

- 2.1.3. Blade seals shall be extruded EPDM, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.
- 2.1.4. Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.
- 2.1.5. Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 7/16" (11.11 mm) aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.
- 2.1.6. Hexagonal control shaft shall be 7/16" (11.11 mm). It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.
- 2.1.7. Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage and a Celcon bearing between moving parts to reduce wear and increase longevity. Linkage that consists of metal rubbing metal will not be approved.
- 2.1.8. Dampers shall be designed for operation in temperatures ranging from -40°F (-40°C) to 212°F (100°C).
- 2.1.9. Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. (0.25 kPa) static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
- 2.1.10. Dampers shall be custom made to required size, with blade stops not exceeding 1¼" (31.7 mm) in height. The blade stop shall be a continuous and integral part of the head/sill. Welded and caulked blade stops shall not be acceptable.
- 2.1.11. Dampers shall be opposed blade action or parallel blade action as indicated on the plans or specified herein.
- 2.1.12. Dampers shall be installed in the following manner: Flanged to Duct, Installed in Duct, Extended Rear Flange, or Square to Round Transition. (Specify one.)
- 2.1.13. Installation of dampers must be in accordance with TAMCO's current installation guidelines, provided with each damper shipment.

2.1.14. Field supplied intermediate structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. (See TAMCO Aluminum Damper Installation Guidelines.)

2.1.15. SC - Severe Cold Temperature Option:

2.1.15.1. Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

2.1.16. MR - Moisture Resistance Option:

2.1.16.1. Extruded aluminum (6063-T5) damper frame shall not be less than 0.080" (2.03 mm) in thickness. Damper frame shall be 4" (101.6 mm) deep x 1" (25.4 mm), with duct mounting flanges on both sides of frame. Damper frame shall have a 2" (50.8 mm) mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame shall be assembled using stainless steel screws. Welded frames shall not be acceptable.

2.1.16.2. Hexagonal control shaft shall be 7/16" (11.11 mm). It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be stainless steel.

2.1.16.3. Linkage hardware shall be aluminum and stainless steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with stainless steel cup-point trunnion screws to prevent linkage slippage and a Celcon bearing between moving parts to reduce wear and increase longevity. Linkage that consists of metal rubbing metal will not be approved.

2.1.17. Standard of Acceptance: Taco 9000 series, Ruskin

2.2. ENHANCED AIR-FOIL CONTROL DAMPER

2.2.1. Extruded aluminum (6063-T5) damper frame shall not be less than 0.080" (2.03 mm) in thickness. Damper frame shall be 4" (101.6 mm) deep x 1" (25.4 mm), with duct mounting flanges on both sides of frame. Damper frame shall have a 2" (50.8 mm) mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners. Welded frames shall not be acceptable.

2.2.2. Blades shall be maximum 6" (152.4 mm) deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06" (1.52mm). Aluminum end caps shall be press fitted to blade ends, in order to seal hollow interior and reduce air leakage rates. All blades shall be symmetrically pivoted.

- 2.2.3. Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.
- 2.2.4. Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.
- 2.2.5. Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 7/16" (11.11 mm) aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.
- 2.2.6. Hexagonal control shaft shall be 7/16" (11.11 mm). It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.
- 2.2.7. Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage and a Celcon bearing between moving parts to reduce wear and increase longevity. Linkage that consists of metal rubbing metal will not be approved.
- 2.2.8. Dampers shall be designed for operation in temperatures ranging from -40°F (-40°C) to 212°F (100°C).
- 2.2.9. Dampers shall be AMCA rated for Leakage Class 1A at 1 in. w.g. (0.25 kPa) static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
- 2.2.10. Dampers shall be custom made to required size, with blade stops not exceeding 1¼" (31.7 mm) in height. Welded and caulked blade stops shall not be acceptable.
- 2.2.11. Dampers shall be opposed blade or parallel blade action, as indicated on the plans and specified herein.
- 2.2.12. Dampers shall be installed in the following manner: Flanged to Duct, Installed in Duct, Extended Rear Flange, or Square to Round Transition. (Specify one.)
- 2.2.13. Installation of dampers must be in accordance with TAMCO's current installation guidelines, provided with each damper shipment.
- 2.2.14. Field-supplied intermediate structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. (See TAMCO Aluminum Damper Installation Guidelines.)

2.2.15. ET - Elevated Temperature Option (Up To 300°F (149°C):

- 2.2.15.1. Bearings shall be a dual bearing system composed of a bronze oilite inner bearing (fixed around a 7/16" (11.11 mm) aluminum hexagon blade pivot pin), rotating within a bronze oilite outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable
- 2.2.15.2. Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage. Trunnion bearings shall be bronze oilite. Linkage that consists of steel rubbing steel will not be approved.
- 2.2.15.3. Dampers shall be designed for operation in temperatures ranging from -40°F (-40°C) to 300°F (149°C).

2.2.16. MR - Moisture Resistance Option:

- 2.2.16.1. Extruded aluminum (6063-T5) damper frame shall not be less than 0.080" (2.03 mm) in thickness. Damper frame shall be 4" (101.6 mm) deep x 1" (25.4 mm), with duct mounting flanges on both sides of frame. Damper frame shall have a 2" (50.8 mm) mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame shall be assembled using stainless steel screws. Welded frames shall not be acceptable.
- 2.2.16.2. Hexagonal control shaft shall be 7/16" (11.11 mm). It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be stainless steel.
- 2.2.16.3. Linkage hardware shall be aluminum and stainless steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with stainless steel cup-point trunnion screws to prevent linkage slippage and a Celcon bearing between moving parts to reduce wear and increase longevity. Linkage that consists of metal rubbing metal will not be approved.

2.2.17. Standard of Acceptance: Tamco 1500 series, Ruskin

2.3. FIRE DAMPERS

- 2.3.1. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555, latest edition. Dampers shall possess a 1 1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating, 165 degrees F fusible link, and shall bear a U.L. label in accordance with Underwriters' Laboratories labeling procedures. Construct fire dampers such that damper frame material and curtain material are galvanized [and 304 stainless steel for dampers serving untreated outside air].

- 2.3.2. Fire dampers shall be curtain blade type and damper shall be constructed so that the blades are out of the air stream to provide 100 percent free area of duct in which the damper is housed (Type B).
- 2.3.3. Use Curtain Type Fire Dampers for fire dampers where possible. Use Multiple Blade Fire Dampers for fire damper sizes that exceed manufacturer's allowable Curtain Type Fire Damper sizes, or where velocities or pressures exceed Curtain Type Fire Dampers.
- 2.3.4. Equip fire dampers for vertical or horizontal installation as required by location shown on Drawings. Install fire dampers in wall and floor openings utilizing steel sleeves, angles and other material and practices as required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be provided and installed per manufacturer's instructions. Damper shall have 5" frame constructed of minimum 20 gauge galvanized steel. Blades shall be minimum 24 gauge galvanized steel. Closure spring shall be Type 301 stainless steel, constant force or spring clip type. Damper shall be classified for dynamic closure to 2000 fpm and 4 inches w.g. static pressure.
- 2.3.5. Completely seal the damper assembly to the building components using manufacturer recommended material(s).
- 2.3.6. Standard of Acceptance: Ruskin, Greenheck, Nailor

PART 3 - EXECUTION

3.1. GENERAL

- 3.1.1. Installation shall meet or exceed all applicable requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- 3.1.2. All installation shall be in accordance with manufacturer's published recommendations.
- 3.1.3. Provide motorized dampers where indicated on the drawings and control schematics.
- 3.1.4. Provide all motorized dampers furnished by the BAS Provider in strict accordance with manufacturer's written installation instruction and requirements of these Specifications.
- 3.1.5. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

3.2. MOTORIZED DAMPERS

- 3.2.1. Dampers shall be installed square and plumb to casing, duct, wall, etc. without racking. Align and adjust dampers to ensure proper opening and closing without binding or hesitation.
- 3.2.2. Seal completely around frame. Provide necessary blank off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
- 3.2.3. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
- 3.2.4. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
- 3.2.5. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- 3.2.6. Install dampers designed for horizontal mounting in horizontal orientation, and dampers designed for vertical mounting in vertical orientation.
- 3.2.7. Adequately reinforce multiple section dampers per manufacturer's recommendations.
- 3.2.8. Coordinate access through ceilings or walls to ensure each damper is accessible.

3.3. FIRE AND SMOKE DAMPERS

- 3.3.1. Fire dampers, smoke dampers and combination fire smoke dampers should not be installed where ducts pass through non fire/smoke rated architectural or structural components. Remove all existing or new fire and smoke dampers and combination fire smoke dampers from non-fire rated architectural or structural constructions.
- 3.3.2. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans, automatic dampers, at fire dampers, smoke dampers, fire/smoke dampers, upstream of air flow measuring stations, downstream from manual dampers (not spin-in fittings) and elsewhere as indicated on Drawings. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated.
- 3.3.3. Provide duct test holes where indicated and where required for testing and balancing purposes.
- 3.3.4. Access doors as specified elsewhere shall be provided for access to all parts of the fire and combination fire and smoke dampers. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.

- 3.3.5. Label access doors according to Section 20 05 53 to indicate the purpose of access door.
- 3.3.6. Install each fire and combination fire and smoke damper square and true to the building. The installation shall not place pressure on the damper frame but shall enclose the damper as required by UL555 and UL555S. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.

3.4. TESTING

- 3.4.1. After each fire damper, smoke damper and combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to installation of ceilings, Contractor shall, as directed by Owner, activate part or all dampers as required to verify "first-time" closure. The activation must be scheduled as part of the commissioning and witnessed by an institutional representative.
- 3.4.2. Activation of damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fire damper fusible link, and manually operating the fire/smoke damper through electronic controls.
- 3.4.3. Failure of damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.
- 3.4.4. Coordinate smoke damper system interlock requirements with the fire alarm system.

Table of Contents

PART 1 - GENERAL 2

1.1. REFERENCES..... 2

1.2. SUBMITTALS 3

1.3. QUALITY ASSURANCE 4

1.4. DELIVERY, STORAGE, AND HANDLING..... 4

1.5. WARRANTY 5

1.6. MAINTENANCE 5

1.7. STANDARDS OF ACCEPTANCE 5

PART 2 - PRODUCTS 5

2.1. CEILING MOUNTED CENTRIFUGAL EXHAUST FAN..... 5

PART 3 - EXECUTION 7

3.1. FAN INSTALLATION 7

3.2. FIELD QUALITY CONTROL 9

3.3. COMMISSIONING 9

PART 1 - GENERAL

1.1. REFERENCES

1.1.1. Air Movement and Control Association Inc. (AMCA):

- 1.1.1.1. 99 - Standards Handbook
- 1.1.1.2. 200 - Publication, Air Systems
- 1.1.1.3. 201-90 - Publication, Fans and Systems
- 1.1.1.4. 202-88 - Publication, Troubleshooting
- 1.1.1.5. 203-90 - Publication, Field Performance Measurement of Fan Systems
- 1.1.1.6. 211-05 - Publication, Certified Ratings Program – Product Rating Manual for Fan Air Performance
- 1.1.1.7. 300-96 - Standard Reverberant Room Method for Sound Testing of Fans
- 1.1.1.8. 311-05 - Publication Certified Ratings Program – Product Rating Manual for Fan Sound Performance
- 1.1.1.9. 99-0401-86 - Classification for Spark Resistant Construction
- 1.1.1.10. 99-2408-69 - Operating Limits for Centrifugal Fans

1.1.2. Air Movement and Control Association Inc. (AMCA), American National Standards Institute (ANSI):

- 1.1.2.1. 204-05 - Standard Balance Quality and Vibration Levels for Fans
- 1.1.2.2. 210-99 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

1.1.3. American National Standards Institute (ANSI):

- 1.1.3.1. 11-r1999 - Method of Evaluating Load Ratings of Bearings

1.1.4. American Society of Civil Engineers (ASCE):

- 1.1.4.1. 7-02 - Minimum Design Loads for Building and Other Structures

1.1.5. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

- 1.1.5.1. Chapter 45 - 2003 handbook, HVAC Applications
- 1.1.5.2. Chapter 7 - 2001 Fundamentals handbook, Sound-Vibration
- 1.1.5.3. Chapter 32 - 2001 Fundamentals handbook, Duct Design
- 1.1.5.4. Chapter 18 - 1992 HVAC System and Equipment handbook, Fans

1.1.6. American Society for Testing and Materials (ASTM):

- 1.1.6.1. E330-02 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylight and Curtain Walls by Uniform Static Air Pressure Difference

1.1.7. National Fire Protection Association (NFPA)

- 1.1.7.1. 70 - National Electrical Code
- 1.1.7.2. 90A-02 - Standard for the Installation of Air-Conditioning and Ventilating Systems
- 1.1.7.3. 92A-06 - Recommend Practice for Smoke-Control System
- 1.1.7.4. 92B-05 - Standard for Smoke Management System in Malls, Atria, and Large Areas
- 1.1.7.5. 96-04 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

1.1.8. Occupational Safety and Health Administration (OSHA):

- 1.1.8.1. 1910.212 - General requirements for Machine Guarding
- 1.1.8.2. 1910.219 - General requirements for guarding safe use of mechanical power transmission apparatus
- 1.1.8.3. 1926.300 - General requirements for safe operation and maintenance of hand and power tools

1.1.9. Underwriters Laboratories (UL):

- 1.1.9.1. 507 - Electric Fans
- 1.1.9.2. 555 - Fire Dampers
- 1.1.9.3. 555S - Smoke Dampers
- 1.1.9.4. 705 - Standard Power Ventilators
- 1.1.9.5. 762 - Standard Power Roof Ventilators for Restaurant Exhaust Appliances
- 1.1.9.6. 793 - Snow Load

1.2. SUBMITTALS

- 1.2.1. Provide dimensional drawings and product data on each fan.
- 1.2.2. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
- 1.2.3. Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones.
- 1.2.4. Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.04 of this specification.
- 1.2.5. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance
- 1.2.6. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving, handling, storage, safety

information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams

1.3. QUALITY ASSURANCE

- 1.3.1. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air and sound performance seal
- 1.3.2. Classification for Spark Resistant Construction shall conform to the intent of ANSI/AMCA Standard 99.
- 1.3.3. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).
- 1.3.4. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.
- 1.3.5. The High Wind models have been analyzed and stamped by a state license P.E. to the ASCE 7-02 Standard which meets the IBC, Florida and Miami-Dade codes.
- 1.3.6. Each High Wind model is subject to be certified by a third party to the ASTM E330 Static Pressure Difference Standard.
- 1.3.7. All High Wind models have been analyzed using Computational Fluid Dynamics (CFD). The CFD simulates the flow of high speed (150MPH) winds over the surface of objects.
- 1.3.8. The Finite Element Analysis (FEA) is the results from the CFD and it can accurately predict the stress, strain, and deflection resulting from high wind loads.

1.4. DELIVERY, STORAGE, AND HANDLING

- 1.4.1. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- 1.4.2. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual.
- 1.4.3. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.5. WARRANTY

- 1.5.1. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
- 1.5.2. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.
- 1.5.3. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station.

1.6. MAINTENANCE

- 1.6.1. Refer to Manufacturer's Installation, Operation and Maintenance Manual (IOM), to find maintenance procedures.

1.7. STANDARDS OF ACCEPTANCE

- 1.7.1. Greenheck
- 1.7.2. Loren-Cook
- 1.7.3. Carnes

PART 2 - PRODUCTS

2.1. CEILING MOUNTED CENTRIFUGAL EXHAUST FAN

- 2.1.1. General Description:
 - 2.1.1.1. Base fan performance at standard conditions (density 0.075 Lb/ft3)
 - 2.1.1.2. Ceiling mounted applications
 - 2.1.1.3. Performance capabilities up to 200 cubic feet per minute (cfm) and static pressure to 0.75 inches of water gauge
 - 2.1.1.4. Fans are available in nineteen sizes (50 - 200 unit sizes)
 - 2.1.1.5. Maximum operating temperatures is 130 Fahrenheit (54.4 Celsius)
 - 2.1.1.6. Sound levels as low as 1.7 AMCA sones
 - 2.1.1.7. UL/cUL listed for above bathtub exhaust
 - 2.1.1.8. Fans are UL/cUL listed 507 - Electric Fans
 - 2.1.1.9. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number

2.1.2. Wheel:

- 2.1.2.1. Forward curved centrifugal wheel
- 2.1.2.2. Constructed of calcium carbonate filled polypropylene
- 2.1.2.3. Statically and dynamically balanced in accordance to AMCA Standard 204-05

2.1.3. Motors:

- 2.1.3.1. Motor enclosures shall be open dripproof (ODP), opening in the frame body and or end brackets
- 2.1.3.2. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase
- 2.1.3.3. Motors shall be mounted on vibration isolators and be accessible for maintenance
- 2.1.3.4. Compatible for use with speed controls
- 2.1.3.5. Thermal overload protection

2.1.4. Housing/Cabinet Construction

- 2.1.4.1. Constructed of heavy gauge galvanized steel
- 2.1.4.2. Profile as low as 6 15/16 inches

2.1.5. Disconnect Switches:

- 2.1.5.1. NEMA rated: 1 or 3R to suit local environment
- 2.1.5.2. Positive electrical shut-off
- 2.1.5.3. Wired from fan motor to junction box installed within motor compartment

2.1.6. Duct Collars:

- 2.1.6.1. Steel duct collar shall be six or four inches in diameter to accept a six or four inch round duct work.
- 2.1.6.2. Shall include a backdraft damper

2.1.7. Options/Accessories:

- 2.1.7.1. Back draft Dampers:
 - 2.1.7.1.1. Prevents air from entering back into the building when fan is off
 - 2.1.7.1.2. Eliminates rattling or unwanted backdrafts
- 2.1.7.2. Vibration Isolation/Suspension:
 - 2.1.7.2.1. Type: Housed Spring, sized to match the weight of each fan
- 2.1.7.3. Grille:
 - 2.1.7.3.1. Type: Aluminum, white enamel finish
 - 2.1.7.3.2. Attached to the housing with screws
- 2.1.7.4. Mounting brackets:

- 2.1.7.4.1. Fully adjustable for multiple installation conditions
- 2.1.7.5. Grille Filter:
 - 2.1.7.5.1. Washable aluminum mesh filter that goes between fan and grille
 - 2.1.7.5.2. Reduces sound levels
 - 2.1.7.5.3. Traps dirt before entering the fan.
- 2.1.7.6.
- 2.1.8. Standard of Acceptance: Greenheck SP-LP or SP-B series, or approved equal. The basis of design is based on Greenheck Model: SP-LP0511.

PART 3 - EXECUTION

3.1. FAN INSTALLATION

- 3.1.1. Coordinate the fan arrangement with project conditions prior to ordering the fan.
- 3.1.2. Receive and inspect fans for defects. All defective or damaged fans shall be replaced at no cost to the Client.
- 3.1.3. Openings shall remain protected during storage. Immediately after installation and assembly, all factory protection shall be restored. Unit shall remain protected until just prior to final acceptance by Client.
- 3.1.4. Use spreader bars on lifting cables when hoisting fans from lifting lugs to prevent cable damage to housing or components. Rig fans per fan manufacturer's recommendations.
- 3.1.5. Fans shall be installed as shown on drawings, in accordance with details, approved submittals and the fan Manufacturer's installation requirements and recommendations. Ensure fans are installed to allow easy accessibility for service or removal of fan components.
- 3.1.6. Provide and install supplemental steel, supports, isolators and hangers necessary to hang or mount fans. Coordinate final location and placement of intermediate steel and ductwork connections in field. Install suspended fans with supports attached to structural members.
- 3.1.7. Install any associated motors, drives, or other components that have been shipped loose. Fan shall be installed, made fully operational, and tested.
- 3.1.8. Install flexible inlet and discharge couplings to prevent vibration transmission to ductwork.
- 3.1.9. Inlet and discharge ductwork shall have a minimum straight run of two (2) fan diameters upstream and downstream of the fan.

3.1.10. Just prior to final acceptance fan shall be thoroughly cleaned of all grease, dirt, and dust, etc. Apply touch-up paint or touch-up coating after final cleaning to repair any damage to the finish.

3.1.11. Provide or coordinate the scope of work associated with the installation of fans as specified in the following sections:

- 3.1.11.1. Roof curbs
- 3.1.11.2. Concrete Housekeeping Pads
- 3.1.11.3. Vibration isolation
- 3.1.11.4. Sheet Metal accessories
- 3.1.11.5. Interconnection wiring and conduit from power source to fan connection (starter).

3.1.12. Perform the following tests and inspections prior to fan operation:

- 3.1.12.1. Verify that shipping, blocking, and bracing are removed.
- 3.1.12.2. Verify that unit is secure on mountings and supporting devices, and that connections to ducts and electrical components are complete.
- 3.1.12.3. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- 3.1.12.4. Verify that cleaning and adjusting are complete.
- 3.1.12.5. Inspect fan scroll for debris or water.
- 3.1.12.6. Remove guards. Align and adjust belt tension, verify that fan wheel and motor rotate freely, and that bearing operation is smooth. Re-install belt guards.
- 3.1.12.7. Adjust damper linkages for proper damper operation.
- 3.1.12.8. Verify lubrication of bearings and other moving parts. Use proper bearing venting procedures, in particular at motor bearings. Use only grease type specifically recommended by fan mfr. Do not over-grease. Fill extended grease lines if not already filled, using mfr. recommended grease and proper venting procedures.
- 3.1.12.9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- 3.1.12.10. Verify proper motor and fan rotation.
- 3.1.12.11. Remove and replace malfunctioning units and retest as specified herein.

3.1.13. Temporary Use of Fans

- 3.1.13.1. Contractor shall thoroughly clean unit of all grease, dirt, and dust, etc. and perform manufacturer's pre-start protocol and commissioning activities just prior to being placed into temporary service.
- 3.1.13.2. During temporary service, perform all of manufacturer's required routine maintenance procedures. Continuously maintain a log of all such procedures.

Store log at unit during temporary use period and include log as part of the final O&M manual.

- 3.1.13.3. Contractor shall thoroughly clean unit of all grease, dirt, and dust, etc., lubricate bearings, align and tighten belts and perform manufacturer's pre-start protocol and commissioning activities after unit has completed temporary service, and install a new, complete set of filters just prior to final acceptance by Owner.

3.2. FIELD QUALITY CONTROL

- 3.2.1. Each fan shall be field tested. Any deficiencies related to performance, manufacture or installation shall be corrected without cost to Owner.

3.3. COMMISSIONING

- 3.3.1. Perform the commissioning activities as outlined in the Division 01 Section Commissioning and other requirements of the Contract Documents.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. REFERENCE STANDARDS..... 2

1.4. QUALITY ASSURANCE 2

1.5. SUBMITTALS 2

PART 2 - PRODUCTS 3

2.1. ADJUSTABLE SQUARE CONE DIFFUSERS..... 3

2.2. ROUND CONE DIFFUSER - ADJUSTABLE DISCHARGE PATTERN 4

2.3. EGG-CRATE RETURN GRILLE 5

2.4. OUTDOOR LOUVER 4" DEEP, 39° EXTRUDED DRAINABLE BLADE 6

PART 3 - EXECUTION 7

3.1. GENERAL..... 7

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 23 05 93 Testing, Adjusting and Balancing For HVAC.

1.3. REFERENCE STANDARDS

- 1.3.1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- 1.3.2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- 1.3.3. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1.3.3.1. AMCA 500 Test Method for Louvers, Dampers and Shutters.
 - 1.3.3.2. ANSI/NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - 1.3.3.3. ARI 890 – Rating of Air Diffusers and Air Diffuser Assemblies.
 - 1.3.3.4. ASHRAE 70 Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
 - 1.3.3.5. SMACNA 1035 - HVAC Duct Construction Standards - Metal and Flexible.

