INFRASTRUCTURE ONTARIO

2017 BUILDING SYSTEMS COMMISSIONING GUIDELINE – PMSP

This document is intended for use by:

Ministry and Infrastructure Ontario Program Planners
Infrastructure Ontario Senior Project Managers and Project Services Managers
Property Land Management Service Provider
Project Management Service Providers
Vendors including Design Consultants
Commissioning Authorities and Contractors

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1. ABOUT THIS GUIDELINE

The purpose of this guideline is to set out the commissioning process for new buildings, systems and equipment installed by IO's Project Management Service Providers (PMSP) and Property and Land Management Services Providers (PLMSP) operating under the Master Services Agreement between IO and each PMSP and PLMSP. The guideline describes the minimum requirements and limitations of the required commissioning services for projects delivered by PMSPs or PLMPS through the planning, execution and close out phases of the work. It is bound by the relevant articles in the MSA, which requires the PMSP to provide acceptable and appropriate commissioning of operating systems and equipment as a part of the services.

The intent of this guideline is to ensure building equipment performs as specified and originally intended as per IO Design Guidelines, installation of equipment meets contract specifications, the commissioning of building systems/equipment, sequence of operations have been verified to on site conditions, and the total performance/integration of new equipment/systems are fully commissioned.

Studies must identify existing building conditions and identify available options based on performance, efficient operation, operating, and capital costs. The options identified in the study shall include Life Cycle Cost Analysis, payback, implementation and preventive maintenance costs, energy savings, and return on investment up to a 25 year period, with a full integration with this guide.

Design solutions are to be based on the studies and confirmed by the Design Engineer. The design engineer is responsible for the overall design and performance and integration of building systems to ensure that they are specified, installed, commissioned and equipment is operating within their design including the requirements of the bid documents, with a full integration with this guide.

Building systems installations are to ensure that the contractor has supplied and installed the equipment and is operating as originally specified and intended to operate. The contractor and consultant are to ensure that final sequence of operations are completed and adjusted throughout the commissioning and warranty process as required.

References are made to ASHRAE Commissioning Guideline 0 in various sections, but IO Commissioning Guideline does not reiterate those procedures that are very familiar to the design and construction industry. It is more heavily focused on the initiation and outcomes of commissioning specific to IO's projects, than the commissioning process. Any definitions that differ from ASHRAE definitions are acknowledged.

In this guideline, the traditional ASHRAE term "Owner" is sometimes represented by the term "stakeholder". Projects undertaken by PMSP will have multiple stakeholders each of who have specific "owner" interests to be verified through the commissioning process.

2. DEFINITION

This guideline uses definitions included in ASHRAE Commissioning Guideline 0, the PMSP MSA, the IO Design Guideline, the IO Sustainability Standards, and other IO contractual documents. Additional information regarding the Project Delivery processes described below is found in the Asset Management Project Delivery Methodology matrices and process maps.

Asset Management: IO's business unit responsible for management of the portfolio of government owned and leased properties through the services of the PLMSP. Asset Management also oversees project delivery undertaken by the Project Management Service Provider(s).

Building Systems: The dynamic operating systems in a building that will be subject to the commissioning process, including but not limited to: HVAC, automation, refrigeration, plumbing, power and lighting, life safety, fire protection, vertical transportation, site services, communication and signal, audio visual, security, food preparation and storage, and other specialized systems. In this guideline, Building Systems includes specialized equipment or systems included in the construction that may be provided for customer programs, such as security systems, CCTV, uninterruptible power supplies and computer room cooling systems. The building envelope including roofing assembly (while not a dynamic system) is also considered a building system for the purposes of this guideline.

Checklists: Verification checklists that are developed and used during all phases of the commissioning process to verify that the owners project requirements are being achieved. This includes checklists for general verification, plus testing, training and other specific requirements.

CMMS (Computerized Maintenance Management System) Asset Update Forms: a tabular process to record specific data on every piece of building equipment that is added, changed, removed or replaced within the scope of the project, to be included in the project O&M manuals, and deliver to the PLMSP CMMS database for inventory and lifecycle maintenance management.