1.4. QUALITY ASSURANCE

- 1.4.1. Test and rate performance of air outlets and inlets in accordance with ASHRAE 70.
- 1.4.2. Test and rate performance of louvers in accordance with AMCA 500.
- 1.4.3. Fire Safety Code: Comply with NFPA 90A.

1.5. SUBMITTALS

- 1.5.1. All air distribution equipment to be the product of the same manufacturer.
- 1.5.2. Submit in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples the following:
 - 1.5.2.1. Manufacturer's name and model number
 - 1.5.2.2. Identification as referenced in the documents

- 1.5.2.3. Capacities/ratings
- 1.5.2.4. Materials of construction
- 1.5.2.5. Sound ratings
- 1.5.2.6. Dimensions
- 1.5.2.7. Finish
- 1.5.2.8. Color selection charts where applicable
- 1.5.2.9. Manufacturer's installation instructions
- 1.5.2.10. Mounting methods and frames

PART 2 - PRODUCTS

2.1. ADJUSTABLE SQUARE CONE DIFFUSERS

2.1.1. General

- 2.1.1.1. The square cone diffuser shall be supplied to deliver a 360 degree radial, horizontal airflow pattern. The cones and backpan shall be one-piece die-formed with smooth, aerodynamically designed surfaces and no corner joints. This contoured design shall protect the ceiling and help to prevent smudging and streaking.

2.1.2. Construction:

- 2.1.2.1. Diffusers shall be aluminum construction, and shall consist of a seamless, one-piece, precision formed backpan that incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct and an outer frame which is recessed from the ceiling plane to allow for field adjustment of the airflow discharge from fully horizontal to fully vertical.
- 2.1.2.2. An inner cone assembly shall consist of 3 cones (300x300 size) or 4 cones (600x600 size) which drop below the ceiling plane to assure optimal VAV air diffusion performance. The inner cone assembly shall be completely removable from the diffuser face to allow for full access to any dampers or other ductwork components located near the diffuser neck.
- 2.1.2.3. Non-protrusive airflow directional tabs shall be provided on the back of the inner cones which may be positioned for either horizontal or vertical discharge.
- 2.1.2.4. The diffuser ceiling module size and neck size shall be as noted on the drawings and equipment schedules.

2.1.3. Paint Specification:

- 2.1.3.1. Paint finish shall be as per the architectural finishing schedule. All components shall have a baked-on powder coat finish.

- 2.1.3.2. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
- 2.1.3.3. The paint film thickness shall be a minimum of 2.0 mils.
- 2.1.3.4. The finish shall have a hardness of 2H.
- 2.1.3.5. The finish shall withstand a minimum salt spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
- 2.1.3.6. The finish shall have an impact resistance of 80 inch-pounds.
- 2.1.3.7. All components shall have a custom finish in a color to match a customer supplied sample.
- 2.1.4. Mounting Frame:
 - 2.1.4.1. The diffuser mounting frame shall be suitable for lay-in or surface mount applications. Refer to architectural reflected ceiling plan and architectural ceiling construction details.
- 2.1.5. Volume Control Damper:
 - 2.1.5.1. The diffuser shall be supplied with a steel radial damper, diffuser mounted
- 2.1.6. Beaded Extended Neck:
 - 2.1.6.1. The diffuser shall be supplied with a beaded neck extended to a depth of 2-1/2 inches.

2.2. ROUND CONE DIFFUSER - ADJUSTABLE DISCHARGE PATTERN

- 2.2.1. Round ceiling diffusers aluminum with steel screws, adjustable. The diffusers shall have four cones and round neck inlets of the sizes and mounting types shown on the plans and outlet schedule.
- 2.2.2. Round diffusers shall be constructed of 0.051 aluminum. The airflow discharge pattern shall be field adjustable from horizontal to vertical by extending or retracting the inner three cones.
- 2.2.3. These three cones shall be constructed as a single inner assembly and must be easily removable using a spring lock mechanism.
- 2.2.4. Vertical to horizontal discharge pattern must be achieved by one of three adjustment methods as follows:
 - 2.2.4.1. Type 1. The inner cone assembly can be removed and repositioned by means of adjusting screws.

- 2.2.4.2. Type 2. The inner cone assembly can be adjusted by sliding the cones up or down.
- 2.2.4.3. Type 3. The center cone can be rotated clockwise or counterclockwise to move the cones up or down.

2.2.5. Volume Control

- 2.2.5.1. Round damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the diffuser. A retainer cable shall be provided to allow the inner core assembly to hang during maintenance of diffusers with a neck size of 12 inches or greater.

2.2.6. Finish

- 2.2.6.1. The finish shall be as per the architectural finishing schedule.
- 2.2.6.2. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H.
- 2.2.6.3. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

2.2.7. Standard of Acceptance: E.h.Price model RCDE, Titus, Ruskin

2.3. EGG-CRATE RETURN GRILLE

2.3.1. Construction:

- 2.3.1.1. Grilles shall be aluminum construction, consisting of an extruded aluminum border and an aluminum $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$ inch grid egg crate core.
- 2.3.1.2. The minimum grille size shall be 150x100 mm (6x4 inches). The maximum one-piece grille size without a mullion shall be 1,200x600 mm (48 inches x 24 inches). The maximum size grille size with a mullion is 2,400x1,200 mm (96 x 48 inches).

2.3.2. Paint Specification:

- 2.3.2.1. All components shall have a baked-on powder coat finish. Finish color as per the architectural schedules.
- 2.3.2.2. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
- 2.3.2.3. The paint film thickness shall be a minimum of 2.0 mils.
- 2.3.2.4. The finish shall have a hardness of 2H.
- 2.3.2.5. The finish shall withstand a minimum salt spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.

2.3.2.6. The finish shall have an impact resistance of 80 inch-pounds.

2.3.3. Volume control

2.3.3.1. The grille shall be supplied with an aluminum with mill finish opposed blade damper.

2.3.4. Border Style:

2.3.4.1. The grille shall be suitable for sidewall, exposed duct, or T-bar lay-in mounting, complete with a border in the following styles - refer to layouts and equipment schedules:

2.3.4.1.1. 1-1/4 inch flat face border for surface mount applications.

2.3.4.1.2. Narrow flat face border for 15/16 inch T-bar lay-in.

2.3.4.1.3. Exposed duct border for mounting directly to exposed ducts.

2.3.4.1.4. Core only (no border) for 15/16 inch T-bar applications.

2.3.5. Mounting Frames:

2.3.5.1. The grille shall be supplied with a 3/8 inch flat border mounting frame.

2.3.6. Fastening:

2.3.6.1. The grille shall be supplied with

2.3.6.1.1. Countersunk screw holes complete with oval-head screws where surface mounted.

2.3.6.1.2. No screw holes (default for T-Bar frames).

2.3.7. Standard of Acceptance:

2.3.7.1. E.H.Price series 80, Titus, Ruskin

2.4. OUTDOOR LOUVER 4" DEEP, 39° EXTRUDED DRAINABLE BLADE

2.4.1. General

2.4.1.1. Louver performance shall be based on tests and procedures in accordance with AMCA publication 500-L.

2.4.1.2. Size: as indicated on the drawings

2.4.2. Construction:

2.4.2.1. Louvers shall be constructed of 6063-T5 alloy extruded aluminum.

2.4.2.2. Louver blades and frames shall be minimum 0.081 inch wall thickness. Louver assemblies shall be 4 inches deep with 39-degree stationary drainable blades. Louvers shall be welded construction.

- 2.4.2.3. Louvers shall be designed to withstand a 25 pound per square foot (100 mile per hour equivalent) wind load.
- 2.4.2.4. Each louver shall be fitted with 1/2 inch x 0.051 inch flattened expanded mesh. Bird screen shall be mounted on interior louver face.
- 2.4.2.5. Louvers shall be supplied with a 1.5 inch flanged frame.
- 2.4.2.6. Louvers shall be supplied with a continuous blade appearance and concealed mullions.
- 2.4.2.7. Louvers shall be supplied with a standard mill finish.
- 2.4.3. Insect Screen:
 - 2.4.3.1. Each louver shall be fitted with 1/2 inch x 0.051 inch flattened expanded mesh. Bird screen shall be permanently secured to a formed aluminum frame and mounted on interior louver face.
- 2.4.4. Finish:
 - 2.4.4.1. Louvers shall be factory primed and finished-after-assembly with a fluoropolymer based resin coating. Primer and resin coating shall be oven cured in accordance with the coating manufacturer's instructions.
 - 2.4.4.2. The coating system shall have a minimum dry film thickness of 0.25 mil primer and 1.0 mil color coat in accordance with ASTM D7091.
 - 2.4.4.3. The coating system product shall meet salt spray and hardness specifications of AAMA 2605.
 - 2.4.4.4. Louvers shall receive an anodized colour finish in accordance with architectural finishing schedules and AAMA 611. The finish shall be applied to chemically etched and pretreated aluminum with a minimum thickness of 0.4 – 0.7 mils.
- 2.4.5. Standard of Acceptance:
 - 2.4.5.1. E.H.Price model DE439, Titus, Ruskin

PART 3 - EXECUTION

3.1. GENERAL

- 3.1.1. All installation shall be in accordance with manufacturer's published recommendations.
- 3.1.2. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, reflected ceiling plans, symmetry, and lighting arrangement. Coordinate location of air distribution equipment with lighting fixtures, fire alarm and PA devices.
- 3.1.3. Install air outlets and inlets to ductwork with airtight connection.

- 3.1.4. Provide balancing dampers on duct take off to diffusers, grilles and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- 3.1.5. Provide all specialties and frames for air distribution devices as required for proper installation in ceiling type as indicated on Architectural Drawings. Provide all cutting and patching of T-bars, gypsum board, and other ceiling systems as required for installation of air devices.
- 3.1.6. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

Table of Contents

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 2

1.5. APPLICABLE PUBLICATIONS..... 3

1.6. STANDARD OF ACCEPTANCE 3

1.7. BASIS OF DESIGN 3

1.8. WARRANTY 4

PART 2 - PRODUCTS 4

2.1. GENERAL..... 4

2.2. INDOOR CEILING MOUNTED ERV EQUIPMENT 4

PART 3 - EXECUTION 6

3.1. INSTALLATION..... 6

3.2. STARTUP SERVICES 7

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. The energy recovery equipment includes the roof mounted equipment and the indoor ceiling mounted type.
- 1.1.2. The units' performance shall be as per the equipment schedule noted on the drawings.

1.2. RELATED WORK

- 1.2.1. Section 23 05 00 Common Work Results for HVAC
- 1.2.2. Section 23 05 51 Noise and Vibration Isolation
- 1.2.3. Section 23 09 00 Instrumentation and Control for HVAC
- 1.2.4. Section 23 05 93 Testing, Adjusting and Balancing For HVAC

1.3. QUALITY ASSURANCE

- 1.3.1. Air Handling Units Certification
 - 1.3.1.1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the UL label.
 - 1.3.1.2. ETL listed complying with requirements of UL 1812 for Energy Recovery Ventilators (ERV) or UL 1995 for air handling units.
 - 1.3.1.3. All wiring shall be in accordance with the National Electrical Code (N.E.C.)
 - 1.3.1.4. The units shall be rated in accordance with Air-conditioning Refrigeration Institute's (ARI) Standard 1060 and bear the ARI Certification label
 - 1.3.1.5. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO)

1.4. SUBMITTALS

- 1.4.1. The contractor shall furnish a complete submission for all roof top units covered in the project. The submission shall include all information listed below. Partial and incomplete submissions shall be rejected without reviews.
- 1.4.2. Manufacturer's Literature and Data:
 - 1.4.2.1. Submittals shall include fans, motors, filter housings, recovery wheel and all other related accessories. The contractor shall provide custom drawings showing total air handling unit assembly including dimensions, operating weight, access sections, flexible connections, door swings, controls penetrations, electrical disconnect, lights, duplex receptacles, switches, wiring,

- utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc) and rigging points.
- 1.4.2.2. Submit sound power levels in each octave band for fan and at entrance and discharge of equipment at scheduled conditions.
 - 1.4.2.3. Provide fan curves showing Liters/Second (cubic feet per minute), static pressure, efficiency, and horsepower for design point of operation and at maximum design Liters/Second (cubic feet per minute) and 110 percent of design static pressure.
 - 1.4.2.4. Submit total fan static pressure, external static pressure, for RTU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air handling unit schedule on drawings.
 - 1.4.2.5. Submit wheel performance.
 - 1.4.2.6. Lifting lugs will be provided to facilitate rigging on shipping splits and joining of segments. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements.

1.5. APPLICABLE PUBLICATIONS

- 1.5.1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- 1.5.2. Air Conditioning, Heating, and Refrigeration Institute (AHRI):
 - 1.5.2.1. 260-01 Sound Rating of Ducted Air Moving and Conditioning Equipment
 - 1.5.2.2. 410 01 Standard for Forced-Circulation Air-Heating and Air-Cooling Coils
 - 1.5.2.3. 430 09 Standard for Central Station Air Handling Units
- 1.5.3. Air Moving and Conditioning Association (AMCA):
 - 1.5.3.1. 210 07 Laboratory Methods of Testing Fans for Rating
- 1.5.4. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
 - 1.5.4.1. 51 2007 Laboratory Methods of Testing Fans for Rating
 - 1.5.4.2. National Fire Protection Association (NFPA):
- 1.5.5. NFPA 90A Standard for Installation of Air Conditioning and Ventilating Systems, 2009

1.6. STANDARD OF ACCEPTANCE

- 1.6.1. Mitsubishi Lossnay (for indoor ceiling mounted) (LGH model) – Basis of Design, or Approved Equivalent.

1.7. BASIS OF DESIGN

- 1.7.1. Basis of Design equipment is custom manufactured to match accurately the existing support structures and location of roof mounted ductwork, access points and power supplies.
- 1.7.2. Any other manufactured item submitted as an equal shall have to match exactly the footprint, capacity, weight and all other characteristics of the Basis of Design Equipment. Any discrepancy noted at shop drawings submission will result in immediate rejection.
- 1.7.3. Any changes to the Bid documents as a result of using an equal equipment will be the full responsibility of the contractor at no additional cost to the Board. This includes but is not limited to the power supply, controls, structural supports, and ductwork connection.

1.8. WARRANTY

- 1.8.1. The warranty period shall commence at the date of initial start up and shall continue for a period of two (2) years not to exceed eighteen (30) months from shipment. Manufacturer's warranty shall include parts only.

PART 2 - PRODUCTS

2.1. GENERAL

- 2.1.1. Unit is complete with filter sections for supply air and return air, energy recovery wheel, direct drive plenum fans with ECM motors, factory installed and tested unit controls and power wiring for fans, wheel and controls.

2.2. INDOOR CEILING MOUNTED ERV EQUIPMENT

2.2.1. General

- 2.2.1.1. The HRV unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, control circuit board and blowers with motors, filters, and insulated foam air guides. Each unit will have an automatic by-pass damper system for economic operation under certain conditions. The unit shall have factory installed control board with functions for local, remote, and optional control modes.

2.2.2. Heat Exchanger

- 2.2.2.1. The heat exchanger element shall be constructed of specially treated cellulous fiber membrane separated by corrugated layers to allow total heat (sensible and latent) energy recovery from the exhaust air to the supply air or from the supply air to the exhaust air as determined by design conditions.

- 2.2.2.2. The element shall have protective filters installed at both the supply and exhaust sides with an access cover to allow easy maintenance.
- 2.2.3. Blowers
 - 2.2.3.1. The unit shall be furnished with two (2) direct drive centrifugal blowers running simultaneously supplying and extracting air at the same rate for balanced ventilation air flow.
 - 2.2.3.2. The blower motors shall be a directly connected to the blower wheels and have permanently lubricated bearings
 - 2.2.3.3. The blowers and motors shall be mounted for quiet operation.
- 2.2.4. Filters
 - 2.2.4.1. The HRV shall be equipped with factory installed air filters located at each intake face (both supply and exhaust sides) of the unit core to clean the air and prevent clogging
- 2.2.5. Bypass Damper
 - 2.2.5.1. HRV shall have an automatic supply side by-pass damper to allow inbound ventilation air to by-pass the unit energy transfer core when outside weather conditions warrant.
 - 2.2.5.2. The mechanism for opening and closing the bypass damper shall be a 208V-230V synchronous electric motor through an actuator supplied as standard with the HRV unit. The motor will drive a steel cable connected to a mechanical damper flap to allow fresh air to bypass the unit element.
 - 2.2.5.3. Thermistors integral to the unit shall control the damper.
- 2.2.6. Mounting
 - 2.2.6.1. Mounting of the Lossnay® HRV shall be as indicated in the plans and drawings. The HRV shall not require and condensate pan or receptacle nor condensate drain or piping. Mounting may be horizontal or vertical and the unit may be inverted as required by ductwork connection
 - 2.2.6.2. Unit to be set on support brackets hung by threaded rod type apparatus (brackets and rods provided by the mechanical contractor)
- 2.2.7. Unit Cabinet
 - 2.2.7.1. The cabinet shall be fabricated of galvanized steel, and covered with polyurethane foam insulation as necessary with steel mounting points securely attached
- 2.2.8. Controls & Function

- 2.2.8.1. The HRV shall be equipped with an M-Net data network control and will be directly connectable to the M-Net Data communication control network and will be able to be electronically interlocked with a Bacnet Interface model BAC-HD150. A Bacnet Interface will be installed and wired as per the Manufacturers requirements. The Bacnet Interface will be able to control up to 50 Lossnay units and will have the control points to allow control (inputs) and monitoring (Status). For required control points and sequence of operation refer to the Mechanical Drawings.
 - 2.2.8.2. A 30vdc fuzzy logic signal generated by the Bacnet Interface model HD-150 via a 2 conductor non polar shielded, jacketed control wire to a PZ-52ZF-E Mitsubishi LCD local controller supplied with each unit.
 - 2.2.8.3. HRV shall be set to Auto Mode — which will automatically change between the Bypass and Heat Recovery modes based on space conditions
- 2.2.9. Accessories
- 2.2.9.1. Duct heater with electronic SCR controller capable of accepting an analogue BAS signal for coil modulation. Output as noted on the drawings.

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Make all connections to power, automation. Connect unit to ductwork.
- 3.1.2. Assemble and install roof top unit components in strict accordance with manufacturer's instructions. Unit to be completely level.
- 3.1.3. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air-handling units clean prior to operation.
- 3.1.4. Install units level, in accordance with manufacturers instructions and as indicated. Maintain service clearances as required by the manufacturer's literature.
- 3.1.5. Provide adequate support from the building structural elements for all indoor units. Use neoprene washers for vibration isolation
- 3.1.6. Use flexible connectors between the ductwork and the HRV unit.
- 3.1.7. Supply all control devices, sensors, relays and wiring required to make the equipment fully functional in accordance with the sequence of operation indicated on the drawings. Assemble all components that require field installation. Include all step-down transformers, relays and other devices, as required

- 3.1.8. Leakage and test requirements for roof top units shall be the same as specified for ductwork except leakage shall not exceed Leakage Class (CL) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.

3.2. STARTUP SERVICES

- 3.2.1. The equipment shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, fan has been test run under observation.
- 3.2.2. An authorized factory representative shall start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Board's staff training, etc.

TABLE OF CONTENTS

PART 1 - GENERAL	2
1.1. GENERAL	2
1.2. DEFINITIONS	2
1.3. RELATED WORK	2
1.4. SUBMITTALS	2
1.5. QUALITY ASSURANCE	3
1.6. DELIVERY, STORAGE AND HANDLING	4
1.7. WARRANTY	4
1.8. PERFORMANCE	4
1.9. STANDARD OF ACCEPTANCE	4
PART 2 - PRODUCTS	4
2.1. REFRIGERANT PIPING	4
2.2. INDOOR UNIT - WALL MOUNTED – SERVING ELEVATOR MACHINE ROOM.....	5
2.3. INDOOR UNIT – SERVING NEW OFFICE SPACES (PEAD DUCTED TYPE – HYPER HEAT INVERTER HEAT PUMP).....	6
2.4. OUTDOOR UNIT – ASSOCIATED WITH EVAPORATOR UNIT FOR ELEVATOR MACHINE ROOM...	9
2.5. OUTDOOR UNIT – ASSOCIATED WITH EVAPORATOR UNIT FOR NEW OFFICE SPACES	11
2.6. BRANCH CONTROLLERS.....	13
PART 3 - EXECUTION	15
3.1. OUTDOOR UNITS	15
3.2. INDOOR UNITS.....	15
3.3. CONNECTIONS	15
3.4. FIELD QUALITY CONTROL	16
3.5. INSTRUCTIONS.....	16
3.6. STARTUP AND TESTING	16
3.7. DEMONSTRATION AND TRAINING	16

PART 1 - GENERAL

1.1. GENERAL

1.1.1. System Description

- 1.1.1.1. The air conditioning system shall be a split system with Variable Compressor Speed Inverter Technology (VCSI), charged with R410A refrigerant.
- 1.1.1.2. The VRF system shall consist of up to twenty-three (23) indoor evaporator section(s), either wall mounted, cassette type, or ceiling concealed, with wireless controller and three (3) outdoor unit air cooled condensing unit.
- 1.1.1.3. Branch Circuit Controllers & Boxes, are to be provided for the new VRF system. Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. Each indoor unit shall be independently controlled.
- 1.1.1.4. VRF system shall automatically vary the target evaporating and condensing temperatures based on building load and weather conditions to increase part load efficiency (Variable Refrigerant Temperature). The condensing unit shall also feature customizable operating modes which allows for the manual setting of target evaporating and condensing temperatures.
- 1.1.1.5. For the Hyper Heat Inverter Heat Pump system shall be a Mitsubishi Electric split system with Variable Speed Inverter Compressor technology. This is the system serving the new office spaces in particular. The system shall consist of a Hyper Heat Inverter horizontal discharge, single phase outdoor unit, a matched capacity indoor section that shall be equipped with a wired wall mounted and/or wireless handheld remote controller. All systems shall be Energy Star Qualified and listed

1.2. DEFINITIONS

- 1.2.1. Energy Efficiency Ratio (EER): The ratio of net cooling capacity is Btu/h to total rate of electricity input in watts under designated operating conditions (Btu hour/Watt).
- 1.2.2. Seasonal Energy Efficiency Ratio (EER): The ratio of the total cooling output of an air conditioner during its normal annual usage period for cooling in Btu/h divided by total electric energy input in watts during the same period (Btu hour/Watt).

1.3. RELATED WORK

- 1.3.1. Section: 23 05 00 Common Work Results for HVAC.
- 1.3.2. Section: 23 23 00 Refrigerant Piping.
- 1.3.3. Section: 23 09 00 Instrumentation and Control for HVAC.

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with specification Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.4.2. Manufacturer's literature and data:
 - 1.4.2.1. Sufficient information, including capacities, pressure drops and piping connections clearly presented, shall be included to determine compliance with drawings and specifications
 - 1.4.2.2. Unit Dimensions required clearances, operating weights accessories and start-up instructions.
 - 1.4.2.3. Electrical requirements, wiring diagrams, interlocking and control wiring showing factory installed and portions to be field installed.
 - 1.4.2.4. Mounting and flashing of the roof curb to the roofing structure with coordinating requirements for the roof membrane system.
- 1.4.3. Certification: Submit proof of specified ARI Certification.
- 1.4.4. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required sensible-to-heat-ratio, energy efficiency ratio (EER), and coefficient of performance (COP).
- 1.4.5. Operating and Maintenance Manual: Submit three copies of Operating and Maintenance manual to Consultant two weeks prior to final inspection.
- 1.4.6. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion

1.5. QUALITY ASSURANCE

- 1.5.1. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- 1.5.2. All wiring shall be in accordance with the Canadian Electrical Code.
- 1.5.3. The units shall be rated in accordance with ARI Standard 210 and bear the ARI label.
- 1.5.4. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which are a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- 1.5.5. A full charge of R410A for 131 feet of refrigerant tubing shall be provided in the condensing unit.
- 1.5.6. A dry air holding charge shall be provided in the evaporator.
- 1.5.7. System efficiency shall meet or exceed 19.0 SEER and 10.6 HSPF.

1.6. DELIVERY, STORAGE AND HANDLING

- 1.6.1. Unit shall be stored and handled according to the manufacturer's recommendation.
- 1.6.2. The wireless controller shall be shipped inside the carton with the indoor unit and able to withstand 40.5°C (105°F) storage temperatures and 95% relative humidity.

1.7. WARRANTY

- 1.7.1. The units shall have a manufacturer's warranty for a period of five (5) years from date of installation.
- 1.7.2. The compressor shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.
- 1.7.3. This warranty does not include labour. Manufacturer has services the Canadian market for a minimum of ten (10) years.

1.8. PERFORMANCE

- 1.8.1. Each system shall perform in accordance to the ratings shown in the equipment schedules.
- 1.8.2. Performance shall be based on 26.7°CDB, 19.4°CWB (80°FDB, 67°FWB) for the indoor unit and 35°C DB, 23.9°C WB (95°FDB, 75°FWB) for the outdoor unit.

1.9. STANDARD OF ACCEPTANCE

- 1.9.1. Indoor & Outdoor units shall be by the same manufacturer.
- 1.9.2. Standard of Acceptance:
 - 1.9.2.1. Mitsubishi VRF (**Basis of Design**)
 - 1.9.2.2. LG VRF
 - 1.9.2.3. Daikin VRF

PART 2 - PRODUCTS

2.1. REFRIGERANT PIPING

- 2.1.1. Refer and comply to the refrigerant piping specifications, including the special considerations for VRF refrigerant piping section.
- 2.1.2. Standard T style joints are not acceptable for a variable refrigerant volume system. Manufacturer specific Y joints shall be supplied by the VRF manufacturer.

2.2. INDOOR UNIT - WALL MOUNTED – SERVING ELEVATOR MACHINE ROOM

2.2.1. General

- 2.2.1.1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, internal piping, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dry air before shipment from the factory.

2.2.2. Unit Cabinet

- 2.2.2.1. The casing shall have a white finish. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard. There shall be a separate back plate which secures the unit firmly to the wall.

2.2.3. Fan

- 2.2.3.1. The indoor unit fan shall be an assembly with a line-flow fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right). A motorized air sweep flow louver shall provide an automatic change in airflow by directing the air up and down to provide for uniform air distribution. The indoor unit fan shall consist of three (3) speeds, High, Medium and Low.

2.2.4. Filter

- 2.2.4.1. Return air shall be filtered by means of easily removed catechin and enzyme filters.

2.2.5. Coil

- 2.2.5.1. The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy. The coil shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

2.2.6. Electrical

- 2.2.6.1. The electrical power of the unit, supplied from the outdoor unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory

operation within voltage limits of 198 volts to 253 volts. The indoor unit shall not have any supplemental electrical heat elements.

2.2.7. Control

- 2.2.7.1. Each system shall be operated by a wall-mounted space sensor coupled with a key switch operated by the head caretaker.
- 2.2.7.2. For details, refer to the sequences of operation on the drawings.
- 2.2.7.3. The control voltage between the indoor unit and the outdoor unit shall be 208 volts or 230 volts AC. The system shall be capable of automatic restart when power is restored after power interruption.

2.2.8. Units shall be provided with a loose field installed condensate pump.

2.3. INDOOR UNIT – SERVING NEW OFFICE SPACES (PEAD DUCTED TYPE – HYPER HEAT INVERTER HEAT PUMP)

2.3.1. General

- 2.3.1.1. The Ducted type indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit, in conjunction with the wired, wall mounted controller, shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

2.3.2. Unit Cabinet

- 2.3.2.1. The cabinet shall be space saving, low profile, horizontal, ducted type. Formed cabinet shall be constructed of G-60 galvanized steel with factory applied foam surface insulation to prevent condensation on outer surfaces. The cabinet shall be provided with four mounting brackets to accommodate suspension from threaded rod or structural support located on the side panels in all four corners. Brackets shall be suitable for supporting the weight of the indoor unit. The indoor unit cabinet shall be equipped with a ducted air outlet and ducted rear return air connection. PEA units shall support an optional Bottom Return Adaptor. PEAD units shall have selectable rear or bottom return as a standard feature. The PEAD units shall be equipped with a 3-15/16" (100mm) diameter ventilation air intake knock-out.

2.3.3. Fan

- 2.3.3.1. The indoor unit fan unit shall be an assembly with [PEAD-A30/36AA two(2) or [PEA-A18AA] four (4) Sirocco fans direct driven by a single motor. Fan shall

develop airflow to deliver up to [PEA] 0.20 [PEAD] 0.60 inches wg of external static pressure. The indoor fans shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. The indoor fans shall operate on any of three (3) speeds, High, Mid, Low and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.

2.3.4. Filter

- 2.3.4.1. Return air shall be filtered by means of a standard factory installed return air filter.

2.3.5. Coil

- 2.3.5.1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and with two (2) 1-9/32" (32mm) drains shall be provided under the coil. In addition to the two (2) gravity drains, the indoor unit shall be provided with an integral condensate lift mechanism able to raise drain water [PEA = 21-21/32" (550mm), PEAD = 27-9/16" (700mm) inches above the condensate pan. Lift mechanism shall incorporate a safety sensor system to shut down the indoor fan and the compressor in the outdoor unit in the event of high level of condensate in the drain pan. An optional drain pan level switch (DPLS1), designed to connect to the control board, shall be provided if required, and installed on the condensate pan to prevent condensate from overflowing.

2.3.6. Electrical

- 2.3.6.1. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit, using Mitsubishi Electric A-Control system.

2.3.7. Control

- 2.3.7.1. The control system shall consist of a minimum of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor

- and outdoor unit shall be pulse signal 24 volts DC. PEA indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.
- 2.3.7.2. For A-Control, a three (3) conductor 14 gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. . If code requires a disconnect mounted near the indoor unit, a TAZ-MS303 3-Pole Disconnect shall be used – all three conductors must be interrupted.
- 2.3.7.3. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
- 2.3.7.4. The indoor unit control board shall have auxiliary control contact connectors to provide:
- 2.3.7.5.
- | | | | | | |
|-----------|---------------------------|-----|------------|-----|-----|
| 2.3.7.6. | Function / Model | PCA | PEA / PEAD | PKA | PLA |
| 2.3.7.7. | CN-2L – Lossnay ControlX | | X | X | X |
| 2.3.7.8. | CN-24(152) Back-up Heat | | X | X | X |
| 2.3.7.9. | CN-32 – Remote Switch X | | X | X | X |
| 2.3.7.10. | CN-51 – Central Control X | | X | X | X |
| 2.3.7.11. | CN-105 – IP Terminal | X | X | X | X |
| 2.3.7.12. | X = Included | | | | |

The Wireless, wall mounted remote controller kit (MHK1) shall consist of a wireless, wall mounted controller (MRCH1), a wireless receiver (MIFH1) and a cable (MRC1) to connect the receiver to the indoor unit. The controller shall be white in color with a light-green LCD display and a backlight feature. The MRCH1 shall consist of four Function buttons below the display, and Increase/Decrease Set Temperature buttons and a Hold button to the right of the display. The controller shall have a built-in temperature sensor and a battery holder, using two AA alkaline batteries. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C), and temperature changes shall be by increments of 1°F (0.5°C).

- 2.3.7.13. The MHK1 uses Honeywell RedLINK™ technology, and the wireless receiver is specially designed for Mitsubishi units. Linking to the wireless network shall be done from the receiver and from the remote controller. There shall not be any interference with other wireless devices or neighboring RedLINK™ products. Communication shall be automatically restored after power resumes and after batteries are replaced.
- 2.3.7.14. Control system shall provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.
- 2.3.7.15. For details, refer to the sequences of operation on the drawings.

- 2.3.7.16. The control voltage between the indoor unit and the outdoor unit shall be 208 volts or 230 volts AC. The system shall be capable of automatic restart when power is restored after power interruption.

2.3.8. Units shall be provided with a loose field installed condensate pump.

2.4. OUTDOOR UNIT – ASSOCIATED WITH EVAPORATOR UNIT FOR ELEVATOR MACHINE ROOM

2.4.1. General

- 2.4.1.1. The outdoor unit is designed specifically for use with VRF components and indoor evaporator units.
- 2.4.1.2. These units are equipped with a circuit board that interfaces to the evaporator indoor units.
- 2.4.1.3. The outdoor unit shall be completely factory assembled, internally piped and wired.
- 2.4.1.4. Each unit must be run tested at the factory.

2.4.2. Unit Construction:

- 2.4.2.1. The condensing unit shall be factory assembled in North America and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, heat exchanger, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, and suction accumulator.
- 2.4.2.2. The system will automatically restart operation after a power failure and will not cause any settings to be lost.
- 2.4.2.3. The unit shall incorporate an auto-charging feature to ensure proper refrigerant charge.
- 2.4.2.4. The following safety devices shall be included on the condensing unit: high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, and anti-recycling timers.
- 2.4.2.5. The inverter scroll compressors shall be high efficiency reluctance DC (digitally commutating), hermetically sealed, variable speed type. Temperatures and pressures shall be read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value. Non inverter-driven compressors shall not be accepted.
- 2.4.2.6. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet

type. Upon complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

- 2.4.2.7. The compressors' motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
- 2.4.2.8. Inverter board shall be refrigerant-cooled to prevent inefficient and unstable operation that can result from air-cooled inverter boards due to varying ambient conditions.
- 2.4.2.9. The compressor shall be internally isolated to avoid the transmission of vibration.
- 2.4.2.10. In the case of multiple condenser modules, operation hours of the compressors shall be balanced by means of the Duty Cycling Function.

2.4.3. Air Cooled Section

- 2.4.3.1. The variable speed inverter compressors in Air-Cooled systems shall also use Flash Vapor injection technology with back pressure control for reduced leakage and additional balancing weights on main shaft for increased for increased compressor lifetime.
- 2.4.3.2. The fan motor shall have inherent protection and permanently lubricated bearings. The motor shall be provided with a fan guard to prevent contact with moving parts. The condensing unit shall consist of one or more propeller type, direct-drive 600 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
- 2.4.3.3. Motors shall be capable of delivering design air at high external static pressures up to 0.32 in WG (factory set as standard at 0.12 in. WG) to accommodate field applied condensing unit discharge ductwork.
- 2.4.3.4. The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.
- 2.4.3.5. Night setback control for low noise operation shall automatically limit the maximum speed of the fan motor.
- 2.4.3.6. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tubes with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
- 2.4.3.7. The fins are to be covered with an anti-corrosion hydrophilic blue coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test of 500hr (ASTM G85 & Blister Rating:10).
- 2.4.3.8. The connection ratio of indoor units to condensing unit shall be permitted and optimized for operation up to 200% of nominal capacity.

2.4.4. Cold Climate Operation:

- 2.4.4.1. The outdoor unit shall be capable of heating operation down to -22°F ambient temperature. Tested factory data on heating capacity and efficiency shall be available.
- 2.4.4.2. The outdoor unit shall be capable of cooling operation down to +23°F without any additional low ambient controls.
- 2.4.4.3. The lower part of the outdoor coil shall be used for inverter cooling, enhancing defrost during heating operation.

2.5. OUTDOOR UNIT – ASSOCIATED WITH EVAPORATOR UNIT FOR NEW OFFICE SPACES

2.5.1. General

- 2.5.1.1. The outdoor unit shall be compatible with the four different types of indoor units (PEA / PEAD – ducted). The connected indoor unit shall be of the same capacity as the outdoor unit.
- 2.5.1.2. Model PUZ-HA36NHA4 shall have the option to connect to two, one-half capacity (18,000 BTU/h), indoor units (PEA, PKA and/or PLA type), within the same confined space, to improve air distribution (total combined indoor unit capacity shall be equal to that of the outdoor unit).
- 2.5.1.3. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.
- 2.5.1.4. The outdoor unit shall be capable of Hyper Heating performance delivering 100% rated heating capacity down to +5° F and 75% rated heating capacity at -13° F outdoor ambient temperature. Further, the outdoor unit shall be capable of cooling operating at 0°F (-18°C) ambient temperature without additional low ambient controls (optional wind baffle shall be required).
- 2.5.1.5. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) between indoor and outdoor units.
- 2.5.1.6. System shall operate at up to a maximum refrigerant tubing length of 245 feet (75 meters) between indoor and outdoor units without the need for line size changes, traps or additional oil. Outdoor units shall be factory pre-charged for a maximum of 100 feet (30 meters) of refrigerant tubing.
- 2.5.1.7. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

2.5.2. Unit Construction:

- 2.5.2.1. The casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a Munsell 3Y 7.8/1.1 finish.
- 2.5.2.2. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability.

- 2.5.2.3. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
- 2.5.2.4. The fan grill shall be of ABS plastic.
- 2.5.2.5. Cabinet mounting and construction shall be sufficient to withstand 155 MPH wind speed conditions for use in Hurricane condition areas. Mounting, base support, and other installation to meet Hurricane Code Conditions shall be by others.
- 2.5.3. Fan
 - 2.5.3.1. Models PUZ-HA30/36NHA4 shall be furnished with two (2) DC fan motors.
 - 2.5.3.2. The fan blades shall be of high performance, aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.
 - 2.5.3.3. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fans shall be provided with a raised guard to prevent external contact with moving parts.
- 2.5.4. Coil:
 - 2.5.4.1. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.
 - 2.5.4.2. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be controlled by a microprocessor controlled step motor.
 - 2.5.4.3. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a - Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. All refrigerant line connections shall be flare type sized as required and tightened to manufacturers specified torque value.
- 2.5.5. Compressor:
 - 2.5.5.1. The compressor for models PUZ-HA30/36NHA4 shall be a Mitsubishi Electric, injection port equipped, Frame Compliant Scroll compressor with Variable Speed Inverter Drive Technology.

- 2.5.5.2. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room loads, increasing the efficiency of the system which shall result in significant energy savings.
- 2.5.5.3. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
- 2.5.5.4. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

2.5.6. Electrical:

- 2.5.6.1. The electrical power of the unit shall be 208volts or 230 volts, single phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts.
- 2.5.6.2. Power for the indoor unit shall be supplied from the outdoor unit via Mitsubishi Electric A-Control using three (3) fourteen (14) gauge AWG conductors plus ground wire connecting the units.
- 2.5.6.3. The outdoor unit shall be controlled by the microprocessor located in the indoor unit.
- 2.5.6.4. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC.
- 2.5.6.5. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

2.5.7. Operating Range:

Operating Range		Indoor Air Intake Temperature	Outdoor Air Intake Temperature
Cooling	Maximum	D.B. 90°F (32°C) W.B. 73°F (23°C)	D.B. 115°F (46°C)
	Minimum	D.B. 66°F (19°C) W.B. 59°F (15°C)	D.B. 0°F (-18°C)*
Heating	Maximum	D.B. 83°F (28°C)	D.B. 70°F (21.1°C) W.B. 59°F (15°C)
	Minimum	D.B. 63°F (17°C)	D.B. -13°F (-25°C) W.B. -13°F (-25°C)

- 2.5.7.1. Requires wind baffle – without wind baffle: D.B. 23°F (-5°C).
- 2.5.7.2. Unit shall be able to provide 100% capacity when operating at 0°F outdoor air temperature and a wind baffle is used.

2.6. BRANCH CONTROLLERS

2.6.1. General:

- 2.6.1.1. The BC (Branch Circuit) Controllers shall be specifically used with this air conditioning system. These units shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.
- 2.6.2. BC Unit Cabinet:
 - 2.6.2.1. The casing shall be fabricated of galvanized steel. Each cabinet shall house a liquid gas separator and multiple refrigeration control valves.
 - 2.6.2.2. The unit shall house two tubes in tube heat exchangers.
- 2.6.3. Refrigerant
 - 2.6.3.1. R410A and R454B refrigerants shall be required for BC Controllers in conjunction with the outdoor unit systems, as indicated per issued drawings in mechanical equipment schedule.
- 2.6.4. Refrigerant valves:
 - 2.6.4.1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and/or three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
 - 2.6.4.2. Each branch shall have multiple two position valves to control refrigerant flow.
 - 2.6.4.3. Service shut off valves shall be field provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
 - 2.6.4.4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
- 2.6.5. Integral Drain Pan:
 - 2.6.5.1. An integral condensate pan and drain shall be provided. Provide condensate pump.
- 2.6.6. Electrical:
 - 2.6.6.1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 187 228 volts (208V/60Hz) or 207 253V (230V/60Hz).
- 2.6.7. The BC Controller shall be controlled by integral microprocessors.

- 2.6.7.1. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2 conductor, twisted pair shielded cable to provide total integration of the system.

PART 3 - EXECUTION

3.1. OUTDOOR UNITS

- 3.1.1. Install outdoor in strict accordance with the manufacturer's instructions; adhere strictly to all manufacturer's instructions pertaining to clearances around the equipment and between the adjacent condensing units.
- 3.1.2. Secure outdoor equipment to the roof supports; for roof supports, refer to details on the drawings.
- 3.1.3. Connect equipment to power supply and refrigerant piping. All refrigerant piping final sizing to be calculated by the manufacturer and submitted at shop drawings stage. Calculation shall be based on the total developed length of the lines.
- 3.1.4. Connect equipment to the BAS and make all connections between the outdoor equipment and the indoor evaporator. Supply and install all wiring and controllers furnished by the manufacturer.

3.2. INDOOR UNITS

- 3.2.1. Install indoor units, where noted on the drawings and conform strictly to the manufacturer's instructions.
- 3.2.2. Connect all refrigerant lines in accordance with the manufacturer's instructions.
- 3.2.3. A full load of refrigerant shall be supplied for each system, adequate for the system capacity and refrigerant lines lengths.
- 3.2.4. Make connections to power supply in accordance to the manufacturer's instructions.
- 3.2.5. Make connections to the BAS in accordance with the sequences of operations and BAS specifications.
- 3.2.6. Connect all evaporators to a condensate drainage loop, discharging onto the janitorial sink, as noted. Slope the drain lines as specified.
- 3.2.7. Coordinate the layout of the drainage with the existing radiators, heating pipes and other services. Cut out round sections through the radiator covers where required and pass in between finned elements.

3.3. CONNECTIONS

- 3.3.1. Verify condensate drainage requirements.
- 3.3.2. Install condensate drain, minimum connection size, with trap and indirect connection to noted discharge point.
- 3.3.3. Install piping adjacent to units to allow service and maintenance.
- 3.3.4. Ground equipment and install power wiring, switches, and controls for self-contained and split systems.
- 3.3.5. Connect refrigerant piping to coils with shutoff valves on the suction and liquid lines at the coil and a union or flange at each connection at the coil and condenser.

3.4. FIELD QUALITY CONTROL

- 3.4.1. Perform tests and inspections and prepare test reports.
- 3.4.2. Tests and Inspections: After installing units and after electrical circuitry has been energized, test units for compliance with requirements. Inspect for and remove shipping bolts, blocks, and tie-down straps. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Remove and replace malfunctioning units and retest as specified above.

3.5. INSTRUCTIONS

- 3.5.1. Provide services of manufacturer's technical representative for four hours to instruct Board personnel in operation and maintenance of units.

3.6. STARTUP AND TESTING

- 3.6.1. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Board project Supervisor and Commissioning Agent. Provide a minimum of 7 days prior notice.

3.7. DEMONSTRATION AND TRAINING

- 3.7.1. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- 3.7.2. Submit training plans and instructor qualifications in accordance with the requirements of Section: 23 08 00 Commissioning of HVAC.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. SUBMITTALS 2

1.4. QUALITY ASSURANCE 2

1.5. WARRANTY 3

1.6. DELIVERY, STORAGE, AND HANDLING..... 3

PART 2 - PRODUCTS 3

2.1. Wall-Fin convectors 3

PART 3 - EXECUTION 4

3.1. EXAMINATION AND PREPARATION 4

3.2. INSTALLATION..... 4

3.3. CLEANING AND PROTECTION 5

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. Air terminal units, air flow control valves, wall-fin convectors.

1.2. RELATED WORK

- 1.2.1. Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.2.2. Section: 23 05 00 Common Work Results for HVAC.
- 1.2.3. Section: 23 05 93 Testing, Adjusting and Balancing For HVAC.

1.3. SUBMITTALS

- 1.3.1. Product Data shall be provided with data indicating configuration, general assembly, and materials used in fabrication, including catalog performance ratings that indicate air flow, static pressure, NC designation, electrical characteristics, and connection requirements.
- 1.3.2. Shop Drawings shall indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and piping connection requirements.
- 1.3.3. Certificates shall be issued to certify that the output capacities, pressure drops, and selection procedures meet or exceed specified requirements or coils are tested and rated in accordance with AHRI 410.
- 1.3.4. Manufacturer's Installation Instructions shall indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- 1.3.5. Project Record Documents shall record actual locations of units and controls components and locations of access doors.
- 1.3.6. Operation and Maintenance Data shall include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- 1.3.7. Manufacturer's warranty shall be submitted and ensure forms have been completed in Owner's name and registered with manufacturer.
- 1.3.8. Maintenance Materials shall be furnished for the Board's use in maintenance of the project.
- 1.3.9. Capacity and performance: as indicated in the equipment schedules.

1.4. QUALITY ASSURANCE

- 1.4.1. Manufacturer Qualifications shall be specified in this section, with minimum ten years of documented experience.

1.5. WARRANTY

- 1.5.1. Provide 12-month manufacturer warranty from date of shipment for air terminal units, integral sound attenuators, integral heating coils, and integral controls.

1.6. DELIVERY, STORAGE, AND HANDLING

- 1.6.1. Mark each terminal unit before shipment to the job site with a unique identifier corresponding to its location and function in the building.

PART 2 - PRODUCTS

2.1. WALL-FIN CONVECTORS

2.1.1. General

- 2.1.1.1. Enclosure lengths are assembled together using concealed joiner strips to give a single unit look in every room.
- 2.1.1.2. Enclosures are made of quality cold rolled steel, 16 gauge, formed and reinforced with top supports, degreased, phosphatized and coated inside and out with a corrosion resistant tan primer. Factory paint enclosures with enamel finish; finish colour shall be selected at the shop drawings review stage (provide available colours for selection).
- 2.1.1.3. Panels are manufactured in lengths of 2'0" to 8'0" by 6" increments. Enclosure complete with components for wall-to-wall installation, following the contour of the wall, complete with end caps, wall trim, concealed joiners, inside corners, outside corners, access doors and pipe covers as required. Joints and filler pieces to be recessed. Support rigidly top and bottom, on wall mounted brackets. Joints and filler pieces to be clear of cover grilles.
- 2.1.1.4. Elements
 - 2.1.1.4.1. Elements are seamless copper tube with aluminum fins. The tubes are expanded within the fins to obtain a permanent thermal bond between the two. These are manufactured in lengths of 1'0" to 10'0" by 6" increments. Both elements can be used on either steam or hot water systems.
 - 2.1.1.4.2. The aluminum fins are square 4" x 4", min. 52 fins/linear foot of heating element.
 - 2.1.1.4.3. All tubes are manufactured to receive standard sweat fittings. The elements are designed for use at 300 deg.F entry water temperature maximum working conditions.
- 2.1.1.5. Accessories

- 2.1.1.5.1. End Piece: End pieces are used to close off enclosure ends when cabinets do not terminate on an adjacent wall. The end piece is manufactured with rounded corners and protrudes 1" beyond enclosure to give a neat finished appearance.
- 2.1.1.5.2. Wall Trim: Joiners are manufactured to overlap enclosures and cover the gap between cabinet end and adjacent wall or columns. These are usually supplied in 4", 5", 6" or 8" lengths.
- 2.1.1.5.3. Concealed Joiner (Butt Joint): This piece fits between two enclosure lengths to give a clean hairline joint appearance to the installation.
- 2.1.1.5.4. Inside Corner: Inside corners are manufactured to overlap enclosures and are used when piping runs on two or more inside walls to meet heating requirements. These are usually supplied at 90 deg. angles, however may be modified to meet project conditions.
- 2.1.1.5.5. Outside Corner: Outside corners are manufactured to overlap enclosures and are used when piping runs on two or more outside walls to meet heating requirements. These are usually supplied at 90 deg. angles, however may be modified to meet project conditions.
- 2.1.1.5.6. Access Doors: Access doors are manufactured to permit access to valves or other controls located inside enclosure. Two types are available, factory installed 5" x 7" or field mounted 5" x 7" with frame. They are supplied as standard with a screw lock, however a camlock type is also available. For field mounted access doors, the contractor is required to perforate the enclosure.
- 2.1.1.5.7. Pipe Covers: Pipe covers are used to hide pipes that run around a column. These are supplied in 5", 11" or 17" heights and are 3 3/4" deep.
- 2.1.1.6. Control Valves
 - 2.1.1.6.1. Refer to Section: 23 09 00 Instrumentation and Control for HVAC for details and standards of acceptance.
 - 2.1.1.7. Standard of Acceptance: Engineered Air (Basis of Design) (Wall-Fin enclosure type WF-1A), Rosemex.