Commissioning (Process): a quality assurance oriented process that ensures the building systems and assemblies perform interactively according to the design document, and that the stakeholders' objectives and operational criteria are achieved through a process of planning, testing, verifying, and documenting the performance of the facilities as it is constructed, and where necessary through seasonal commissioning after occupancy.

Commissioning Authority: an individual or firm identified by the PMSP who will lead, plan, and schedule and coordinate the activities to implement the commissioning process. The commissioning authority may be the project design consultants for lower complexity projects, or another specialist retained by the PMSP. This definition reflects IO's model and may be slightly at variance from the ASHRAE definition. See also: Independent Commissioning Authority.

Commissioning Plan: a document prepared by the commissioning authority to set out the organization, schedule, specifications, and documentation requirements of the Commissioning Process for inclusion in tender documents as a draft, with fine tuning of plan when shop drawings are received

Commissioning Reports: functional performance verification reports, test data records, performance reports etc that record the commissioning results for every item of equipment, assembly, or entire system as described in the commissioning plan.

Commissioning Verification Forms: an IO template to record the completion of commissioning work that is documented in detail in the commissioning reports

Commissioning Issues Log: a formal and ongoing record of problems or concerns, and their resolutions, during the course of the Commissioning Process, and included in the Final Commissioning Report.

Contractor commissioning: commissioning activities on non-complex projects carried out by the contractor following a basic commissioning plan, but not necessarily needing a commissioning authority.

Design Review - Commissioning: a review of the design documents to determine compliance with the Owner's Project Requirements, including coordination between systems and assemblies being commissioned, features and access for testing, commissioning and maintenance, and other reviews required by the commissioning plan.

Independent Commissioning Authority: a commissioning specialist who is independent of the design team engaged by the PMSP who leads, plans, and schedules and coordinates the commissioning team to implement the

commissioning process for complex or LEED projects. This term "independent" reflects IO's model and may be slightly at variance from the ASHRAE definition.

Ministry Scope Definition Document: a checklist used by the Ministry to identify in scope requirements of a project. It is submitted as an attachment to the Project Services Initiation form.

Operations and Maintenance (O&M) Manual "Schedule B": systems-focused composite document of use to the building operator and owner during the occupancy and operation phase, which includes the owner's requirements, operating manual, maintenance manual and additional information such as warranties. Each O&M manual shall include an electronic copy in searchable PDF format of the manual on a USB drive in the back of the manual.

Owner: the various project stakeholders, being IO, its PLMS, and its customer ministries, each of which may have program specific requirements and deliverables that may vary between building types and regions.

Owner's Project Requirements (OPR): The IO Design Guideline, a document that details the scope of the project and the expectations of how it will be used and operated. For IO projects, the OPR is:

- PJ (project justification document) for the project.
- Attachments to the project PJ
- Charter for project as agreed with owner

Post Occupancy Commissioning: the detailed calibration of the systems and equipment designed to control the indoor environment, through a full cycle of four seasons (usually 12 months or longer, commencing from the date of Substantial Performance), to maximize the building efficiency and occupant comfort.

Project Bid Documents: a collection of written documents including bid information and forms, contract forms and conditions, and drawings, specifications and schedules, the combination of which provides all particulars required to complete the construction project, including commissioning specifications for each trade.

Project Charter: the IO form used to confirm the client/stakeholders' scope, schedule, budget and other delivery considerations in the initiation stage of a project or study

Project Management Service Providers (PMSP): an entity engaged by IO to provide all services required to deliver projects in accordance with the MSA. In this Guideline the term "PMSP" means any employee of the PMSP team.

Project Justification Form (PJF): a form prepared by IO, or its PLMSP to identify scope and funding requirements related to upcoming capital repairs and replacements.

Project Services Initiation Form (PSIF): the form prepared by customer ministries to authorize funding and request initiation of a customer funded project.

Project Service Manager (PSM): the IO project manager (IO Representative) who oversees the PMSP's activities at a regional level, to ensure delivery of projects to meet owner's needs.

Project Delivery Methodology: the business process designed in accordance with PMI principles that prescribe each discrete element and sub element for delivery of a design and construction or study project to be delivered by PMSPs. The elements are organized in phases described as "Initiation, Planning, Execution and Close Out".