PART 3 - EXECUTION

3.1. EXAMINATION AND PREPARATION

- 3.1.1. Review and examine conditions affecting work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- 3.2.1. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- 3.2.2. Handle and install units in accordance with manufacturer's written instructions.

- 3.2.3. Support units rigidly so they remain stationary at all times. Cross bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.
- 3.2.4. Install in strict accordance with the manufacturer's instruction and with all fittings indicated on the drawings and schematics. Support finned elements using the manufacturer's supplied brackets; space wall-fin supports in accordance with the manufacturer's instructions.
- 3.2.5. Provide for pipe movement during normal operation
- 3.2.6. Ensure that adequate space is provided within the equipment enclosures for the isolation valves, control valves and strainers. Ensure that access doors are provided to all control elements. Panels shall be constructed in a manner to allow for disassembly and access to hot water piping connections without damaging the radiator panel.
- 3.2.7. Manufacturer to visit the site prior to submission of shop drawings and perform accurate measurements, to ensure that the wall-fin covers match the exact room sizes.
- 3.2.8. Where redundant openings are left above, below or around the new heating equipment, make good wall to match existing. Where necessary, enlarge the existing wall openings as required to fit the new equipment. Make good all surfaces affected by the work and paint to match existing wall finishes.
- 3.2.9. Provide power and wiring to all new forced flow heaters; provide all new thermostats, sensors, control valves and control wiring.
- 3.2.10. Automatic control valves shall be supplied, installed and wired by the Mechanical Contractor.
- 3.2.11. Mechanical contractor shall supply the step-down transformers required to power the control valves. Line voltage to the step-down transformers shall be provided by Division 16. Coordinate the location of junction boxes that will provide the power to the step-down controls transformers.
- 3.2.12. Coordinate with Division 26 the location of junction boxes required.

3.3. CLEANING AND PROTECTION

- 3.3.1. Protect terminal heating equipment, controllers and valves throughout the entire construction period, until Substantial Completion.

TABLE OF CONTENTS

PART 1 - GENERAL	3
1.1. DESCRIPTION	3
1.2. MINIMUM REQUIREMENTS.....	3
1.3. TEST STANDARDS.....	3
1.4. DEFINITIONS	3
1.5. QUALIFICATIONS (PRODUCTS AND SERVICES)	5
1.6. APPLICABLE PUBLICATIONS, CODES AND STANDARDS	5
1.7. MANUFACTURED PRODUCTS	6
1.8. VARIATIONS FROM CONTRACT REQUIREMENTS	6
1.9. MATERIALS AND EQUIPMENT PROTECTION	7
1.10. WORK PERFORMANCE.....	7
1.11. COORDINATION AND INTERFERENCE DRAWINGS	8
1.12. EQUIPMENT INSTALLATION AND REQUIREMENTS	8
1.13. EQUIPMENT IDENTIFICATION.....	9
1.14. SUBMITTALS	9
1.15. RECORD DRAWINGS	11
1.16. ACCEPTANCE CHECKS AND TESTS	12
1.17. CODES, PERMITS AND INSPECTIONS	12
1.18. WARRANTY	12
1.19. INSTRUCTION.....	12
PART 2 - PRODUCTS	14
2.1. MATERIALS AND EQUIPMENT	14
2.2. EQUIVALENTS AND ALTERNATES.....	15
2.3. MATERIAL SUBSTITUTION	15
2.4. WARNING SIGNS.....	16
2.5. FINISHES.....	16
2.6. CAN/CSA/NEMA RATING	16
PART 3 - EXECUTION	16
3.1. INSTALLATION.....	16
3.2. SITE SERVICES	17

3.3.	CONTRACTOR'S SHOP	17
3.4.	TEMPORARY SERVICES	18
3.5.	ACCESS TO ELECTRICAL EQUIPMENT, JUNCTION BOXES AND PULL BOXES.....	18
3.6.	NAMEPLATES	18
3.7.	LOCK OFF TABS	18
3.8.	FIRESTOPPING	18
3.9.	BASES AND SUPPORTS.....	19
3.10.	INSERTS, SLEEVES AND CURBS	19
3.11.	CUT PATCH AND MAKE GOOD.....	20
3.12.	REMOVALS AND DEMOLITION	21
3.13.	REMOVED MATERIAL.....	22
3.14.	NUMBER AND LOCATION OF OUTLETS	22
3.15.	MOUNTING HEIGHTS.....	23
3.16.	MECHANICAL AND ELECTRICAL CO-ORDINATION OF RESPONSIBILITIES	23
3.17.	FLASHING.....	25
3.18.	SYSTEM STARTUP	25
3.19.	CLEANING	25

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section applies to all sections of Division 26 - Electrical.
- 1.1.2. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.
- 1.1.3. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.
- 1.1.4. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

1.2. MINIMUM REQUIREMENTS

- 1.2.1. Canadian Electrical Safety Code, (CESC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.
- 1.2.2. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

1.3. TEST STANDARDS

- 1.3.1. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.

1.4. DEFINITIONS

- 1.4.1. Listed: Materials and equipment included in a list published by an organization that is acceptable to the Authority Having Jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
- 1.4.2. Labeled: Materials and equipment to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the Authority Having Jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled materials and equipment, and by who's labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
- 1.4.3. "Concealed" means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, or partitions. Wiring, raceways, and electrical boxes for all new or relocated devices shall be concealed.
- 1.4.4. "Exposed" means work normally visible to any person standing, sitting, or otherwise using the occupied space, including work in equipment rooms, tunnels, and similar spaces.
- 1.4.5. "Provide" (and all tenses) means supply and install for a complete, operational, and code-compliant system, including all devices/equipment as specified complete with wiring, raceways (conduit), electrical boxes, and all other accessories required for a complete, operational, and code compliant installation.
- 1.4.6. "Install" (and all tenses) means secure in position, connect as specified, test, and verify.
- 1.4.7. "Supply" means to supply all devices/equipment to the responsible trade.
- 1.4.8. "Remove" means to isolate, disconnect, disassemble, remove, and dispose of all devices, equipment, wiring, raceways, and connections to other equipment all the way to the main source. Patch and make good all surfaces affected by the removal. Include for all disposal costs in the tender price.
- 1.4.9. The term "approved", "approval", etc., shall be understood to mean approved by authorities having jurisdiction as conforming to Codes, Standards, By-laws, etc.
- 1.4.10. The term "accessible" shall be understood to mean readily accessible by a person using necessary tools but without cutting or breaking out material.
- 1.4.11. The term "listed" shall be understood to mean that the materials or equipment have been tested in accordance with applicable standards, and have been approved and listed for their intended use by a testing company approved by the Authorities having jurisdiction.

1.4.12. The term "listed" shall be understood to mean that the materials or equipment have been tested in accordance with applicable standards, and have been approved and listed for their intended use by a testing company approved by the Authorities having jurisdiction

1.4.13. Where used, wordings such as "approved, to approval, as directed, permitted, permission, accepted, acceptance", shall mean: approved, directed, permitted, accepted, by an authorized representative of the Owner. and Install: material, equipment and labor shall be provided as required to make the equipment or system fully operational. Include all required wiring, conduit and other electrical devices as required, whether shown on the drawings, specified herein or not.

1.4.14. Certified: Materials and equipment which:

1.4.14.1. Have been tested and found to meet nationally recognized standards or to be safe for use in a specified manner.

1.4.14.2. Bear a label, tag, or other record of certification.

1.5. QUALIFICATIONS (PRODUCTS AND SERVICES)

1.5.1. Manufacturer's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least three years.

1.5.2. Product Qualification:

1.5.2.1. Manufacturer's materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least three years.

1.5.2.2. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within eight hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.6. APPLICABLE PUBLICATIONS, CODES AND STANDARDS

1.6.1. Applicable publications listed in all Sections of Division 26 are the latest issue, unless otherwise noted.

1.6.2. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

1.6.3. Publications:

- 1.6.3.1. CAN/CSA C22.1-015, Canadian Electrical Code Part 1 (23rd Edition), Safety Standard for Electrical Installations.
- 1.6.3.2. Ontario Electrical Safety Code 26th Edition / 2015 or later.
- 1.6.3.3. CAN3-C235-83 (R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000V.
- 1.6.3.4. National Building Code of Canada.
- 1.6.3.5. National Fire Code of Canada.
- 1.6.3.6. Ontario Building Code 2012.
- 1.6.3.7. National Fire Protection Code NFPA-70

1.7. MANUFACTURED PRODUCTS

- 1.7.1. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available.
- 1.7.2. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.
- 1.7.3. Equipment Assemblies and Components:
 - 1.7.3.1. Components of an assembled unit need not be products of the same manufacturer.
 - 1.7.3.2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
- 1.7.4. Components shall be compatible with each other and with the total assembly for the intended service.
- 1.7.5. Constituent parts which are similar shall be the product of a single manufacturer.
- 1.7.6. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.
- 1.7.7. When Factory Testing Is Specified:
 - 1.7.7.1. The Board shall have the option of witnessing factory tests. The Contractor shall notify the Board a minimum of 15 working days prior to the manufacturer's performing the factory tests.
 - 1.7.7.2. When materials and equipment fail factory tests, and re-testing and re-inspection is required, the Contractor shall be liable for all additional expenses for the Board to witness re-testing.

1.8. VARIATIONS FROM CONTRACT REQUIREMENTS

- 1.8.1. Where the Board or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.9. MATERIALS AND EQUIPMENT PROTECTION

- 1.9.1. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
- 1.9.2. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
- 1.9.3. During installation, equipment shall be protected against entry of foreign matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
- 1.9.4. Damaged equipment shall be repaired or replaced, as determined by the Consultant.
- 1.9.5. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
- 1.9.6. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.10. WORK PERFORMANCE

- 1.10.1. All electrical work shall comply with the requirements of CESC, NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, in addition to other references required by contract.
- 1.10.2. Job site safety and worker safety is the responsibility of the Contractor.
- 1.10.3. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
- 1.10.4. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
- 1.10.5. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Consultant

1.10.6. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility.

1.10.7. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions.

1.10.8. Coordinate location of equipment and conduit with other trades to minimize interference.

1.11. COORDINATION AND INTERFERENCE DRAWINGS

1.11.1. Provide information and cooperate with the General/Mechanical Contractor for the preparation of interference and coordination drawings.

1.11.2. Interference and coordination drawings to be provided in order to make clear the Work intended or to show how it affects other trades.

1.11.3. interference and coordination drawings to be provided for:

- 1.11.3.1. Mechanical, Electrical, Communications Rooms
- 1.11.3.2. Service corridors and tunnels
- 1.11.3.3. Corridor, lobbies and all public spaces
- 1.11.3.4. Crawl spaces
- 1.11.3.5. Attic spaces
- 1.11.3.6. Underground Trenches
- 1.11.3.7. Raised floor spaces

1.12. EQUIPMENT INSTALLATION AND REQUIREMENTS

1.12.1. Equipment location shall be as close as practical to locations shown on the drawings.

1.12.2. Working clearances shall not be less than specified in the CEC.

1.12.3. Inaccessible Equipment:

- 1.12.3.1. Where the Consultant determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Board.
- 1.12.3.2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.12.4. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility

company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

1.13. EQUIPMENT IDENTIFICATION

- 1.13.1. In addition to the requirements of the CEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- 1.13.2. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 12 mm (1/2 inch) high. Identification signs shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.
- 1.13.3. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm²), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

1.14. SUBMITTALS

- 1.14.1. All submittals shall include copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Board to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted.
- 1.14.2. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
- 1.14.3. The Consultant's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.

1.14.4. The submittals shall include the following:

- 1.14.4.1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.
- 1.14.4.2. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
- 1.14.4.3. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.

1.14.5. Maintenance and Operation Manuals:

- 1.14.5.1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
- 1.14.5.2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the material or equipment.
- 1.14.5.3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.

1.14.6. The manuals shall include:

- 1.14.6.1. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
- 1.14.6.2. A control sequence describing start-up, operation, and shutdown.
- 1.14.6.3. Description of the function of each principal item of equipment.
- 1.14.6.4. Installation instructions.
- 1.14.6.5. Safety precautions for operation and maintenance.
- 1.14.6.6. Diagrams and illustrations.
- 1.14.6.7. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
- 1.14.6.8. Performance data.
- 1.14.6.9. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.

- 1.14.6.10. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
- 1.14.6.11. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

1.15. RECORD DRAWINGS

- 1.15.1. The Consultant will provide to the Electrical Contractor one set of AutoCad computer files and one set of white prints of all drawings relating to the work of this contract, for the purpose of preparing record drawings. As the job progresses, mark up the white prints to accurately indicate installed work, i.e. location and elevations, etc. On completion of the work, the Electrical Contractor to transfer the information neatly onto the computer files based on AutoCad 2007 or higher, and submit the electronic files and one set of prints for review and comment. Correct the files as directed by the Consultant and hand these over to the Board, together with a set of white prints, on completion.
- 1.15.2. Record, as the job progresses, all approved changes and deviations made to any work shown on the original contract drawings whether by addenda, requested changes, job instructions, and changes due to job conditions.
- 1.15.3. Indicate on the drawings all conduits, pull boxes, junction boxes, empty conduits, concealed main and sub-feeder conduits and any other equipment not clearly in view, with exact dimensions for future reference. Tie dimensions by measurement to existing topographical features, and include changes in directions as well as at least three points on straight runs of conduits on raceways.
- 1.15.4. All conduits in slabs, under slab and direct buried are to be shown on the Record drawings.
- 1.15.5. Record drawings to be kept up to date and be available for checking at any time by Boards and Consultant. Progress draws will not be reviewed unless the record drawing set is up to date.
- 1.15.6. All equipment schedules, panel schedules, system schedules, riser diagrams, details, etc. to be updated to reflect the as installed condition and included as part of the record drawing submission.
- 1.15.7. Provide a schedule indicating the protective device trip setting of all Air Circuit Breakers and Electronic Solid State Circuit Breakers which are reflected on each of the Power Distribution Single Line Riser Diagram drawings. The protective device trip settings that are to be listed in the schedule are to be those which are based upon the final reviewed and accepted version of the short circuit and protection and coordination as well as the arc flash study.

1.15.8. Branch circuiting, lighting zoning, switching, etc. methodology to be the same as that indicated on the electrical contract documents that are issued for construction.

1.15.9. Electrical record drawings to be submitted in both AutoCad and PDF format.

1.15.10. Record drawings will not be reviewed for acceptance until project substantial completion has been issued.

1.16. ACCEPTANCE CHECKS AND TESTS

1.16.1. The Contractor shall furnish the instruments, materials, and labor for tests.

1.16.2. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Board.

1.16.3. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests. Repair, replacement, and retesting shall be accomplished at no additional cost to the Board.

1.17. CODES, PERMITS AND INSPECTIONS

1.17.1. All work to meet or exceed the latest requirements of the Codes and Standards as listed in PART 1 of these specifications, supplements, local inspection bulletins and all Authorities Having Jurisdiction.

1.17.2. Arrange for inspection of all work and pay all fees in this regard. On completion of the work, deliver the final unconditional certificate of approval of the Electrical Safety Authority (ESA).

1.17.3. It is hereby agreed that all requirements meet CAN/CSA requirements and a complete installation in accordance with these requirements to be provided.

1.17.4. Keep a permanent record of each inspection made by the Electrical Safety Authority showing the date, inspector's name, scope of the inspection and statement of special decisions or permissions granted. Make these records available to the Consultant at any time, and turn them over at completion of the work.

1.18. WARRANTY

1.18.1. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Board's representative.

1.19. INSTRUCTION

- 1.19.1. Instruction to designated Board personnel shall be provided for the particular equipment or system as required in each associated technical specification section.
- 1.19.2. Furnish the services of competent instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be trained in operating theory as well as practical operation and maintenance procedures.
- 1.19.3. New sub distribution panel to be provided and installed. All new required power feeds and wiring, and conduits to be provided as required.
- 1.19.4. All new breakers, and fused disconnects to be provided as indicated per the drawings.
- 1.19.5. New fused disconnect to be provided for the new elevator as indicated per the drawings.
- 1.19.6. New light fixtures, switches, and outlets, and devices to be provided in all areas as indicated per the drawings.
- 1.19.7. New Conventional/Addressable type fire alarm panel to be provided and installed. Existing conventional fire alarm devices and new addressable type fire alarm devices to be connected to the new fire alarm panel. New fire alarm annunciator panel to be provided also.
- 1.19.8. All new electrical and fire alarm devices for the new elevator is to be provided as indicated for a complete functioning system. Coordinate with architect and elevator consultant as required.
- 1.19.9. New electric strike and automatic door operator to be provided where indicated on drawings. All wiring to be provided for a complete operational system.
- 1.19.10. ESA reports to be provided for all new work.
- 1.19.11. Contractor to update the building's fire alarm zoning and provide a complete verification report.
- 1.19.12. All required electrical and fire alarm devices to be provided for the new elevator and elevator hoistway for a complete operating system.
- 1.19.13. All new wireless access points to be provided as indicated.
- 1.19.14. New communication devices such as PA phones to be provided as indicated.
- 1.19.15. New Electric duct heaters and duct heat control boxes to be provided as indicated per the mechanical and electrical drawings. Refer to drawings for locations.

- 1.19.16. All new required relays for the new fire alarm panel to be provided.
- 1.19.17. New occupancy sensors, light dimmer switches, and electrical devices as indicated in the drawings to be provided and installed.
- 1.19.18. New disconnects to be provided for new mechanical equipment and where indicated on drawings.
- 1.19.19. Relocated devices and equipment such as, but not limited to PA phones, security devices, PA consoles, PA media player to be coordinated with Board and architect as to the exact relocation areas.
- 1.19.20. New smoke detectors for elevator recall system to be provided.
- 1.19.21. A training schedule shall be developed and submitted by the Contractor and approved by the Consultant at least 15 days prior to the planned training.

PART 2 - PRODUCTS

2.1. MATERIALS AND EQUIPMENT

- 2.1.1. All materials and equipment to be new and free from defects.
- 2.1.2. All material and equipment to be CAN/CSA certified. Where CAN/CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- 2.1.3. Where materials, equipment, apparatus, or other products are specified by the manufacturer, brand name, type or catalogue number, such designation is to establish the standards of desired quality, style or dimensions and to be the basis of the Bid. Furnish materials so specified under this Contract unless changed by mutual agreement. Where two or more designations are listed, the Electrical Contractor to choose one of those listed.
- 2.1.4. Where the use of equivalent, alternate or substitute equipment alters the design or space requirements indicated on the plans, the Electrical Contractor for this contract to include all items of cost for the revised design and construction, including the cost of all the other trades involved.
- 2.1.5. Acceptance of the proposed equivalents, alternates or substitutions to be subject to the review by the Consultant, and if requested, the Electrical Contractor to submit for inspection, samples of both the specified and the proposed alternate items.
- 2.1.6. In all cases where the use of equivalents, alternates or substitutions is permitted, the Electrical Contractor to bear any extra costs of evaluating the quality of materials and the equipment to be installed.

2.2. EQUIVALENTS AND ALTERNATES

- 2.2.1. Should the Electrical Contractor propose to furnish material and equipment other than those specified, he is to apply in writing to the Consultant for approval of equivalents at least ten working days prior to the closing of Bids, submitting with his request for approval, complete descriptive and technical data on the item or items he proposes to furnish. Approval for changes in the base bid specifications will be considered only upon the individual requests of the Electrical Contractor. No blanket approval for equipment will be given to suppliers, distributors or contractors.
- 2.2.2. Unless requests for changes in base bid specifications are received and approved prior to the opening of the bids, as defined above, the Electrical Contractor will be held to furnish all specified items under his base bid. After the Contract is awarded, changes in specifications will be made only as defined in the Article dealing with Material Substitution.
- 2.2.3. Replace unspecified materials or rejected equivalents and alternates built into the work with specified or accepted materials at no additional cost to the Owner.
- 2.2.4. If any material or equipment being considered for substitution involves additional design, architectural or engineering fees or other costs in checking whether or not the substitute material or equipment is suitable for the project, such fees or costs to be paid for by the Electrical Contractor. A minimum of five hundred dollars (\$500.00) to be applied to each piece of device or equipment requested for review. There is no guarantee that the reviewed product will be accepted by the Board or the reviewing Consultant.

2.3. MATERIAL SUBSTITUTION

- 2.3.1. After award of the Contract, requests for substitution of materials of makes other than those specifically named in the Contract Documents may be considered by the Consultant subject to the following:
 - 2.3.1.1. The specified material cannot be delivered to the job in time to complete the work in proper sequence to work of other trades, due to conditions beyond the control of the Electrical Contractor.
 - 2.3.1.2. Requests for substitutions to be accompanied by documentary proof of equality, difference in price and delivery, if any, in the form of certified quotations from suppliers of both specified and proposed equipment.
 - 2.3.1.3. In case of difference in price, the Owner is to receive all benefit of the difference in cost involved in any substitution and the Contract altered by change order to credit the Owner with any savings so obtained.

- 2.3.1.4. Materials and equipment substituted or offered as alternatives to have spare parts and servicing available and to fit into the space allocation shown on the drawings.
- 2.3.1.5. If any material or equipment being considered for substitution involves additional design, architectural or engineering fees or other costs in checking whether or not the substitute material or equipment is suitable for the project, such fees or costs to be paid for by the Electrical Contractor. A minimum of five hundred dollars (\$500.00) to be applied to each piece of device or equipment requested for review. There is no guarantee that the reviewed product will be accepted by the Board or the reviewing Consultant.

2.4. WARNING SIGNS

- 2.4.1. Warning Signs: in accordance with requirements of Authority Having Jurisdiction and Consultants.
- 2.4.2. Comply with Health Canada/Workplace Hazardous Materials Information System (WHMIS).
- 2.4.3. Provide warning labels in both English and French where project requires.

2.5. FINISHES

- 2.5.1. Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and two coats of finish enamel.
- 2.5.2. Paint outdoor electrical distribution equipment green finish to EEMAC Y1-2.
- 2.5.3. Paint indoor normal power distribution equipment enclosures light grey to EEMAC 2Y-1.
- 2.5.4. Paint indoor emergency power "Life Safety" distribution equipment enclosures Red.
- 2.5.5. Paint indoor emergency power "Non-life Safety" distribution equipment enclosures International Orange, RAL #2009.
- 2.5.6. Paint indoor UPS power distribution equipment enclosures Blue, RAL #5017.

2.6. CAN/CSA/NEMA RATING

- 2.6.1. All electrical equipment provided for this project to be CAN/CSA/NEMA Rated only. IEC Rated equipment is not acceptable and will not be accepted.

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Comply with all Codes and Standards listed in PART 1 – GENERAL.

- 3.1.2. Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions, product carton installation instructions, MSDS, and product datasheets.
- 3.1.3. Protect electrical equipment from dust and dirt. Plug or cap openings of conduits, fixtures and equipment during construction with approved materials for such use.
- 3.1.4. The Electrical Contractor to be responsible for the layout of the work of this contract, and for any damage caused to site or existing building, or other Contracts by improper location or carrying out of this work.
- 3.1.5. Ensure the prompt installation of the work of this contract in advance of concrete pouring or similar work.
- 3.1.6. No conduits for any power or systems to be permitted to be installed within the concrete slabs or concrete walls for this project except in select identified areas as per the drawings and specifications.
- 3.1.7. Furnish items to be "built-in" in ample time and give any necessary information and assistance in connection with the building-in of the same.
- 3.1.8. Manufactured products supplied with instructions for their use to be used in strict accordance with those instructions.
- 3.1.9. Ensure that all equipment and material is ordered in time to meet the building schedule. Provide a schedule of equipment deliveries to the Construction Manager within the time limit stipulated.

3.2. SITE SERVICES

- 3.2.1. Site services: acquire a full working knowledge of the building site, services and any existing conditions thereon that may impact the project implementation. Review and examine the contract drawings and schedules of all trades prior to bid submittal to ensure full knowledge of the contract scope of work is ascertained.
- 3.2.2. The location of equipment indicated or specified is considered approximate. Review proposed locations with Consultant prior to installation.
- 3.2.3. Locate equipment, piping, duct and/or conduit to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

3.3. CONTRACTOR'S SHOP

- 3.3.1. Provide job site office, workshop, tools, scaffolds, material storage, etc., as required to complete the work of this contract and as directed by the Consultant.

- 3.3.2. The electrical contractor's office should as a minimum have the following capabilities, Phone, fax, email, High speed internet connection, router with a spare port and patch cable in order that the consultant can access the internet to deal with project related issues, copier and printer.

3.4. TEMPORARY SERVICES

- 3.4.1. Provide temporary electrical services with all poles, transformer and protection equipment from the locations as coordinated with the Owner. Provide all power panels at various locations on the site required to perform the work and as specified by the Consultant. All temporary services must be coordinated with the Owner. Do not use the permanent service of new or existing building for temporary power for construction unless specific written approval is obtained from the Consultant and coordinated with the Board

3.5. ACCESS TO ELECTRICAL EQUIPMENT, JUNCTION BOXES AND PULL BOXES

- 3.5.1. Clear access of a minimum of 1 meter must be provided for all electrical equipment, junction boxes and pull boxes.
- 3.5.2. All junction boxes and pull boxes to be within 600mm of an access panel or access luminaire and be easily accessed.
- 3.5.3. All electrical boxes that have free sides (IE: no conduits entering or leaving a side) to be kept clear in order to permit installation of conduits at a later date. Hence free sides of all electrical boxes to be clear of other conduits and services.

3.6. NAMEPLATES

- 3.6.1. Ensure manufacturer's nameplates, CAN/CSA labels and identification nameplates are visible and legible after equipment is installed.

3.7. LOCK OFF TABS

- 3.7.1. Provide lock off tabs on all panel boards for circuits that serve:
- 3.7.1.1. Emergency lighting;
 - 3.7.1.2. Exit lighting;
 - 3.7.1.3. Fire alarm equipment
 - 3.7.1.4. Security equipment.

3.8. FIRESTOPPING

- 3.8.1. Where cables, sleeves or conduits, pass through floors and fire rated walls pack space between wiring and sleeve or opening and seal with Hilti fire stopping system that is appropriate. The fire stopping installation must meet one of the approved details as

required to meet the rating of the assembly. Contact the Hilti representative to ensure that the installation meet Hilti requirements.

- 3.8.2. Care must be taken to keep integrity of all assemblies and maintain good finishes of surrounding areas, use tape for finish at edges when apply fire stopping materials. Provide at the end of the project a letter from Hilti indicating that the installation meets all requirements.
- 3.8.3. Meet all requirements of the Codes and fire proofing requirements as specified within the Contract Documents.
- 3.8.4. Provide Shop drawings for the various Fire stopping assemblies that will be utilized on the project to achieve the fire rating for construction assemblies or methods.
- 3.8.5. Refer (where applicable) to architectural drawings for fire separation diagrams. Such drawings may not be issued as part of the electrical documents; it is the electrical contractor's obligation to review all contract documentation of all involved disciplines (drawings and specifications).

3.9. BASES AND SUPPORTS

- 3.9.1. Where conduit and equipment are located on walls or slabs which will not permit the support of equipment, provide suitable supports to the building structure. Supports to be constructed of steel members or of steel pipe and fittings designed to safely support the equipment.
- 3.9.2. All equipment bases to be set on pads of kinetic pre-compressed fiberglass or vibration isolators sized to suit the equipment which they ought to support.

3.10. INSERTS, SLEEVES AND CURBS

- 3.10.1. Provide all inserts, sleeves and curbs required for the work of this contract.
- 3.10.2. Use only factory made threaded or toggle type inserts as required for support and anchors, properly sized for the load to be carried. Place inserts only in portions of the main structure and not in any finishing material.
- 3.10.3. Use factory made expansion shields where inserts cannot be placed, but only where approved by the Structural Engineer and only for loads of 50 kg or less.
- 3.10.4. Do not use powder activated tools unless with written permission of the Board's Representative.
- 3.10.5. Supply and locate all inserts, holes, anchor bolts and sleeves in time when walls, floors and roof are erected.

3.10.6. Size sleeves to provide 25 mm clearance all around.

3.10.7. Pack all sleeves between the conduit or cable passing through the sleeve and the sleeve and all spare sleeves with loose fiberglass insulation. Seal the annular space both sides as follows:

- 3.10.7.1. For all horizontal sleeves in exposed areas, use a seal of equal or better fire rating than the wall to be sealed.
- 3.10.7.2. For all horizontal concealed sleeves through fire walls and through walls separating areas of different air pressure, use a permanently resilient silicone base or equal sealing compound.
- 3.10.7.3. For all vertical sleeves through roofs, washrooms, janitor closets, equipment rooms, use permanently resilient silicone base or equal compound, non-flammable and waterproof. Ensure that the seal is compatible with floor and ceiling finishes. Check the room finishes schedules for further information.

3.11. CUT PATCH AND MAKE GOOD

- 3.11.1. All drilling, cutting, patching, concrete curbs, housekeeping pads and similar work required for installation of the specified systems shall be done under this contract.
- 3.11.2. Do not use powder actuated tools using explosives, unless permitted expressly by the Board in writing.
- 3.11.3. All cutting of steel shall be by mechanical cutters or saws. Torches and abrasives will only be permitted if there is no alternative. Prior to using torches or abrasives obtain Hot Work Permit in accordance with the Board's hot work procedure.
- 3.11.4. Scan the walls/floor slabs using ground penetrating radar (GPR) technology prior to making openings to determine the presence and location of embedded conduits or rebar. Clean the floors/walls immediately after core drilling/saw cutting is complete. All core drilling and loud and/or prolonged drilling shall be done after normal working hours (during silent hours) or as permitted by the "hammer drilling" schedule and 48 hour lead notice is to be provided to the building Owner to confirm contractor has met all mandatory conditions.
- 3.11.5. Core drilling through floors and walls shall be done with diamond drills only. The use of pneumatic hammers will not be permitted.
- 3.11.6. Patch and make good all surfaces cut, damaged or disturbed to the Board 's approval. Match existing material, colour, finish and texture.
- 3.11.7. Welding and cutting: conform to Ontario Health and Safety Act O.Reg. 213/91 amended to O.Reg. 628/05 Construction Projects. Obtain a Hot Work Permit from the PM prior to welding and cutting operations. Follow the PM's hot work procedures.

- 3.11.8. Do not dispose of cement, mortar, plaster or other similar materials into drainage system. Contractor shall be liable for all costs associated with cleanup and reinstatement to original condition after doing so.
- 3.11.9. Dispose of sediment-containing liquids such as those resulting from core drilling or concrete cutting into designated drains. Flush drain with sufficient quantity of clean water to ensure that drain is free-flowing and unobstructed. Be liable for all costs associated with cleanup and reinstatement of drain and piping to original condition if found to be blocked by sediment.
- 3.11.10. Firestop all penetrations through wall and floor assemblies with Hilti Firestop solutions having a fire resistance rating not less than the assembly penetrated, colour: red. Unless otherwise noted, use the following assembly ratings: floors 2-hours; walls except around stairways – 1½ hours; walls around stairways: 2 – hours. Submit to Consultant for approval the proposed system detail sheets bearing the UL/CUL system number. Provide specified firestopping compound on both sides of assembly penetrated regardless of UL/CUL detail requirements.

3.12. REMOVALS AND DEMOLITION

- 3.12.1. The drawings indicate the general scope of electrical removals. Verify on site the exact requirements and extent of removals.
- 3.12.2. Visit the site to determine the extent of all removals.
- 3.12.3. Maintain, retain and make good as required all existing systems, branch wiring and feeders intended to remain operational in areas which are affected by these renovations.
- 3.12.4. Schedule all demolition work with project manager prior to any service interruption in occupied building area.
- 3.12.5. All shutdowns of existing base building systems shall be coordinated with the Board's representative. Pay for any cost incurred. All building services to remain fully operational during construction. Include in tender for off hours to install new breaker in existing panels and connection for feeders.
- 3.12.6. Remove electrical equipment as required complete with wiring up to associated panel. Remove all electrical components to be demolished or to be relocated and make safe all wiring. Hand over removed items to owner if requested. Dispose of the equipment properly which Owner does not wish to retain. Update existing panel directory which is affected.
- 3.12.7. Inform the Consultant and the Board immediately if any contaminated materials are found on site. Remove the items so that they can be packed and removed from the site. Provide assistance and cooperation for the complete removal.

- 3.12.8. The contractor shall be responsible to relocate any existing electrical equipment and/or wiring that will interfere with new construction.
- 3.12.9. The contractor shall be responsible for reconnection of any services that are to remain and have been disconnected during the course of demolition or construction.
- 3.12.10. All systems and components which are affected by the renovation shall remain operational subsequent to project completion. Reinstate immediately any services disrupted during demolition not intended to be removed as part of this contract at no extra cost.
- 3.12.11. Retain continuity of service of the fire alarm system to all occupied areas of the building.
- 3.12.12. The contractor shall advise security in the event that fire alarm system continuity is disrupted such that a fire watch can commence immediately.
- 3.12.13. Repair all damages inside and outside of the renovated areas caused by the demolition/construction without extra cost to the Owner.

3.13. REMOVED MATERIAL

- 3.13.1. All material removed during demolition shall become the property of the Contractor. The contractor shall remove material from the site and dispose of in accordance with provincial regulations. Under no circumstances is the contractor to use the building Owner's refuse containers for disposal.

3.14. NUMBER AND LOCATION OF OUTLETS

- 3.14.1. Provide outlets for power and systems of the number and in the locations shown on the drawings. Locate all outlets accurately with respect to building lines and in centering outlets due allowance to be made for overhead pipes, ducts, equipment and for variations in wall or ceiling finishes, window trim, paneling, etc. When necessary, make adjustments to ensure that all outlets are properly centered.
- 3.14.2. The location of any outlet may be changed without extra cost or credit providing that the new location is within 6 metres (20 feet) of that originally shown on the drawings and that instructions for the change are issued before installation of the outlet.
- 3.14.3. Do not mount outlet boxes in walls and partitions back-to-back and provide a minimum of 150 mm (6 inch) between boxes. Provide acoustic insulating medium in conduits which join boxes on opposite sides of same wall or partition. Acoustic properties of the wall to be matched or exceeded. Where applicable, for acoustically sensitive/critical rooms, more spacing separation and acoustic box seal is required. Refer to acoustic specifications and electrical drawings for detailed requirements.

3.15. MOUNTING HEIGHTS

- 3.15.1. The mounting height of equipment is measured from the finished floor to the centerline of the equipment unless specified or otherwise indicated.
- 3.15.2. If the mounting height of any equipment is not indicated, verify the mounting height before proceeding with the installation.
- 3.15.3. Install electrical equipment at the following mounting heights unless otherwise detailed or indicated. Refer to Architectural reflected ceiling plans, elevations, sections and details for final device location and to confirm all mounting heights.
- 3.15.4. All device mounting heights and orientation to be coordinated and confirmed by the Prime Consultant prior to installation.
 - 3.15.4.1. Local switches and control devices: 1100 mm (42 inch)
 - 3.15.4.2. Wall receptacles:
 - 3.15.4.2.1. General: 400 mm (15 inch)
 - 3.15.4.2.2. Above top of counters or backsplash: 175 mm (7 inch)
 - 3.15.4.2.3. In mechanical rooms: 1400 mm (55 inch)
- 3.15.5. Panelboards:
 - 3.15.5.1. 1800 mm (70 inch) to the top except that the panelboard not to be lower than 150 mm (6 inch) above the floor.
 - 3.15.5.2. Where multiple panelboards are mounted together, align the tops of all the panelboards or trims with the highest panelboard determining the height.
- 3.15.6. Fire alarm system pull stations: 1200 mm (48 inch)
 - 3.15.6.1. Fire alarm system speakers/strobes: 2300 mm (90 inch) and at least 150 mm (6 inch) below the ceiling measured to the top of device, or on ceiling.
 - 3.15.6.2. Fire Alarm System end of line resistors as per code requirements. EOL resistors to be grouped in service spaces.
 - 3.15.6.3. Fire fighter's phone: 1400 mm (55 inch) measured to the centerline of the enclosure.
- 3.15.7. Individual starters:
 - 3.15.7.1. 1500 mm (60 inch) to the top.
 - 3.15.7.2. Where multiple starters are mounted together, align the tops of all the starters or trims with the highest starter determining the height.
- 3.15.8. Splitters: 100 mm (4 inch) below the lowest equipment connected to the splitter.

3.16. MECHANICAL AND ELECTRICAL CO-ORDINATION OF RESPONSIBILITIES

3.16.1. The following is a list of mechanical and electrical responsibilities for the above mentioned project:

- 3.16.1.1. The Electrical Contractor to provide all starters or combinations starters/disconnects (fused or non-fused, as specified) for Mechanical Motors along with Line and Load side power wiring with the exception of Packaged Mechanical Equipment or Units.
- 3.16.1.2. Where so specified, Packaged Mechanical Equipment to be provided with its own integral disconnect(s), starters(s) or unit mounted VFD(s). With respect to Packaged Mechanical Equipment or Units the Electrical Contractor to provide the Line Side power wiring and connection(s) to the equipment connection point(s).
- 3.16.1.3. The Electrical Contractor to provide equipment isolation disconnect switches for all remote mechanical equipment unless otherwise indicated within the Mechanical Contract Documents or unless equipment is already furnished with a local disconnect. Where applicable, weather-proof enclosures shall be used. Remote definition: not in sight, as per NFPA-70 article 430.102
- 3.16.1.4. All BAS equipment and devices, to be supplied by the BAS vendor and installed by the mechanical Contractor.
- 3.16.1.5. The Mechanical Contractor to provide all control wiring, BAS wiring, and 120 volt control wiring for Mechanical Equipment or Units.
- 3.16.1.6. The Mechanical Contractor to provide all motors.
- 3.16.1.7. The Electrical Contractor to provide all fire alarm interface wiring to the Mechanical Equipment or Units for fire alarm Fan Shut Down, Fan Start-up as and for fire alarm Smoke Control.
- 3.16.1.8. The Electrical Contractor to provide all fire alarm wiring.
- 3.16.1.9. The Electrical Contractor to provide all relays for interface to control wiring for fan shutdown and fan start up for air handling units used as part of the smoke control system(s).
- 3.16.1.10. The Mechanical Contractor to provide all relays as required by the Mechanical Equipment or Units to connect to the various building systems.
- 3.16.1.11. The Mechanical Contractor to provide electric pipe heat tracing which to be based upon the self-limited type and be at 208 volts 1 Phase. The Electrical Contractor to provide 208 volts 1 Phase power connection(s) for the electric pipe heat tracing system(s). The Mechanical Contractor to provide loads requirements of the heat tracing to the Electrical Contractor prior to final power connection.
- 3.16.1.12. The Mechanical Contractor to provide electric heating, associated controls and control wiring. The Electrical Contractor to provide the Line Side power connection to the electric heating. The Mechanical Contractor to provide any framing required for recessed electric heating.
- 3.16.1.13. Separate Variable Frequency Drives (VFDs) to be provided by the Mechanical Contractor. Should the Mechanical Contractor change or modify motor sizes from

what is specified within the Bid Documents during any stage of this project the Mechanical Contractor will be responsible to cover all associated electrical costs such as revised motor starter and feeds, etc.

3.17. FLASHING

- 3.17.1. Coordinate with requirements for roofing, waterproofing and flashing with the Roofing Contractor.
- 3.17.2. Flash electrical parts passing through or built into a roof, an outside wall or a waterproof floor.
- 3.17.3. Provide 8-pound sheet lead flashing for cast iron or wrought iron sleeves passing through roof.
- 3.17.4. Flashing shall suit roof angle and shall extend minimum 450 mm (18 inch) on all sides. Leave flashing as directed by the Roofing Contractor for him to build into roofing, rendering a watertight connection.
- 3.17.5. Provide counter flashing on stacks, ducts and pipes passing through roof to fit over flashing or curb.
- 3.17.6. Provide sleeves passing through outside walls with lead or copper flashing as directed.

3.18. SYSTEM STARTUP

- 3.18.1. Inform Consultant and operating personnel in operation, care and maintenance of systems, system equipment and components.
- 3.18.2. Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- 3.18.3. Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.19. CLEANING

- 3.19.1. Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- 3.19.2. Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

- 3.19.3. During the performance of the work and on the completion, remove from the site and premises all debris, rubbish and waste materials caused by the performance of the work for this contract. Remove all tools and surplus materials after completion and acceptance of the work.
- 3.19.4. Vacuum all equipment thoroughly at the time of final acceptance of the work. Clean plastic components and exposed components of luminaires in accordance with the manufacturer's recommendation.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. FACTORY TESTS..... 2

1.4. SUBMITTALS 2

1.5. APPLICABLE PUBLICATIONS..... 2

PART 2 - PRODUCTS 3

2.1. CONDUCTORS AND CABLES..... 3

2.2. SPLICES..... 4

2.3. CONNECTORS AND TERMINATIONS 4

2.4. CONTROL WIRING..... 5

2.5. WIRE LUBRICATING COMPOUND 5

PART 3 - EXECUTION 5

3.1. GENERAL..... 5

3.2. SPLICE AND TERMINATION INSTALLATION 6

3.3. CONDUCTOR IDENTIFICATION..... 6

3.4. FEEDER CONDUCTOR IDENTIFICATION 6

3.5. EXISTING CONDUCTORS 6

3.6. CONTROL WIRING INSTALLATION 6

3.7. CONTROL WIRING IDENTIFICATION 7

3.8. ACCEPTANCE CHECKS AND TESTS 7

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.2. RELATED WORK

- 1.2.1. Section: 26 05 00 Common Work Results for Electrical.
- 1.2.2. Section: 26 05 26 Grounding and Bonding for Electrical Systems.
- 1.2.3. Section: 26 05 33 Raceway and Boxes for Electrical Systems.

1.3. FACTORY TESTS

- 1.3.1. Conductors and cables shall be thoroughly tested at the factory per NEMA to ensure that there are no electrical defects. Factory tests shall be certified.

1.4. SUBMITTALS

1.4.1. Shop Drawings:

- 1.4.1.1. Submit sufficient information to demonstrate compliance with drawings and specifications.
- 1.4.1.2. Submit the following data for approval:
- 1.4.1.3. Electrical ratings and insulation type for each conductor and cable.
- 1.4.1.4. Splicing materials and pulling lubricant.

1.4.2. Certifications: Two weeks prior to final inspection, submit the following.

- 1.4.2.1. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
- 1.4.2.2. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

1.5. APPLICABLE PUBLICATIONS

- 1.5.1. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

- 1.5.1.1. CAN/CSA-C22.2 NO.38-10, Thermoset-Insulated Wire and Cables (Tri-national
- 1.5.1.2. standard, with UL 44 and ANCE NMX-J-451).
- 1.5.1.3. CAN/CSA C22.2 NO.51-09, Armored Cables.

- 1.5.1.4. CAN/CSA C22.2 NO.75-08, Thermoplastic-Insulated Wires and Cables (Trinational
- 1.5.1.5. standard, with UL 83 and NMX-J-010-ANCE-2008).
- 1.5.1.6. CAN/CSA C22.2 NO.124-04 (R2009), Mineral-Insulated Cable.
- 1.5.1.7. CAN/CSA C22.2 NO.131-07, Type TECK 90 Cable.
- 1.5.1.8. CAN/CSA C22.2 NO. 239-09, Control and Instrumentation Cables.
- 1.5.1.9. American Society of Testing Material (ASTM):
 - 1.5.1.9.1. D2301-10 Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
 - 1.5.1.9.2. D2304-10 Test Method for Thermal Endurance of Rigid Electrical Insulating Materials
 - 1.5.1.9.3. D3005-10 Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- 1.5.1.10. National Electrical Manufacturers Association (NEMA):
 - 1.5.1.10.1. WC 70-09 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- 1.5.1.11. National Fire Protection Association (NFPA):
 - 1.5.1.11.1. 70-11 National Electrical Code (NEC)
- 1.5.1.12. Underwriters Laboratories, Inc. (UL):
- 1.5.1.13. 44-10 Thermoset-Insulated Wires and Cables
- 1.5.1.14. 83-08 Thermoplastic-Insulated Wires and Cables
- 1.5.1.15. 467-07 Grounding and Bonding Equipment
- 1.5.1.16. 486A-486B-03 Wire Connectors
- 1.5.1.17. 486C-04 Splicing Wire Connectors
- 1.5.1.18. 486D-05 Sealed Wire Connector Systems
- 1.5.1.19. 486E-09 Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
- 1.5.1.20. 514B-04 Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS

2.1. CONDUCTORS AND CABLES

- 2.1.1. Conductors and cables shall be in accordance with NEMA, UL, as specified herein, and as shown on the drawings.
- 2.1.2. All conductors shall be copper.
- 2.1.3. Single Conductor and Cable:
 - 2.1.3.1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
 - 2.1.3.2. No. 8 AWG and larger: Stranded.

- 2.1.3.3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.

- 2.1.4. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

2.2. SPLICES

- 2.2.1. Splices shall be in accordance with NEC and UL.

- 2.2.2. Above Ground Splices for No. 10 AWG and Smaller:

- 2.2.2.1. Solderless, screw on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
- 2.2.2.2. The integral insulator shall have a skirt to completely cover the stripped conductors.
- 2.2.2.3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

- 2.2.3. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:

- 2.2.3.1. Compression, hex screw, or bolt clamp type of high conductivity and corrosion resistant material, listed for use with copper and aluminum conductors.
- 2.2.3.2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
- 2.2.3.3. Splice and insulation shall be product of the same manufacturer.
- 2.2.3.4. All bolts, nuts, and washers used with splices shall be cadmium-plated.

- 2.2.4. Above Ground Splices for 250 kcmil and Larger:

- 2.2.4.1. Long barrel "butt-splice" or "sleeve" type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
- 2.2.4.2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
- 2.2.4.3. Splice and insulation shall be product of the same manufacturer.

2.3. CONNECTORS AND TERMINATIONS

- 2.3.1. Mechanical type of high conductivity and corrosion resistant material, listed for use with copper and aluminum conductors.

2.3.2. Long barrel compression type of high conductivity and corrosion resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.

2.3.3. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be cadmium-plated.

2.4. CONTROL WIRING

2.4.1. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.