Startup Checklist: the record of the initial starting or activating of systems and equipment, including completion of construction checklists.

Scope of Work: means the description of the project scope as approved by the client through the project charter.

Training Plan: a written document that details the expectations, schedules, budget and deliverables of commissioning process activities, related to training of project operating and maintenance personnel, users and occupants.

Verification: the process by which specific components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Bid documents and the project requirements. Verification onsite will include at least 10% of input/output devices including terminal units such as VAV boxes, 100% of supply and generating systems, along with testing of 100% of sequences of operation.

3. INTRODUCTION

3.1 PREAMBLE

Traditionally, the term "commissioning" generally means testing and acceptance of only individual components and systems of newly constructed facilities such as the HVAC systems, elevators, electrical and life safety systems. Today, with increasing concerns of meeting energy targets, emphasis on the green environment, increased complexity of building systems, equipment, assemblies, new materials, and the impact on the environment and sustainability, there is a renewed emphasis on commissioning as an important part of ensuring sustainability targets are met in new construction, and also through the operating life cycle of our buildings. In this context, commissioning will sometimes extend to static elements of buildings such as building envelope (doors, windows, and cladding and roof systems) which are a key part of overall building performance.

IO has many commitments to sustainability established through assessment and target exercises, and companywide targets. In 2008, IO established sustainability objectives that are now embedded in its corporate goals, including reducing electrical demand, increasing waste diversion, extended certification of buildings, and responding to a sustainability framework. In 2007, the Government adopted the LEED framework as the standard for all new Ontario Government buildings that meet established criteria. Commissioning by a third party is a mandatory component of LEED certification. The Government is expected to direct (within parameters described later), that new buildings and major building retrofits will be designed to achieve LEED silver as a base level certification. Within the certification, there will be mandatory LEED credits related to re-commissioning procedures to maintain the LEED levels of operational performance throughout the lifecycle of the building.

IO projects delivered by PMSPs by nature are "situational", meaning that the commissioning requirements for each project will vary according to the project scope, cost, complexity, and various other project specific factors. For this reason these guidelines are scalable for various project sizes and types, and can be adjusted at the project charter stages by default and exception mechanisms, as mentioned in the **IO Design Guideline.**

3.2 SCOPE

The intended audience for this guideline includes:

- Ministry and IO Program Planners
- Property Land Management Service Provider (PLMSP)
- Project Management Service Providers (PMSPs)
- Commissioning Authorities, Consultants and Contractors (if no Consultant engagement), and
- Project Services Managers (PSMs)

Supplementary technical guidelines for any given system or assembly are not included, but may be developed later by IO if required to provide specific information on specialized systems. When using this guideline, the user should always check the PMO Web portal to ensure they have the most current version.

This guideline is organized around the project management principles established by the Project Management Institute (PMI), being the framework for the business processes in the Project Services business model, and embedded in the articles of the Master Services Agreement. It includes principles from the ASHRAE Commissioning Guideline 0 "The Commissioning Process".

This guideline describes the application of the Commissioning process for the entire project life cycle beginning with project identification in the Program Planning phase followed by the Initiation, Planning, Execution, and Close Out phases as summarized below:

- **Program Planning and Project Identification Phase** identifies the Owner's Project Requirements and commissioning requirements including the identification of specific CMMS forms.
- **Initiation Phase** describes the intended commissioning process as established by IO in the project charter.

- **Planning Phase** The Commissioning Authority sets out the commissioning requirements, including the equipment specific CMMS forms for existing equipment to be modified and/or removed, during the project design work.
- **Execution Phase** describes the requirements for start-up, verification, seasonal performance testing, and training during the construction stage, including post-occupancy Fine Tuning and final submission of CMMS forms for new equipment.
- **Close Out phase** describes the handover documents and requirements for post occupancy commissioning at the close out stage of the project, and re commissioning where it applies.

3.3 APPLICATION

The unique nature of any project (or program of similar projects) means that each project will require its own documentation, performance criteria, and checklists for each system or assembly to be commissioned. Throughout, references to process thresholds, codes, other guidelines and industry references should be considered as the minimum, whereas the project stakeholders have more stringent requirements, Owner Project Requirements that may modify or replace the benchmark for verifying the requirement. This includes hiring an independent commissioning authority as per schedule A & C or if requested by IO or its representatives.