2.4.2. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.5. WIRE LUBRICATING COMPOUND

2.5.1. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

2.5.2. Shall not be used on conductors for isolated power systems.

PART 3 - EXECUTION

3.1. GENERAL

3.1.1. Install conductors in accordance with the CSEC, NEC, as specified, and as shown on the drawings.

3.1.2. Install all conductors in metallic conduits, unless specified otherwise. Where multiple conduits follow the same routing, provide raceway systems.

3.1.3. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.

3.1.4. Conductors of different systems (e.g., 120 V and 347 V) shall not be installed in the same raceway.

3.1.5. Install conduit supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.

3.1.6. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.

3.1.7. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.

3.1.8. Use expanding foam or non-hardening duct-seal to seal conduits entering a building or where penetrating building walls/floors, after installation of conduits.

3.1.9. Conductor and Cable Pulling:

- 3.1.9.1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
- 3.1.9.2. Use nonmetallic pull ropes.
- 3.1.9.3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
- 3.1.9.4. All conductors in a single conduit shall be pulled simultaneously.
- 3.1.9.5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- 3.1.9.6. No more than three branch circuits shall be installed in any one conduit.
- 3.1.9.7. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

3.2. SPLICE AND TERMINATION INSTALLATION

- 3.2.1. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.
- 3.2.2. Where the Consultant determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Board.

3.3. CONDUCTOR IDENTIFICATION

- 3.3.1. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.

3.4. FEEDER CONDUCTOR IDENTIFICATION

- 3.4.1. In each interior pullbox, install brass tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the embossed type, 40 mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

3.5. EXISTING CONDUCTORS

- 3.5.1. Unless specifically indicated on the plans, existing conductors shall not be reused.

3.6. CONTROL WIRING INSTALLATION

- 3.6.1. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.
- 3.6.2. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

3.7. CONTROL WIRING IDENTIFICATION

- 3.7.1. Install a permanent wire marker on each wire at each termination.
- 3.7.2. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- 3.7.3. Wire markers shall retain their markings after cleaning.

3.8. ACCEPTANCE CHECKS AND TESTS

- 3.8.1. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 - 3.8.1.1. Visual Inspection and Tests: Inspect physical condition.
- 3.8.2. Electrical tests:
 - 3.8.2.1. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors' phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
 - 3.8.2.2. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
 - 3.8.2.3. Perform phase rotation test on all three-phase circuits

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 2

1.5. APPLICABLE PUBLICATIONS..... 2

PART 2 - PRODUCTS 3

2.1. GROUNDING AND BONDING CONDUCTORS 3

2.2. GROUND RODS 4

2.3. CONCRETE ENCASED ELECTRODE..... 4

2.4. GROUND CONNECTIONS 5

2.5. EQUIPMENT RACK AND CABINET GROUND BARS 5

2.6. GROUND TERMINAL BLOCKS..... 5

2.7. GROUNDING BUS BAR 5

PART 3 - EXECUTION 5

3.1. GENERAL 6

3.2. INACCESSIBLE GROUNDING CONNECTIONS..... 6

3.3. SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS..... 6

3.4. RACEWAY..... 7

3.5. OUTDOOR METALLIC FENCES AROUND ELECTRICAL EQUIPMENT 8

3.6. CORROSION INHIBITORS..... 8

3.7. CONDUCTIVE PIPING 8

3.8. MAIN ELECTRICAL ROOM GROUNDING 9

3.9. GROUND RESISTANCE..... 9

3.10. GROUND ROD INSTALLATION..... 9

3.11. ACCEPTANCE CHECKS AND TESTS 9

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- 1.1.2. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by CESC and NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- 1.1.3. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

1.2. RELATED WORK

- 1.2.1. Section: 26 05 00 Common Work Results for Electrical.
- 1.2.2. Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables.
- 1.2.3. Section: 26 05 33 Raceway and Boxes for Electrical Systems.

1.3. QUALITY ASSURANCE

- 1.3.1. Quality Assurance shall be in accordance with Section: 26 05 00 Common Work Results for Electrical.

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with requirements of Section: 26 05 00 Common Work Results for Electrical, and the following requirements:
 - 1.4.1.1. Shop Drawings:
 - 1.4.1.1.1. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - 1.4.1.1.2. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.
 - 1.4.1.2. Test Reports:
 - 1.4.1.2.1. Two weeks prior to the final inspection, submit ground resistance field test reports to the Consultant
 - 1.4.1.3. Certifications:
 - 1.4.1.3.1. Certification by the Contractor that the grounding equipment has been properly installed and tested.

1.5. APPLICABLE PUBLICATIONS

- 1.5.1. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- 1.5.2. Canadian Standards Association (CSA)
 - 1.5.2.1. CAN/CSA Standard C22.2 No.0.4-04(R2009) - Bonding of Electrical Equipment.
 - 1.5.2.2. CAN/CSA Standard C22.2 No.41-07 - Grounding and Bonding Equipment (Bimetallic standard, with UL 467).
 - 1.5.2.3. Canadian and Ontario Electrical Safety Codes. (Latest Edition).
- 1.5.3. ANSI/TIA/EIA-607.
- 1.5.4. (CAN/CSA TS27) Best Practices for Ground and Bonding of Devices in Telecommunication Spaces.
- 1.5.5. Latest edition of IEEE Standard No. 80.
- 1.5.6. American Society for Testing and Materials (ASTM):
 - 1.5.6.1. B1-13 Standard Specification for Hard-Drawn Copper Wire
 - 1.5.6.2. B3-13 Standard Specification for Soft or Annealed Copper Wire
 - 1.5.6.3. B8-11 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- 1.5.7. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1.5.7.1. 81-12 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- 1.5.8. National Fire Protection Association (NFPA):
 - 1.5.8.1. 70-17 National Electrical Code (NEC)
 - 1.5.8.2. 70E-15 National Electrical Safety Code
- 1.5.9. Underwriters Laboratories, Inc. (UL):
 - 1.5.9.1. 44-14 Thermoset Insulated Wires and Cables
 - 1.5.9.2. 83-14 Thermoplastic Insulated Wires and Cables
 - 1.5.9.3. 467-13 Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1. GROUNDING AND BONDING CONDUCTORS

2.1.1. Install a complete, permanent and continuous system for earthing and grounding of networks, circuits and apparatus. The system shall include electrodes, conductor, connectors and required accessories on drawings to satisfy local authorities.

2.1.2. Install bonding/grounding connections from exposed non-current carrying metal parts of equipment including, but not necessarily limited to the following:

- 2.1.2.1. Frames of all motors.
- 2.1.2.2. All Starters.
- 2.1.2.3. Main Electrical Switchboards.
- 2.1.2.4. Medium Voltage Load Interrupter Switches.
- 2.1.2.5. Panelboards and Distribution Panels.
- 2.1.2.6. Isolations Switch(es).
- 2.1.2.7. Exterior mounted cable trays.
- 2.1.2.8. Raised floor pedestals.
- 2.1.2.9. Conductive Flooring.
- 2.1.2.10. Communication Rooms.
- 2.1.2.11. Transformers.
- 2.1.2.12. Transfer Switches.
- 2.1.2.13. Power Raceway System.
- 2.1.2.14. Generating equipment.

2.1.3. Install connectors according to manufacturer's recommendations.

2.1.4. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.

2.1.5. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

2.1.6. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

2.1.7. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

2.2. GROUND RODS

2.2.1. Copper clad steel, 19 mm (0.75 inch) diameter by 3m (10 feet) long.

2.2.2. Quantity of rods shall be as required to obtain the specified ground resistance.

2.3. CONCRETE ENCASED ELECTRODE

- 2.3.1. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

2.4. GROUND CONNECTIONS

- 2.4.1. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.

- 2.4.2. Above Grade:

- 2.4.2.1. Bonding Jumpers: Listed for use with copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
- 2.4.2.2. Connection to Building Steel: Exothermic-welded type connectors.
- 2.4.2.3. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
- 2.4.2.4. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.5. EQUIPMENT RACK AND CABINET GROUND BARS

- 2.5.1. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

2.6. GROUND TERMINAL BLOCKS

- 2.6.1. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.7. GROUNDING BUS BAR

- 2.7.1. Pre-drilled rectangular copper bar with stand-off insulators, minimum 6.3 mm (0.25 inch) thick x 100 mm (4 inches) high in cross-section, length as shown on the drawings, with hole size, quantity, and spacing per detail shown on the drawings. Provide insulators and mounting brackets.

PART 3 - EXECUTION

3.1. GENERAL

3.1.1. Installation shall be in accordance with the CEC, NEC, and manufacturer's instructions.

3.1.2. System Grounding:

- 3.1.2.1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
- 3.1.2.2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- 3.1.2.3. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2. INACCESSIBLE GROUNDING CONNECTIONS

3.2.1. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.3. SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

3.3.1. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

3.3.2. Metallic Piping, Building Structural Steel, and Supplemental Electrode(s):

- 3.3.2.1. Provide a grounding electrode conductor sized per CESC and NEC between the service equipment ground bus and all metallic water pipe systems, building structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.
- 3.3.2.2. Provide a supplemental ground electrode to bond to the grounding electrode system.

3.3.3. Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control Centers, Engine-Generators, Automatic Transfer Switches, and other electrical equipment:

- 3.3.3.1. Connect the equipment grounding conductors to the ground bus.
- 3.3.3.2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

3.3.4. Transformers:

- 3.3.4.1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.

- 3.3.4.2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the nearest suitable component of the grounding electrode system.

3.4. RACEWAY

3.4.1. Conduit Systems:

- 3.4.1.1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
- 3.4.1.2. Nonmetallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
- 3.4.1.3. Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
- 3.4.1.4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.

- 3.4.2. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

3.4.3. Boxes, Cabinets, Enclosures, and Panelboards:

- 3.4.3.1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
- 3.4.3.2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

3.4.4. Wireway Systems:

- 3.4.4.1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
- 3.4.4.2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).

- 3.4.4.3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
- 3.4.4.4. Use insulated No. 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).
- 3.4.4.5. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
- 3.4.5. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- 3.4.6. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5. OUTDOOR METALLIC FENCES AROUND ELECTRICAL EQUIPMENT

- 3.5.1. Fences shall be grounded with a ground rod at each fixed gate post and at each corner post.
- 3.5.2. Drive ground rods until the top is 300 mm (12 inches) below grade. Attach a No. 4 AWG copper conductor by exothermic weld to the ground rods, and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 300 mm (12 inches) of fence mesh and fasten by two approved bronze compression fittings, one to bond the wire to post and the other to bond the wire to fence. Each gate section shall be bonded to its gatepost by a 3 mm x 25 mm (0.375 inch x 1 inch) flexible, braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

3.6. CORROSION INHIBITORS

- 3.6.1. When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.7. CONDUCTIVE PIPING

- 3.7.1. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- 3.7.2. In operating rooms and at intensive care and coronary care type beds, bond the medical gas piping and medical vacuum piping at the outlets directly to the patient ground bus.

3.8. MAIN ELECTRICAL ROOM GROUNDING

- 3.8.1. Provide ground bus bar and mounting hardware at each main electrical room where incoming feeders are terminated, as shown on the drawings. Connect to pigtail extensions of the building grounding ring, as shown on the drawings.

3.9. GROUND RESISTANCE

- 3.9.1. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.
- 3.9.2. Grounding system resistance shall comply with the electric utility company ground resistance requirements.

3.10. GROUND ROD INSTALLATION

- 3.10.1. For outdoor installations, drive each rod vertically in the earth, until top of rod is 610 mm (24 inches) below final grade.
- 3.10.2. For indoor installations, leave 100 mm (4 inches) of each rod exposed.
- 3.10.3. Where buried or permanently concealed ground connections are required, make the connections by the exothermic process, to form solid metal joints. Make accessible ground connections with mechanical pressure-type ground connectors.
- 3.10.4. Where rock or impenetrable soil prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified ground resistance.

3.11. ACCEPTANCE CHECKS AND TESTS

- 3.11.1. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized or connected to the electric utility company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.
- 3.11.2. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- 3.11.3. Below-grade connections shall be visually inspected by the Consultant prior to backfilling. The Contractor shall notify the Consultant 24 hours before the connections are ready for inspection

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 2

1.5. APPLICABLE PUBLICATIONS..... 2

PART 2 - PRODUCTS 4

2.1. MATERIAL 4

2.2. CONDUIT FITTINGS 4

PART 3 - EXECUTION 7

3.1. PENETRATIONS 7

3.2. INSTALLATION, GENERAL..... 7

3.3. CONCEALED WORK INSTALLATION..... 8

3.4. EXPOSED WORK INSTALLATION 9

3.5. HAZARDOUS LOCATIONS..... 10

3.6. WET OR DAMP LOCATIONS 10

3.7. MOTORS AND VIBRATING EQUIPMENT 10

3.8. EXPANSION JOINTS..... 10

3.9. CONDUIT SUPPORTS..... 11

3.10. BOX INSTALLATION..... 12

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- 1.1.2. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2. RELATED WORK

- 1.2.1. Section: 26 05 00 Common Work Results for Electrical.

1.3. QUALITY ASSURANCE

- 1.3.1. Refer to Paragraph, QUALIFICATIONS, in Section: 26 05 00 Common Work Results for Electrical.

1.4. SUBMITTALS

- 1.4.1. Submit in accordance with Section: 26 05 00 Common Work Results for Electrical.
- 1.4.2. Shop Drawings:
 - 1.4.2.1. Size and location of main feeders.
 - 1.4.2.2. Size and location of panels and pull-boxes.
 - 1.4.2.3. Layout of required conduit penetrations through structural elements.
 - 1.4.2.4. Submit the following data for approval:
 - 1.4.2.5. Raceway types and sizes.
 - 1.4.2.6. Conduit bodies, connectors and fittings.
 - 1.4.2.7. Splitter troughs
 - 1.4.2.8. Junction and pull boxes, types and sizes.
- 1.4.3. Certifications: Two weeks prior to final inspection, submit the following:
 - 1.4.3.1. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.
 - 1.4.3.2. Certification by the Contractor that raceway, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have been properly installed.

1.5. APPLICABLE PUBLICATIONS

1.5.1. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

1.5.2. Canadian Standards Association (CSA International)

- 1.5.2.1. CAN/CSA C22.2 No. 18.3-12, Conduit, Tubing, and Cable Fittings (Tri-National standard, with ANCE NMX-J-017 and UL 514B).
- 1.5.2.2. CAN/CSA C22.2 No. 18.4-04 (R2009), Hardware for the Support of Conduit, Tubing, and Cable (Bi-National standard, with UL 2239).
- 1.5.2.3. CAN/CSA C22.2 No. 18.5-02 (R2012), Positioning Devices (Bi-National standard, with UL 1565).
- 1.5.2.4. C22.2 NO.45.1-07, Electrical Rigid Metal Conduit – Steel (Tri-national standard, with UL 6 and NMX-J-534-ANCE-2007).
- 1.5.2.5. C22.2 No.56-04 (R2009) Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- 1.5.2.6. C22.2 NO.83-M1985 (R2008), Electrical Metallic Tubing.
- 1.5.2.7. C22.2 No.211.2-06 (R2011) Rigid PVC (Unplasticized) Conduit.
- 1.5.2.8. CAN/CSA C22.2 NO.227.1-06 (R2011), Electrical Nonmetallic Tubing (Bi-National standard, with UL 1653).
- 1.5.2.9. CAN/CSA C22.2 NO.227.2.1-04 (R2009), Liquid-Tight Flexible Nonmetallic Conduit (Bi-National standard, with UL 1660).
- 1.5.2.10. CAN/CSA C22.2 No. 227.3-05 (R2010), Nonmetallic Mechanical Protection Tubing (NMPT), (Bi-national standard, with UL 1696).

1.5.3. American National Standards Institute (ANSI):

- 1.5.3.1. C80.1-05 Electrical Rigid Steel Conduit
- 1.5.3.2. C80.3-05 Steel Electrical Metal Tubing
- 1.5.3.3. C80.6-05 Electrical Intermediate Metal Conduit

1.5.4. National Fire Protection Association (NFPA):

1.5.5. 70-11 National Electrical Code (NEC)

1.5.6. Underwriters Laboratories, Inc. (UL):

- 1.5.6.1. 1-05 Flexible Metal Conduit
- 1.5.6.2. 5-11 Surface Metal Raceway and Fittings
- 1.5.6.3. 6-07 Electrical Rigid Metal Conduit - Steel
- 1.5.6.4. 50-95 Enclosures for Electrical Equipment
- 1.5.6.5. 360-13 Liquid-Tight Flexible Steel Conduit
- 1.5.6.6. 467-13 Grounding and Bonding Equipment
- 1.5.6.7. 514A-13 Metallic Outlet Boxes

1.5.6.8.	514B-12	Conduit, Tubing, and Cable Fittings
1.5.6.9.	514C-07	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
1.5.6.10.	797-07	Electrical Metallic Tubing
1.5.6.11.	1242-06	Electrical Intermediate Metal Conduit - Steel

1.5.7. National Electrical Manufacturers Association (NEMA):

- 1.5.7.1. FB1-12 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- 1.5.7.2. FB2.10-13 Selection and Installation Guidelines for Fittings for use with Non-Flexible Conduit or Tubing (Rigid Metal Conduit, Intermediate Metallic Conduit, and Electrical Metallic Tubing)
- 1.5.7.3. FB2.20-12 Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable

PART 2 - PRODUCTS

2.1. MATERIAL

- 2.1.1. Conduit Size: In accordance with the CEC/NFPA-70, but not less than 13 mm (0.5-inch) unless otherwise shown.
- 2.1.2. Rigid Steel Conduit (RMC): Shall conform to CAN/CSA C22.2 NO.45.1, UL 6 and ANSI C80.1. *Application: for all outdoor installations and other locations where specified or shown on the drawings.*
- 2.1.3. Rigid Intermediate Steel Conduit (IMC): Shall conform to CAN/CSA C22.2 NO.18.3, UL 1242 and ANSI C80.6. *Application: for all outdoor installations and other locations where specified or shown on the drawings.*
- 2.1.4. Electrical Metallic Tubing (EMT): Shall conform to CAN/CSA C22.2 NO.83, UL 797 and ANSI C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less. *Application: for all indoor installations and other locations where specified or shown on the drawings.*
- 2.1.5. Flexible Metal Conduit: Shall conform to CAN/CSA C22.2 NO.56, UL 1. *Application: last 1000 mm (40") before final connections to burners and other locations where specified or shown on the drawings.*
- 2.1.6. Liquid-tight Flexible Metal Conduit: Shall conform to CAN/CSA C22.2 NO.227.2.1, UL 360. *Applications: last 1000 mm (40") before connecting to motors and other vibrating equipment and other locations where specified or shown on the drawings.*

2.2. CONDUIT FITTINGS

2.2.1. Rigid Steel and Intermediate Metallic Conduit Fittings:

- 2.2.1.1. Fittings shall meet the requirements of UL 514B and NEMA FB1.
- 2.2.1.2. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
- 2.2.1.3. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
- 2.2.1.4. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
- 2.2.1.5. Erickson (Union Type) and Set Screw Type Couplings: Approved for use in concrete is permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
- 2.2.1.6. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2.2.2. Electrical Metallic Tubing Fittings:

- 2.2.2.1. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
- 2.2.2.2. Only steel or malleable iron materials are acceptable.
- 2.2.2.3. Both compression and setscrew fittings are allowed, but one choice is to be made for a project. Fittings are to be of uniform type throughout the project.
- 2.2.2.4. Compression Couplings and Connectors: Concrete-tight and rain-tight, with connectors having insulated throats
- 2.2.2.5. Setscrew Couplings and Connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding
- 2.2.2.6. Indent-type connectors or couplings are prohibited.
- 2.2.2.7. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.

2.2.3. Flexible Metal Conduit Fittings:

- 2.2.3.1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
- 2.2.3.2. Clamp-type, with insulated throat.
- 2.2.3.3. Liquid tight Flexible Metal Conduit Fittings:
- 2.2.3.4. Fittings shall meet the requirements of UL 514B and NEMA FB1.
- 2.2.3.5. Only steel or malleable iron materials are acceptable.

- 2.2.3.6. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 2.2.4. Surface Metal Raceway Fittings:
 - 2.2.4.1. As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
- 2.2.5. Expansion and Deflection Couplings:
 - 2.2.5.1. Conform to UL 467 and UL 514B.
 - 2.2.5.2. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - 2.2.5.3. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the CEC tables for equipment grounding conductors.
- 2.2.6. Jacket: Flexible, corrosion resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
- 2.2.7. Conduit Supports:
 - 2.2.7.1. Parts and Hardware: Zinc coat or provide equivalent corrosion protection.
 - 2.2.7.2. Individual Conduit Hangers: Designed for the purpose, having a pre assembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 2.2.7.3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) diameter steel hanger rods.
 - 2.2.7.4. Solid Masonry and Concrete Anchors: Self drilling expansion shields, or machine bolt expansion.
- 2.2.8. Outlet, Junction, and Pull Boxes:
 - 2.2.8.1. Applicable Publications
 - 2.2.8.1.1. CAN/CSA C22.2 NO.18.1-04 (R2009), Metallic Outlet Boxes (Tri-National standard with ANCE NMX-J-023/1 and UL 514A).
 - 2.2.8.1.2. C22.2 NO.18.2-06, Nonmetallic Outlet Boxes.
 - 2.2.8.1.3. CAN/CSA C22.2 NO.18.3-12, Conduit, Tubing and Cable Fittings (Tri-national standard, with ANCE NMX-J-017 and UL 514B).
 - 2.2.8.1.4. UL-50 and UL-514A.
 - 2.2.8.2. Rustproof cast metal where required by the NEC or shown on drawings.
 - 2.2.8.3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.

2.2.9. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

2.2.10. Splitter troughs

- 2.2.10.1. Sheet metal enclosure with welded edges and hinged shaped cover with locking facility when closed.
- 2.2.10.2. Copper bus bars c/w terminals corresponding to the number and size of the incoming and outgoing conductors as shown.
- 2.2.10.3. Unless otherwise indicated the splitters shall have sufficient length to accommodate the layout of the secondary equipment.
- 2.2.10.4. Supply at least three space terminals for each terminal size in 400 A and less splitters.

PART 3 - EXECUTION

3.1. PENETRATIONS

3.1.1. Cutting or Holes:

- 3.1.1.1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams.
- 3.1.1.2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw.
- 3.1.1.3. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases.
- 3.1.1.4. Verify that roof penetration details are shown on drawings.
- 3.1.1.5. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight.

3.2. INSTALLATION, GENERAL

- 3.2.1. In accordance with ULC, OESC, CEC, NEC, NEMA, as shown on drawings, and as specified herein.
- 3.2.2. Raceway systems used for Essential Electrical Systems (EES) shall be entirely independent of other raceway systems.
- 3.2.3. Install conduit as follows:
 - 3.2.3.1. In fully completed mechanically and electrically continuous runs before pulling in cables or wires.

- 3.2.3.2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
 - 3.2.3.3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.
 - 3.2.3.4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 - 3.2.3.5. Cut conduits square, ream, remove burrs, and draw up tight.
 - 3.2.3.6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials or as shown on drawings.
 - 3.2.3.7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
 - 3.2.3.8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
 - 3.2.3.9. Close ends of empty conduits with plugs or caps at the rough in stage until wires are pulled in, to prevent entry of debris.
 - 3.2.3.10. Conduit installations under fume and vent hoods are prohibited.
 - 3.2.3.11. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 - 3.2.3.12. Flashing of penetrations of the roof membrane is shown on the drawing details.
 - 3.2.3.13. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
- 3.2.4. Conduit Bends:
- 3.2.4.1. Make bends with standard conduit bending machines.
 - 3.2.4.2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
 - 3.2.4.3. Bending of conduits with a pipe tee or vise is prohibited.
- 3.2.5. Layout and Homeruns:
- 3.2.5.1. Install conduit with wiring, including homeruns, as shown on drawings.
 - 3.2.5.2. Deviations: Make only where necessary to avoid interferences.

3.3. CONCEALED WORK INSTALLATION

3.3.1. In Concrete:

- 3.3.1.1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.

- 3.3.1.2. Align and run conduit in direct lines.
- 3.3.1.3. Install conduit through concrete beams only:
- 3.3.1.4. Where shown on the structural drawings.
- 3.3.1.5. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
- 3.3.1.6. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
- 3.3.1.7. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
- 3.3.1.8. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (0.75-inch) of concrete around the conduits.
- 3.3.1.9. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

3.3.2. Above Furred or Suspended Ceilings and in Walls:

- 3.3.2.1. Conduit for Conductors 600 V and Below: EMT.
- 3.3.2.2. Align and run conduit parallel or perpendicular to the building lines.
- 3.3.2.3. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
- 3.3.2.4. Tightening set screws with pliers is prohibited.
- 3.3.2.5. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.

3.4. EXPOSED WORK INSTALLATION

- 3.4.1. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- 3.4.2. Conduit for Conductors 600 V and Below: Rigid steel or IMC (outdoors), EMT (indoors). Mixing different types of conduits in the system is prohibited.
- 3.4.3. Align and run conduit parallel or perpendicular to the building lines.
- 3.4.4. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- 3.4.5. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.
- 3.4.6. Surface Metal Raceways: Use only where shown on drawings.
- 3.4.7. Painting:
 - 3.4.7.1. Paint exposed conduit as specified

3.5. HAZARDOUS LOCATIONS

- 3.5.1. Use rigid steel conduit only.
- 3.5.2. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.6. WET OR DAMP LOCATIONS

- 3.6.1. Use rigid steel or IMC conduits unless as shown on drawings.
- 3.6.2. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
- 3.6.3. Use rigid steel or IMC conduit within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.
- 3.6.4. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

3.7. MOTORS AND VIBRATING EQUIPMENT

- 3.7.1. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- 3.7.2. Use liquid tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.
- 3.7.3. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.

3.8. EXPANSION JOINTS

- 3.8.1. Conduits 75 mm (3 inch) and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

3.8.2. Provide conduits smaller than 75 mm (3 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.

3.8.3. Install expansion and deflection couplings where shown.

3.9. CONDUIT SUPPORTS

3.9.1. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

3.9.2. Use pipe straps or individual conduit hangers for supporting individual conduits.

3.9.3. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with U bolts or other approved fasteners.

3.9.4. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T bars, angle supports, and similar items.

3.9.5. Fasteners and Supports in Solid Masonry and Concrete:

3.9.5.1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.

3.9.6. Existing Construction:

3.9.6.1. Steel expansion anchors not less than 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.

3.9.6.2. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).

3.9.6.3. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.

3.9.6.4. Hollow Masonry: Toggle bolts.

3.9.6.5. Bolts supported only by plaster or gypsum wallboard are not acceptable.

3.9.6.6. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

3.9.6.7. Attachment by wood plugs, raw plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

3.9.6.8. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

3.9.6.9. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

- 3.9.6.10. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.10. BOX INSTALLATION

3.10.1. Boxes for Concealed Conduits:

- 3.10.1.1. Flush-mounted.
- 3.10.1.1.1. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- 3.10.1.1.2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.
- 3.10.1.1.3. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.
- 3.10.1.1.4. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap in metal covers for sheet metal boxes.
- 3.10.1.1.5. Outlet boxes mounted back to back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.
- 3.10.1.2. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.
- 3.10.1.3. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
- 3.10.1.4. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG FA JB No. 1."
- 3.10.1.5. On all branch circuit junction box covers, identify the circuits with black marker.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 2

PART 2 - PRODUCTS 2

2.1. TRANSFORMERS 3

PART 3 - EXECUTION 4

3.1. INSTALLATION..... 4

3.2. ACCEPTANCE CHECKS AND TESTS 4

3.3. FOLLOW-UP VERIFICATION 5

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the furnishing, installation, connection, and testing of low-voltage dry-type general-purpose transformers, indicated as transformers in this section.

1.2. RELATED WORK

- 1.2.1. Section 26 05 00 – Common Work Results for Electrical Systems
- 1.2.2. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables
- 1.2.3. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.3. QUALITY ASSURANCE

- 1.3.1. Quality Assurance shall be in accordance with Section 26 05 11, COMMON RESULTS – ELECTRICAL WORK.

1.4. SUBMITTALS

1.4.1. Shop Drawings

- 1.4.1.1. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, accessories, and device nameplate data.

1.4.2. Manuals

- 1.4.2.1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.
- 1.4.2.2. Schematic signal and control diagrams, with all terminals identified, matching terminal identification in the transformers.
- 1.4.2.3. Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.
- 1.4.2.4. Certifications: Two weeks prior to final inspection, submit the following.
- 1.4.2.5. Certification by the manufacturer that the transformers conform to the requirements of the drawings and specifications.
- 1.4.2.6. Certification by the Contractor that the transformers have been properly installed, adjusted, and tested.

PART 2 - PRODUCTS

2.1. TRANSFORMERS

2.1.1. Unless otherwise specified, transformers shall be in accordance with CESC, NEMA, NFPA, UL and as shown on the drawings.

2.1.2. Transformers shall have the following features:

- 2.1.2.1. Self-cooled by natural convection, isolating windings, dry-type. Rating and winding connections shall be as shown on the drawings.
- 2.1.2.2. Ratings shown on the drawings are for continuous duty without the use of cooling fans.
- 2.1.2.3. Copper windings.

2.1.3. Insulation systems:

- 2.1.3.1. Transformers 30 kVA and larger: UL rated 220 °C (428 °F) system with an average maximum rise by resistance of 150 °C (302 °F) in a maximum ambient of 40 °C (104 °F).
- 2.1.3.2. Transformers below 30 kVA: Same as for 30 kVA and larger or UL rated 185 °C (365 °F) system with an average maximum rise by resistance of 115 °C (239 °F) in a maximum ambient of 40 °C (104 °F).

2.1.4. Core and coil assemblies:

- 2.1.4.1. Rigidly braced to withstand the stresses caused by short-circuit currents and rough handling during shipment.
- 2.1.4.2. Cores shall be grain-oriented, non-aging, and silicon steel.
- 2.1.4.3. Coils shall be continuous windings without splices except for taps.
- 2.1.4.4. Coil loss and core loss shall be minimized for efficient operation.
- 2.1.4.5. Primary and secondary tap connections shall be brazed or pressure type.
- 2.1.4.6. Coil windings shall have end filters or tie-downs for maximum strength.
- 2.1.4.7. Average audible sound levels shall comply with NEMA.
- 2.1.4.8. If not shown on drawings, nominal impedance shall be as permitted by NEMA.
- 2.1.4.9. Single phase transformers rated 15 kVA through 25 kVA shall have two 5% full capacity taps below normal rated primary voltage. All transformers rated 30 kVA and larger shall have two 2.5% full capacity taps above, and four 2.5% full capacity taps below normal rated primary voltage.
- 2.1.4.10. Core assemblies shall be grounded to their enclosures with adequate flexible ground straps.

2.1.5. Enclosures:

- 2.1.5.1. Comprised of not less than code gauge steel.
- 2.1.5.2. Outdoor enclosures shall be NEMA 3R.

- 2.1.5.3. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
 - 2.1.5.4. Ventilation openings shall prevent accidental access to live components.
 - 2.1.5.5. The enclosure at the factory shall be thoroughly cleaned and painted with manufacturer's prime coat and standard finish.
 - 2.1.5.6. Standard NEMA features and accessories, including ground pad, lifting provisions, and nameplate with the wiring diagram and sound level indicated.
 - 2.1.5.7. Dimensions and configurations shall conform to the spaces designated for their installations.
- 2.1.6. Standard of Acceptance:
- 2.1.6.1. Eaton
 - 2.1.6.2. Cutler Hammer
 - 2.1.6.3. General Electric

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Installation of transformers shall be in accordance with the CEC, NEC, as recommended by the equipment manufacturer and as shown on the drawings.
- 3.1.2. Anchor transformers with rustproof bolts, nuts, and washers, in accordance with manufacturer's instructions, and as shown on drawings.
- 3.1.3. Exterior Location: Mount transformers on concrete slab. Unless otherwise indicated, the slab shall be at least 200 mm (8 inches) thick, reinforced with a 150 by 150 mm (6 by 6 inches) No. 6 mesh placed uniformly 100 mm (4 inches) from the top of the slab. Slab shall be placed on a 150 mm (6 inches) thick, well-compacted gravel base. The top of the concrete slab shall be approximately 100 mm (4 inches) above the finished grade. Edges above grade shall have 15 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 200 mm (8 inches) beyond the equipment. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm (3 inches) above slab surface.
- 3.1.4. Install transformers with manufacturer's recommended clearance from wall and adjacent equipment for air circulation. Minimum clearance shall be 150 mm (6 inches).
- 3.1.5. Install transformers on vibration pads designed to suppress transformer noise and vibrations.

3.2. ACCEPTANCE CHECKS AND TESTS

3.2.1. Perform tests in accordance with the manufacturer's recommendations. In addition, include the following:

- 3.2.1.1. Visual Inspection and Tests.
- 3.2.1.2. Compare equipment nameplate data with specifications and approved shop drawings.
- 3.2.1.3. Inspect physical and mechanical condition.
- 3.2.1.4. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections.
- 3.2.1.5. Perform specific inspections and mechanical tests as recommended by manufacturer.
- 3.2.1.6. Verify correct equipment grounding.
- 3.2.1.7. Verify proper secondary phase-to-phase and phase-to-neutral voltage after energization and prior to connection to loads.

3.3. FOLLOW-UP VERIFICATION

3.3.1. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the transformers are in good operating condition, and properly performing the intended function.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. SUBMITTALS 2

1.4. APPLICABLE PUBLICATIONS 3

1.5. DELIVERY, STORAGE, AND HANDLING 3

PART 2 - PRODUCTS 3

2.1. CIRCUIT BREAKER PANELBOARD – LIGHTING AND APPLIANCES 3

2.2. POWER DISTRIBUTION PANELBOARD 7

PART 3 - EXECUTION 9

3.1. INSTALLATION 9

3.2. FOLLOW-UP VERIFICATION 10

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1.1. This section specifies the furnishing, installation, and connection of panelboards.

1.2. RELATED WORK

- 1.2.1. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
- 1.2.2. Section 26 05 19, LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES:
- 1.2.3. Section 26 05 33, CONDUITS AND BOXES FOR ELECTRICAL SYSTEMS

1.3. SUBMITTALS

- 1.3.1. Submit the following.

- 1.3.1.1. Shop Drawings:

- 1.3.1.1.1. Submit sufficient information to demonstrate compliance with drawings and specifications.
- 1.3.1.1.2. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, circuit breakers, wiring and connection diagrams, accessories, and nameplate data.

- 1.3.1.2. Manuals:

- 1.3.1.2.1. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering circuit breakers and replacement parts.
- 1.3.1.2.2. Include schematic diagrams, with all terminals identified, matching terminal identification in the panelboards.
- 1.3.1.2.3. Include information for testing, repair, troubleshooting, assembly, and disassembly.
- 1.3.1.2.4. Include drawings which shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems
- 1.3.1.2.5. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
- 1.3.1.2.6. Certifications: Two weeks prior to final inspection, submit the following.
- 1.3.1.2.7. Certification by the manufacturer that the panelboards conform to the requirements of the drawings and specifications.
- 1.3.1.2.8. Certification by the Contractor that the panelboards have been properly installed, adjusted, and tested.

1.4. APPLICABLE PUBLICATIONS

1.4.1. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

- 1.4.1.1. NEMA PB 1 - Panelboards
- 1.4.1.2. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- 1.4.1.3. NEMA AB 1 - Molded Case Circuit Breakers
- 1.4.1.4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- 1.4.1.5. UL 50 - Enclosures for Electrical Equipment
- 1.4.1.6. UL 67 - Panelboards
- 1.4.1.7. UL 98 - Enclosed and Dead-front Switches
- 1.4.1.8. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures
- 1.4.1.9. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards
- 1.4.1.10. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers
- 1.4.1.11. NFPA 70 - National Electrical Code (NEC)
- 1.4.1.12. ASTM - American Society of Testing Materials

1.5. DELIVERY, STORAGE, AND HANDLING

- 1.5.1. Inspect and report concealed damage to carrier within their required time period.
- 1.5.2. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.
- 1.5.3. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

PART 2 - PRODUCTS

2.1. CIRCUIT BREAKER PANELBOARD – LIGHTING AND APPLIANCES

- 2.1.1. Interior
 - 2.1.1.1. Panelboards for up to 600Y/347 VAC maximum. Continuous main current ratings, as indicated on associated schedules and drawings, not to exceed 600 amperes for main breaker panelboards and not to exceed 800 amperes for main lug panelboards.
 - 2.1.1.2. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall

be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated [copper] [aluminum]. Bussing rated for 600 and 800 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.

- 2.1.1.3. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
- 2.1.1.4. A solidly bonded copper equipment ground bar shall be provided. An additional copper isolated/insulated ground bar shall also be provided.
- 2.1.1.5. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.
- 2.1.1.6. CSA and UL Listed panelboards with 200% rated solid neutral shall be plated copper for non-linear load applications. Panelboards shall be marked for non-linear load applications.
- 2.1.1.7. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting space.
- 2.1.1.8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA/UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
- 2.1.1.9. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 125A interiors shall be horizontally or vertically mounted. Main circuit breakers over 125A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
- 2.1.1.10. Interior phase bus shall be pre-drilled to accommodate field installable options. (i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs)
- 2.1.1.11. Interiors shall accept 125 ampere breakers (110 amperes when used in 600Y/347 applications) in group mounted branch construction.
- 2.1.1.12. Neutral bus shall be 200% rated, mounted on insulated supports.
- 2.1.1.13. Grounding bus bar shall be equipped with screws or lugs for the connection of equipment grounding conductors.
- 2.1.1.14. Bus bars shall be braced for the available short-circuit current as shown on the drawings, but not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 347/575 V panelboards.
- 2.1.1.15. In two-section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type panelboards, and have field-installed

cable connections to the second section as shown on the drawings. Panelboard sections with tapped bus or crossover bus are not acceptable.

- 2.1.1.16. Series-rated panelboards are not permitted.

2.1.2. Main Circuit Breaker

- 2.1.2.1. Main circuit breakers shall have an over-center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
- 2.1.2.2. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
- 2.1.2.3. Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be CSA and UL Listed for reverse connection without restrictive line or load markings.
- 2.1.2.4. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
- 2.1.2.5. Lugs shall be CSA and UL Listed to accept solid or stranded copper conductors. Lugs shall be suitable for 75° C rated wire according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
- 2.1.2.6. The circuit breakers shall be CSA and UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

2.1.3. Branch Circuit Breakers

- 2.1.3.1. Circuit breakers shall be CSA and UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules and drawings.
- 2.1.3.2. Molded case branch circuit breakers shall have bolt-on type bus connectors.
- 2.1.3.3. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.

- 2.1.3.4. The exposed faceplates of all branch circuit breakers shall be flush with one another.
 - 2.1.3.5. Lugs shall be UL Listed to accept solid or stranded copper conductors. Lugs shall be suitable for 75° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.
 - 2.1.3.6. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than 10,000 A symmetrical
 - 2.1.3.7. Circuit breaker features shall be as follows:
 - 2.1.3.7.1. A rugged, integral housing of molded insulating material.
 - 2.1.3.7.2. Silver alloy contacts.
 - 2.1.3.7.3. Arc quenchers and phase barriers for each pole.
 - 2.1.3.7.4. Quick-make, quick-break, operating mechanisms.
 - 2.1.3.7.5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
 - 2.1.3.7.6. Electrically and mechanically trip free.
 - 2.1.3.7.7. An operating handle which indicates closed, tripped, and open positions.
 - 2.1.3.7.8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
 - 2.1.3.8. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.
 - 2.1.3.9. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Update the panel directory accordingly
 - 2.1.3.10. Breaker shall be CSA and UL Listed with the following ratings: (15-125A) Heating, Air Conditioning, and Refrigeration (HACR), (15-30A) High Intensity Discharge (HID), (15-20A) Switch Duty (SWD), (15-50A) Equipment Protection Device (EPD).
- 2.1.4. Enclosures And Trims
- 2.1.4.1. Enclosures:
 - 2.1.4.1.1. Boxes shall be galvanized steel constructed in accordance with UL 50 requirements.
 - 2.1.4.1.2. NEMA rating as shown on the drawings or as required for the environmental conditions in which installed.
 - 2.1.4.1.3. Enclosures shall not have ventilating openings.
 - 2.1.4.1.4. Enclosures may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.
 - 2.1.4.1.5. Provide manufacturer's standard option for prepunched knockouts on top and bottom endwalls.
 - 2.1.4.1.6. Include removable inner dead front cover, independent of the panelboard cover.

2.1.4.2. Trims:

- 2.1.4.2.1. Hinged "door-in-door" type.
- 2.1.4.2.2. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
- 2.1.4.2.3. Outer hinged door shall be securely mounted to the panelboard enclosure with factory bolts, screws, clips, or other fasteners, requiring a key or tool for entry. Hand-operated latches are not acceptable.
- 2.1.4.2.4. Inner and outer doors shall open left to right.
- 2.1.4.2.5. Trims shall be flush or surface type as shown on the drawings.

2.1.5. Standard Of Acceptance

- 2.1.5.1. Schneider NF Series, Eaton, Square D, Siemens

2.2. POWER DISTRIBUTION PANELBOARD

2.2.1. Interior

- 2.2.1.1. Shall be rated 600 VAC or 250 VDC maximum. Continuous main current ratings as indicated on associated schedules and drawings not to exceed 1,200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
- 2.2.1.2. Provide UL Listed short circuit current ratings (SCCR) not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII.
- 2.2.1.3. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
- 2.2.1.4. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 100 through 600 amperes shall be plated copper. Bussing rated 800 amperes and above shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel-mounting pan by fasteners.
- 2.2.1.5. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.

- 2.2.1.6. A solidly bonded copper equipment ground bar shall be provided. An additional copper isolated/insulated ground bar shall also be provided.
 - 2.2.1.7. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. UL Listed panelboards with 200% rated solid neutrals shall have plated copper neutral bus for non-linear load applications. Gutter-mounted neutral will not be acceptable.
 - 2.2.1.8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label, and Short Circuit Current Rating shall be displayed on the interior or in a booklet format. Leveling provisions shall be provided for flush mounted applications.
- 2.2.2. Thermal magnetic molded case circuit breakers – below 400 A
- 2.2.2.1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
 - 2.2.2.2. Circuit breakers shall be standard interrupting. Ampere ratings shall be as shown on the drawings.
- 2.2.3. Electronic trip molded case full function 100% rated circuit breakers (above 400 Amp)
- 2.2.3.1. All electronic circuit breakers shall have the following time/current response adjustments: Long-Time Pickup, Long-Time Delay, and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - 2.2.3.2. Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated [schedule] [drawing].
 - 2.2.3.3. Local visual trip indication for overload, short circuit and ground fault trip occurrences.
 - 2.2.3.4. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
 - 2.2.3.5. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.
 - 2.2.3.6. Circuit breaker shall be provided with Zone selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as noted on [schedules] [drawings]
 - 2.2.3.7. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
- 2.2.4. Thermal magnetic molded case circuit breakers – below 400 A

- 2.2.4.1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
- 2.2.4.2. Circuit breakers shall be standard interrupting. Ampere ratings shall be as shown on the drawings.
- 2.2.5. Enclosures and Trim
 - 2.2.5.1. Enclosures
 - 2.2.5.1.1. Boxes shall be galvanized steel constructed in accordance with UL 50 requirements.
 - 2.2.5.1.2. NEMA rating as shown on the drawings or as required for the environmental conditions in which installed.
 - 2.2.5.1.3. Enclosures shall not have ventilating openings.
 - 2.2.5.1.4. Enclosures may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.
 - 2.2.5.1.5. Provide manufacturer's standard option for prepunched knockouts on top and bottom endwalls.
 - 2.2.5.1.6. Include removable inner dead front cover, independent of the panelboard cover.
 - 2.2.5.2. Trims:
 - 2.2.5.2.1. Hinged "door-in-door" type.
 - 2.2.5.2.2. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
 - 2.2.5.2.3. Outer hinged door shall be securely mounted to the panelboard enclosure with factory bolts, screws, clips, or other fasteners, requiring a key or tool for entry. Hand-operated latches are not acceptable.
 - 2.2.5.2.4. Inner and outer doors shall open left to right.
 - 2.2.5.2.5. Trims shall be flush or surface type as shown on the drawings.
- 2.2.6. Standard Of Acceptance
 - 2.2.6.1. Schneider I-Line Series, Eaton, Square D, Siemens

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- 3.1.2. Locate panelboards so that the present and future conduits can be conveniently connected.

- 3.1.3. Install a printed schedule of circuits in each panelboard. Schedules shall reflect final load descriptions, room numbers, and room names connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards
- 3.1.4. Mount panelboards such that the maximum height of the top circuit breaker above the finished floor shall not exceed 1980 mm (78 inches).
- 3.1.5. Provide blank cover for each unused circuit breaker mounting space.
- 3.1.6. For panelboards located in areas accessible to the public, paint the exposed surfaces of the trims with finishes to match surrounding surfaces after the panelboards have been installed. Do not paint nameplates
- 3.1.7. Rust and scale shall be removed from the inside of existing enclosures where new interior components are to be installed. Paint inside of enclosures with rust-preventive paint before the new interior components are installed. Provide new trim. Trim shall fit tight to the enclosure.
- 3.1.8. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.
- 3.1.9. Acceptance Checks and Tests
- 3.1.10. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 - 3.1.10.1. Compare equipment nameplate data with specifications and approved shop drawings.
 - 3.1.10.2. Inspect physical, electrical, and mechanical condition.
 - 3.1.10.3. Verify appropriate anchorage and required area clearances.
 - 3.1.10.4. Verify that circuit breaker sizes and types correspond to approved shop drawings.
 - 3.1.10.5. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.
- 3.1.11. Vacuum-clean enclosure interior. Clean enclosure exterior.

3.2. FOLLOW-UP VERIFICATION

- 3.2.1. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the panelboards are in good operating condition and properly performing the intended function.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. RELATED SECTIONS..... 2

1.2. REFERENCES..... 2

1.3. SUBMITTALS 2

PART 2 - PRODUCTS 2

2.1. BREAKERS GENERAL 2

2.2. GENERAL REQUIREMENTS..... 3

PART 3 - EXECUTION 3

3.1. INSTALLATION..... 3

3.2. FIELD QUALITY CONTROL 4

3.3. ADJUSTING..... 4

PART 1 - GENERAL

1.1. RELATED SECTIONS

- 1.1.1. Section: 26 24 16 Panelboards

1.2. REFERENCES

- 1.2.1. CAN/CSA-C22.2 No. 5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard, with UL 489 and NMX-J-266-ANCE-2010).
- 1.2.2. AN/CSA-C22.2 No. 144-M91 (R2011): Ground Fault Circuit Interrupters.
- 1.2.3. CAN/CSA-C22.2 No. 144.1- 06 (R2011): Ground-Fault Circuit-Interrupters (Tri-National standard, with UL 943 and NMX-J-520-ANCE).

1.3. SUBMITTALS

- 1.3.1. Submit product data in accordance with Section: 01 33 23 Shop Drawings, Product Data, and Samples.
- 1.3.2. Include time-current characteristic curves for breakers with ampacity of 200A and over or with interrupting capacity of 22,000A symmetrical (rms) and over at system voltage.
- 1.3.3. Acceptable Materials
 - 1.3.3.1. Schneider Electric Canada;
 - 1.3.3.2. Siemens Canada;
 - 1.3.3.3. Eaton Electric.