3.4 GOVERNANCE

Ministry Accommodation Planners and PLMS Facility Managers are responsible for project identification and ensuring commissioning requirements comply with this guideline.

IO Staff (Director, Portfolio Real Estate Manager, Project Services Managers and Technical Services Team) is responsible for an initial definition of the commissioning deliverables in the project charter. Also, to review and approve a project charter, approve an acceptable Commissioning Plan, and oversee PMSP compliance with the approved commissioning activities

The PMSP is responsible to refine and confirm the commissioning requirements in the project charter, including all associated costs. The PMSP is responsible for preparation of a commissioning plan (via the design consultant or commissioning authority) to define roles and responsibilities in accordance with IO requirements.

4. INITIATION PHASE

4.1 OBJECTIVE

The objective in this phase is to ensure that planning for commissioning proceeds in an organized manner as per this guideline to ensure the project charter is complete and accurate, and to avoid project charter changes after approval. A properly defined project charter is the cornerstone of an effective commissioning program.

4.2 PROJECT INITIATION

In the project delivery methodology, the Initiation Phase includes all processes beginning with a request to initiate a project through a PSIF or a PJF, to where a consultant is retained by the PMSP to begin design. A key step in this phase is that the PMSP identify and confirm commissioning requirements in the project charter.

Preparation of the project charter includes a detailed project scope of work including requirements in the PSIF/PJF and any attachments to those documents. Within the project scope, the intended Commissioning approach (in respect to the specifics of the project) should be defined. Section 3 of the project charter also includes a simple check-box section to indicate (among other things) commissioning related deliverables and project specific requirements such as the need for an independent commissioning authority.

4.3 IO RESPONSIBILITIES

Project Charter: The PSM must ensure that IO Design Guideline and IO commissioning Guideline requirements are included in the Project Charter produced by the PMSP.

4.4 PMSP RESPONSIBILITIES:

At project initiation the PMSP will determine the following parameters and enter the details in the project charter. The PMSP will make any enquiries necessary to clarify the intended scope of work to determine the basic commissioning requirements:

- Is commissioning needed in this project? For most building systems, Answer should be yes.
- If no, provide a reason why it is not needed? If yes, provide a high level description of the scope of commissioning required including a list of which systems will be commissioned.
- Is this a "LEED" certified project, and what level of certification will be pursued?
- Based on the anticipated schedule and system complexity, is the post occupancy commissioning needed?

The PMSP will also select and indicate the required deliverables, and the project specific requirements related to commissioning in Section 3 of the project charter.

Commissioning Thresholds: Refer to Schedule A

Commissioning requirements for IO projects delivered by PMSPs need to be scalable to match a wide range of project types, scope, cost and complexity. Schedule A of this Guideline provides a chart of thresholds to be used to determine who will oversee the contractor's commissioning activities. The IO Design Guideline provides the Owner Project Requirements. The decision on who will manage the commissioning, guided by schedule A, will be confirmed by all parties in the project.

It is essential that the PMSP fully understand the scope of work, in particular the work to be performed on building systems, to be able to define the high level commissioning requirements ensuring that The IO Design Guideline is followed. In Capital and Repair projects, the PJF will usually be accompanied by substantive technical information that should permit the commissioning decisions to be made with minimal additional effort. Conversely, in ministry funded projects, the information may be no more than what is included in the PSIF, which will require some investigative work by the PMSP to complete the commissioning requirements in the project charter.

Project Specific Requirements must follow the sections below

- Owner's Project Requirements (OPR) – IO Design Guideline
- Commissioning Authority – see Schedule A & C
- M&V Consultant – measurement and verification role, key in energy savings projects,
- Post Occupancy Commissioning – consider project timing, system complexity and seasonal impact on system operation such as HVAC

Complete the Project Charter

Once the level of commissioning is determined and client agreement is reached, the associated costs for commissioning must be included in the project estimate. This is a critical step because once all parties have signed off on the project charter a subsequent change will require a charter change process.

5. PLANNING PHASE

5.1 OBJECTIVE

The objective of the activities in this phase is to clearly lay out all commissioning activities in a complete and logical manner, ensuring a successful outcome to the commissioning activities to follow in the execution phase.