PART 2 - PRODUCTS

2.1. BREAKERS GENERAL

- 2.1.1. Molded case circuit breakers and Ground-fault circuit interrupters: to C22.2 NO. 5.
- 2.1.2. Comply with UL 489, NEMA AB 1, and NEMA AB 3, fully rated with interrupting capacity to comply with available fault currents.
- 2.1.3. Bolt-on moulded case circuit breakers: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- 2.1.4. Common-trip breakers: with single handle for multi-pole applications.
- 2.1.5. Magnetic instantaneous trip elements in circuit breakers to operate only when the value of the current reaches the setting.

- 2.1.6. Trip settings on breakers with adjustable trips to range of 3 to 8 times the rated current.
- 2.1.7. Provide pad locking devices where indicated on breakers to lock the handle of a breaker in the "on" or "off" position with the trip units to remain free to function and protect the circuit from both overload and short circuit conditions.

2.2. GENERAL REQUIREMENTS

- 2.2.1. Circuit breakers 250 Amps and larger shall be rated to carry 100% of their current rating continuously.
- 2.2.2. Thermal-Magnetic Circuit Breakers:
 - 2.2.2.1. Molded case circuit breakers to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
 - 2.2.2.2. Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A up to 400 A.
 - 2.2.2.3. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- 2.2.3. Solid State Trip Breakers (LSI)
 - 2.2.3.1. Moulded case circuit breakers to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for circuit protection.
 - 2.2.3.2. Electronic Trip Circuit Breakers: 400 A and larger. Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 2.2.3.3. Instantaneous trip.
 - 2.2.3.4. Long- and short-time pickup levels.
 - 2.2.3.5. Long- and short-time time adjustments.
 - 2.2.3.6. Ground-fault pickup level, time delay, and I^2t response
- 2.2.4. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
- 2.2.5. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

PART 3 - EXECUTION

3.1. INSTALLATION

3.1.1. Circuit breakers in panelboards shall be factory installed.

3.1.2. Install individual breakers where indicated.

3.1.3. New Circuit Breakers in Existing Panelboards:

3.1.3.1. Circuit breakers shall be of standard manufacture and match existing devices.

3.1.3.2. Circuit breakers shall be "bolt-on" type.

3.1.3.3. Circuit breakers shall have an AIC rating compatible with the Building's short circuit analysis report.

3.2. FIELD QUALITY CONTROL

3.2.1. Perform tests and inspections.

3.2.2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.2.3. Acceptance Testing Preparation:

3.2.3.1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

3.2.3.2. Test continuity of each circuit.

3.2.4. Tests and Inspections:

3.2.4.1. Perform each visual and mechanical inspection and electrical test stated in Acceptance Testing Specification. Certify compliance with test parameters.

3.2.4.2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.2.4.3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

3.2.4.4. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.2.4.5. Prepare test and inspection report, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.3. ADJUSTING

3.3.1. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

- 3.3.2. Set field-adjustable circuit-breaker trip ranges. Provide list of “as left” settings and submit to Client

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. SUBMITTALS 2

1.4. APPLICABLE PUBLICATIONS 3

PART 2 - PRODUCTS 3

2.1. PANELBOARD-MOUNTED FUSED DISCONNECTS..... 3

2.2. FUSED DISCONNECT SWITCHES RATED 600 AMPERES AND LESS 4

2.3. UNFUSED DISCONNECT SWITCHES RATED 600 AMPERES AND LESS 5

2.4. CIRCUIT BREAKER TYPE DISTRIBUTION PANELS 5

2.5. MOTOR RATED TOGGLE SWITCHES..... 6

2.6. CARTRIDGE FUSES..... 6

2.7. MOLDED CASE CIRCUIT BREAKERS 6

PART 3 - EXECUTION 7

3.1. INSTALLATION..... 7

3.2. MOLDED CASE CIRCUIT BREAKER..... 7

3.3. FUSES 7

3.4. IDENTIFICATION..... 7

3.5. ACCEPTANCE CHECKS AND TESTS 8

3.6. SPARE PARTS..... 8

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the furnishing, installation, and connection of fused and unfused disconnect switches (indicated as switches in this section), circuit breaker distribution panels and separately-enclosed circuit breakers for use in electrical systems rated 600 V and below.

1.2. RELATED WORK

- 1.2.1. Section: 26 05 00 Common Work Results for Electrical.
- 1.2.2. Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables.
- 1.2.3. Section: 26 05 33 Raceway and Boxes for Electrical Systems.

1.3. SUBMITTALS

- 1.3.1. Submit the following.
 - 1.3.1.1. Shop Drawings:
 - 1.3.1.1.1. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - 1.3.1.1.2. Submit the following data for approval:
 - 1.3.1.1.3. Electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, fuses, circuit breakers, wiring and connection diagrams, accessories, and device nameplate data.
 - 1.3.1.2. Manuals:
 - 1.3.1.2.1. Submit complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering fuses, circuit breakers, and replacement parts.
 - 1.3.1.2.2. Include schematic diagrams, with all terminals identified, matching terminal identification in the enclosed switches and circuit breakers.
 - 1.3.1.2.3. Include information for testing, repair, troubleshooting, assembly, and disassembly.
 - 1.3.1.2.4. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
 - 1.3.1.2.5. Certifications: Two weeks prior to final inspection, submit the following.
 - 1.3.1.2.6. Certification by the manufacturer that the enclosed switches and circuit breakers conform to the requirements of the drawings and specifications.
 - 1.3.1.2.7. Certification by the Contractor that the enclosed switches and circuit breakers have been properly installed, adjusted, and tested.

1.4. APPLICABLE PUBLICATIONS

- 1.4.1. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- 1.4.2. CAN/CSA-22.2
 - 1.4.2.1. CAN/CSA-C22.2 No. 4-04 (R2009), Enclosed Switches.
 - 1.4.2.2. CAN/CSA C22.2 NO.39-M1987 (R2007) Fuseholder Assemblies).
- 1.4.3. National Electrical Manufacturers Association (NEMA):
 - 1.4.3.1. Low Voltage Cartridge Fuses
 - 1.4.3.2. Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- 1.4.4. National Fire Protection Association (NFPA):
 - 1.4.4.1. 70-11 National Electrical Code (NEC)
- 1.4.5. Underwriters Laboratories, Inc. (UL):
 - 1.4.5.1. 98-07 Enclosed and Dead-Front Switches
 - 1.4.5.2. 248-00 Low Voltage Fuses
 - 1.4.5.3. 489-09 Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

2.1. PANELBOARD-MOUNTED FUSED DISCONNECTS

- 2.1.1. Circuit breakers shall be per CAN/CSA22.2 #4, UL, NEC, as shown on the drawings, and as specified.
- 2.1.2. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory accordingly.
- 2.1.3. Circuit breakers shall be bolt-on type.
- 2.1.4. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
 - 2.1.4.1. 120/208 V Panelboard: 10,000 A symmetrical.
 - 2.1.4.2. 120/240 V Panelboard: 10,000 A symmetrical.
 - 2.1.4.3. 347/575 V Panelboard: 14,000 A symmetrical.

- 2.1.4.4. Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for less than 400 A frame. Circuit breakers with 400 A frames and above shall have magnetic trip, adjustable from 5x to 10x.

2.1.5. Circuit breaker features shall be as follows:

- 2.1.5.1. A rugged, integral housing of molded insulating material.
- 2.1.5.2. Silver alloy contacts.
- 2.1.5.3. Arc quenchers and phase barriers for each pole.
- 2.1.5.4. Quick-make, quick-break, operating mechanisms.
- 2.1.5.5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
- 2.1.5.6. Electrically and mechanically trip free.
- 2.1.5.7. An operating handle which indicates closed, tripped, and open positions.
- 2.1.5.8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
- 2.1.5.9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.

2.2. FUSED DISCONNECT SWITCHES RATED 600 AMPERES AND LESS

- 2.2.1. Switches shall be in accordance with CAN/CSA22.2 #4, NEMA, NEC, UL, as specified, and as shown on the drawings.
- 2.2.2. Shall be NEMA classified General Duty (GD) for 240 V switches, and NEMA classified Heavy Duty (HD) for 575 V switches.
- 2.2.3. Shall be horsepower (HP) rated.
- 2.2.4. NEMA 1 (indoor applications), NEMA 3R (outdoor or wet environment))
- 2.2.5. Shall have the following features:
 - 2.2.5.1. Switch mechanism shall be the quick-make, quick-break type.
 - 2.2.5.2. Copper blades, visible in the open position.
 - 2.2.5.3. An arc chute for each pole.
 - 2.2.5.4. External operating handle shall indicate open and closed positions, and have lock open padlocking provisions.
 - 2.2.5.5. Mechanical interlock shall permit opening of the door only when the switch is in the open position, defeatable to permit inspection.
 - 2.2.5.6. Fuse holders for the sizes and types of fuses specified.

- 2.2.5.7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
- 2.2.5.8. Ground lugs for each ground conductor.
- 2.2.6. Enclosures:
 - 2.2.6.1. Shall be the NEMA types shown on the drawings.
 - 2.2.6.2. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
 - 2.2.6.3. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel.
- 2.2.7. Standards of Acceptance: Eaton, Cutler Hammer, Siemens, Square D
- 2.3. **UNFUSED DISCONNECT SWITCHES RATED 600 AMPERES AND LESS**
 - 2.3.1. Shall be the same as fused switches, but without provisions for fuses.
 - 2.3.2. Standards of acceptance: same as fused disconnects
- 2.4. **CIRCUIT BREAKER TYPE DISTRIBUTION PANELS**
 - 2.4.1. Distribution panels conforming to CSA C22.2 no. 29 standard.
 - 2.4.2. Supplied by the same and only manufacturer.
 - 2.4.3. As specified on the drawings
 - 2.4.4. Arrange bus bars per phase order. All circuits shall be identified by a letter, as shown on drawings.
 - 2.4.5. Panels shall have bus bars, and number of branch circuits and circuit breakers as shown.
 - 2.4.6. Panels to be complete with door, lock and two keys, locks and keys to be interchangeable for all panels of the same type.
 - 2.4.7. Bus bars shall be copper as the supports and circuit breakers material have the same expansion coefficients, with full capacity neutral.
 - 2.4.8. For surface or flush mounting as shown on drawings.
 - 2.4.9. Panel bus bars to be compatible with bolted-on circuit breakers.
 - 2.4.10. Standard finish: ASA 61 grey baked enamel.
 - 2.4.11. Circuit breakers: conforming to article "Molded Case Circuit Breakers" described herein.
 - 2.4.12. The grounding bus bar shall conform to article Grounding and Bonding.

2.4.13. Acceptable manufacturers:

2.4.13.1. Eaton, Siemens, GE.

2.5. MOTOR RATED TOGGLE SWITCHES

2.5.1. Not applicable

2.6. CARTRIDGE FUSES

2.6.1. Shall be in accordance with CSA C22.2 no. 106 and C22.2 no. 248 standards.

2.6.2. High rupturing capacity (HRC) fuses 200kA RMS symmetrical and current limiting fuses.

2.6.3. Supplied by the same and only manufacturer.

2.6.4. Service Entrance: Class L, fast acting.

2.6.5. Feeders: Class L, fast acting

2.6.6. Motor and Transformer Branch Circuits: Class RK1 time delay.

2.6.7. Other Branch Circuits: Class J (less than 600A) or Class L (over 600A), fast acting.

2.6.8. Control Circuits: Class CC fast acting

2.6.9. Standard of Acceptance: Cooper Busman, Eaton

2.7. MOLDED CASE CIRCUIT BREAKERS

2.7.1. Molded case circuit breakers conforming to CSA C22.2 no. 5 standard.

2.7.2. Circuit protection devices contained in plastic insulated enclosures.

2.7.3. Bolted to the panel bus bars.

2.7.4. Quick make quick break mechanism.

2.7.5. Manually operated.

2.7.6. Complete with thermal and magnetic trip unit compensated for an ambient temperature of 40 °C (104 °F).

2.7.7. Multi-pole breakers to have a common trip device and operating lever.

2.7.8. In 120 or 208 Volts circuits use, unless otherwise noted on the distribution diagram or on the panel description sheets, single, two or three pole circuit breakers having the ratings as shown and with a 10 kA minimum RMS, symmetrical rupturing capacity.

2.7.9. Authentication of new breakers (not counterfeited)

- 2.7.9.1. Except otherwise noted, all breakers installed in panels (new or existing) shall be new and obtained exclusively from a distributor authorized by manufacturer.
- 2.7.9.2. Submit with breaker shop drawings, a copy of the purchase order to the distributor. Quantities, models and sizes shown on the purchase order shall correspond to those indicated on the shop drawings.

PART 3 - EXECUTION

3.1. INSTALLATION

- 3.1.1. Installation shall be in accordance with the manufacturer's instructions, the CEC, as shown on the drawings, and as specified.
- 3.1.2. Fused switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuses.
- 3.1.3. All disconnect switches and fuses supplied by the same manufacturer.
- 3.1.4. Safety switches in the circuit between a motor and a variable frequency drive shall be fitted with one type C auxiliary contact. Connect this contact to the variable frequency drive with two (2) # 14 AWG conductors inside a 12 mm (½") conduit.

3.2. MOLDED CASE CIRCUIT BREAKER

- 3.2.1. Install circuit breakers and connect as shown.
- 3.2.2. When a panel is replaced with a new one, the contractor shall verify the compatibility of the existing breakers with the new panel type. New breakers shall be supplied if the existing breakers are not compatible with the new panel and cannot be relocated.

3.3. FUSES

- 3.3.1. Install fuses in fuse holders just before energizing.
- 3.3.2. Ensure that fuses and holders are perfectly matched.
- 3.3.3. Ensure that the right fuse is used to protect the corresponding circuit.
- 3.3.4. Store the spare fuses in an orderly manner

3.4. IDENTIFICATION

- 3.4.1. Identify switches, as to equipment served, with engraved laminated phenolic name plates.

3.5. ACCEPTANCE CHECKS AND TESTS

3.5.1. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

3.5.2. Visual Inspection and Tests:

- 3.5.2.1. Compare equipment nameplate data with specifications and approved shop drawings.
- 3.5.2.2. Inspect physical, electrical, and mechanical condition.
- 3.5.2.3. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

3.5.3. Vacuum-clean enclosure interior. Clean enclosure exterior.

3.6. SPARE PARTS

3.6.1. Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fused disconnect switch installed on the project. Deliver to the Board representative.

TABLE OF CONTENTS

PART 1 - GENERAL 2

1.1. DESCRIPTION 2

1.2. RELATED WORK 2

1.3. QUALITY ASSURANCE 2

1.4. SUBMITTALS 2

1.5. APPLICABLE PUBLICATIONS..... 3

PART 2 - PRODUCTS 3

2.1. LIGHTING FIXTURES 3

2.2. LED EXIT LIGHT FIXTURES 4

2.3. LED LIGHT FIXTURES 5

PART 3 - EXECUTION 5

3.1. INSTALLATION..... 5

3.2. ACCEPTANCE CHECKS AND TESTS 7

3.3. FOLLOW-UP VERIFICATION 7

PART 1 - GENERAL

1.1. DESCRIPTION

- 1.1.1. This section specifies the furnishing, installation, and connection of the interior lighting systems. The terms "lighting fixture," "fixture," and "luminaire" are used interchangeably.

1.2. RELATED WORK

- 1.2.1. Section: 26 05 00 Common Work Results for Electrical
- 1.2.2. Section: 26 05 19 Low-Voltage Electrical Power Conductors and Cables
- 1.2.3. Section: 26 05 26 Grounding and Bonding for Electrical Systems

1.3. QUALITY ASSURANCE

- 1.3.1. Quality Assurance shall be in accordance with Section: 26 05 00 Common Work Results for Electrical.

1.4. SUBMITTALS

- 1.4.1. Submit the following information for each type of lighting fixture:

- 1.4.1.1. Material and construction details, include information on housing and optics system.
- 1.4.1.2. Physical dimensions and description.
- 1.4.1.3. Wiring schematic and connection diagram.
- 1.4.1.4. Installation details.
- 1.4.1.5. Energy efficiency data.
- 1.4.1.6. Photometric data based on laboratory tests complying with IES Lighting Measurements testing and calculation guides.
- 1.4.1.7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours), and color temperature (degrees Kelvin).
- 1.4.1.8. For LED lighting fixtures, IES L70 rated life.

- 1.4.2. Manuals:

- 1.4.2.1. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
- 1.4.2.2. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

1.4.3. Certifications: Two weeks prior to final inspection, submit the following.

1.4.3.1. Certification by the Contractor that the interior lighting systems have been properly installed and tested.

1.5. APPLICABLE PUBLICATIONS

1.5.1. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

1.5.2. American Society for Testing and Materials (ASTM):

1.5.2.1. C635/C635M-22 Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings

1.5.3. Illuminating Engineering Society of North America (IESNA):

1.5.3.1. LM-79-19 Electrical and Photometric Measurements of Solid-State Lighting Products

1.5.3.2. LM-80-21 Measuring Lumen Maintenance of LED Light Sources

1.5.3.3. LM-82-19 Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature

1.5.4. Institute of Electrical and Electronic Engineers (IEEE):

1.5.4.1. C62.41-91(R1995) Surge Voltages in Low Voltage AC Power Circuits

PART 2 - PRODUCTS

2.1. LIGHTING FIXTURES

2.1.1. Shall be in accordance with NFPA, UL, as shown on drawings, and as specified.

2.1.2. Sheet Metal:

2.1.2.1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.

2.1.2.2. Wireways and fittings shall be free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.

2.1.2.3. When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.

2.1.2.4. Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.

2.1.3. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

2.1.4. Metal Finishes:

2.1.4.1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.

2.1.4.2. Interior light reflecting finishes shall be white with not less than 85 percent reflectance, except where otherwise shown on the drawing.

2.1.5. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

2.1.6. Light Transmitting Components for Fluorescent Fixtures:

2.1.6.1. Shall be 100 percent virgin acrylic.

2.1.6.2. Flat lens panels shall have not less than 3 mm (1/8 inch) of average thickness.

2.1.6.3. Unless otherwise specified, lenses, reflectors, diffusers, and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction without distortion or cracking.

2.2. LED EXIT LIGHT FIXTURES

2.2.1. Exit light fixtures shall meet applicable requirements of NFPA and UL.

2.2.2. Housing and door shall be die-cast aluminum.

2.2.3. For general purpose exit light fixtures, door frame shall be hinged, with latch. For vandal-resistant exit light fixtures, door frame shall be secured with tamper-resistant screws.

2.2.4. Finish shall be satin or fine-grain brushed aluminum.

2.2.5. There shall be no radioactive material used in the fixtures.

2.2.6. Fixtures:

2.2.6.1. Inscription panels shall be cast or stamped aluminum a minimum of 2.25 mm (0.090 inch) thick, stenciled with 150 mm (6 inch) high letters, baked with red

color stable plastic or fiberglass. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass.

2.2.6.2. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.

2.2.6.3. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.

2.2.7. Voltage: Multi-voltage (120 – 277V).

2.3. LED LIGHT FIXTURES

2.3.1. General:

2.3.1.1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.

2.3.1.2. LED drivers shall include the following features unless otherwise indicated:

2.3.1.2.1. Minimum efficiency: 85% at full load.

2.3.1.2.2. Minimum Operating Ambient Temperature: -20° C. (-4° F.)

2.3.1.2.3. Input Voltage: 120 - 277V (±10%) at 60 Hz.

2.3.1.2.4. Integral short circuit, open circuit, and overload protection.

2.3.1.2.5. Power Factor: ≥ 0.95.

2.3.1.2.6. Total Harmonic Distortion: ≤ 20%.

2.3.1.2.7. Comply with FCC 47 CFR Part 15.

2.3.1.3. LED modules shall include the following features unless otherwise indicated:

2.3.1.3.1. Comply with IES LM-79 and LM-80 requirements.

2.3.1.3.2. Minimum CRI: 80 or higher. Minimum Color Fidelity Index (IES Rf): 80 or higher.

2.3.1.3.3. Color temperature between 3500K - 4000K.

2.3.1.3.4. Minimum Rated Life: 50,000 hours per IES L70.

2.3.1.3.5. Acceptable Manufacturers: Columbia Lighting, Cooper Lighting, and Nora Lighting

PART 3 - EXECUTION

3.1. INSTALLATION

3.1.1. Installation shall be in accordance with the NEC, manufacturer's instructions, and as shown on the drawings or specified.

3.1.2. Align, mount, and level the lighting fixtures uniformly.

- 3.1.3. Provide two-way and three-way switches as noted on the drawings and as required to operate the new lighting fixtures
- 3.1.4. Wall-mounted fixtures shall be attached to the studs in the walls, or to a 20 gauge metal backing plate that is attached to the studs in the walls. Lighting fixtures shall not be attached directly to gypsum board.
- 3.1.5. Lighting Fixture Supports:
- 3.1.5.1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.
 - 3.1.5.2. Shall maintain the fixture positions after cleaning and relamping.
 - 3.1.5.3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
 - 3.1.5.4. Surface mounted lighting fixtures:
 - 3.1.5.4.1. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts (or stud clips) shall be minimum 6 mm (1/4 inch) bolt, secured to main ceiling runners and/or secured to cross runners. Non turning studs may be attached to the main ceiling runners and cross runners with special non friction clip devices designed for the purpose, provided they bolt through the runner, or are also secured to the building structure by 12 gauge safety hangers. Studs or bolts securing fixtures weighing in excess of 25 kg (56 pounds) shall be supported directly from the building structure.
 - 3.1.5.4.2. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.
 - 3.1.5.4.3. Fixtures less than 6.8 kg (15 pounds) in weight and occupying less than 3715 sq cm (two square feet) of ceiling area may, when designed for the purpose, be supported directly from the outlet box when all the following conditions are met.
 - Screws attaching the fixture to the outlet box pass through round holes (not key hole slots) in the fixture body.
 - The outlet box is attached to a main ceiling runner (or cross runner) with approved hardware.
 - The outlet box is supported vertically from the building structure.
 - 3.1.5.4.4. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.
 - 3.1.5.5. Single or double pendant mounted lighting fixtures:
 - 3.1.5.5.1. Each stem shall be supported by an approved outlet box mounted swivel joint and canopy which holds the stem captive and provides spring load (or

approved equivalent) dampening of fixture oscillations. Outlet box shall be supported vertically from the building structure.

- 3.1.5.6. Outlet boxes for support of lighting fixtures (where permitted) shall be secured directly to the building structure with approved devices or supported vertically in a hung ceiling from the building structure with a nine gauge wire hanger, and be secured by an approved device to a main ceiling runner or cross runner to prevent any horizontal movement relative to the ceiling.
- 3.1.6. Furnish and install the new lamps as specified for all lighting fixtures installed under this project, and for all existing lighting fixtures reused under this project.
- 3.1.7. The electrical and ceiling trades shall coordinate to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges, etc.), to match the ceiling system being installed.
- 3.1.8. Bond lighting fixtures to the grounding system as specified in Section: 26 05 26 Grounding and Bonding for Electrical Systems.

3.2. ACCEPTANCE CHECKS AND TESTS

- 3.2.1. Perform the following:
 - 3.2.1.1. Visual Inspection:
 - 3.2.1.1.1. Verify proper operation by operating the lighting controls.
 - 3.2.1.1.2. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.
- 3.2.2. Electrical tests:
 - 3.2.2.1. Observe for visually detectable flicker and replace defective components at no cost to the Board.
 - 3.2.2.2. Burn-in all lamps that require specific aging period to operate properly, prior to project hand-over to the Board. Burn-in period to be 40 hours minimum, unless specifically recommended otherwise by the lamp manufacturer.

3.3. FOLLOW-UP VERIFICATION

- 3.3.1. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting systems are in good operating condition and properly performing the intended function.