5.2 THE COMMISSIONING PLAN

Schedule A describes 3 thresholds of commissioning responsibilities:

- Projects where NO Design Consultant is engaged, contractor and trades are responsible for all commissioning activities (contractor commissioning)
- Projects up to $1million where the Design Consultants are the commissioning authority, as long as certified.
- Projects over $1million where the commissioning authority is a specialist that is independent of the design consultants and the PMSP.

The designer and/or commissioning authority will prepare an initial concise commissioning plan (the plan) near the completion of schematic design stage. The plan will prescribe all activities and responsibilities to be completed throughout the subsequent planning, execution and close out stages. The PSM, Asset Management staff, PLMSP and the ministry representative will review the plan and provide comments to the PMSP. As the project proceeds through the design stages, the plan will be updated to reflect the specifics of the project.

The plan will be finalized at the completion of the bid documents stage to be reviewed by IO stuff, PLMSP and the ministry representative where appropriate. Once all comments have been addressed by the designer and/or commissioning authority, the PMSP will formally accept the plan. The initial investment of time in a properly developed plan will be repaid later in the project as it will form the core of the final commissioning report.

The plan should be based upon ASHRAE Commissioning Guideline 0, and at a minimum, should include the following topics in a concise manner, of which some topics will be included in the tender documents that directly relate to the implementation stage:

- Overview of the commissioning process specific to the project including definitive listing of systems to be commissioned. A high level explanation of what commissioning entails is not needed.
- Special design/commissioning requirement for BAS related projects on sites that have a diagnostic analytic system, such as Backbone (data logger) system or any other system. The project manager or commissioning agent will need to issue a PO to the base diagnostic system vendor to eliminate gross markups by contractors. It should be noted that this system can and shall be used to verify the contractors work. The reconfiguration needs to be completed for substantial performance and then updated at final performance in case any changes were done
- Format for describing commissioning requirements in trade sections of the specifications
- Startup checklist sample as provided by recognized equipment manufacturer representative(s)
- Intended test procedures, and test data records specific to the project
- Statement of design and performance requirements including integration to existing systems and OPR.
- Detailed description of activities during the construction, substantial performance, occupancy and post occupancy stages
- Format for commissioning submittals and final documentation for verification, and performance testing
- CMMS Asset Update forms and data collection process
- Review of shop drawing submittals for compliance with design intent and bid documents.

- Procedures for situations where verification process fails to achieve design requirements
- Quality based sampling procedures for verification of design requirements having been achieved
- Issues log process, and corrective procedure
- Procedures specific to LEED certification where applicable

Commissioning Plan shall be sent to Project.Review@InfrastructureOntario.ca account

5.3 OPERATION AND MAINTENANCE MANUAL

In accordance with the MSA, the PMSP will coordinate the development of an Operations and Maintenance Manual, Schedule B of this guide. The O&M manual will be submitted in hard copy and electronic copy versions, meaning every part of the manual must be scanned into an electronic form.

The manual will be prepared by the general contractor, certified by the design team as well as the commissioning authority, and once accepted by the PMSP, submitted to the client and IO at Substantial Performance. The requirement for an O&M manual will be noted by PSM in the project charter. The manual may take several forms:

- Where the project involves significant work on building systems and the project will produce information essential to the ongoing operation of the building such as commissioning data, equipment inventories, warranties, maintenance data etc, a full scope O&M manual is required;
- Where the project involves minor change to building systems and the quantity of project information related to the ongoing operation of the facility is minor, a condensed version of the O&M manual is required. This reduced scale manual could be considered as an annex to the existing O&M manuals for the facility.

On a project specific basis, where little significant documentation will be produced to pass on to IO, the PSM may determine that an O&M manual or an annex to the manual is not required, and shall indicate that in Section 3 of the project charter.

5.4 COMMISSIONING AUTHORITY TASK AT THE DESIGN STAGE

In projects where the project design team will be the commissioning authority, IO will rely upon the professional integrity of the entire design team under the direction of the PMSP, to achieve the design intent through all design stages, in the most cost effective and environmentally responsible manner possible in compliance with this guideline.
In projects where an independent commissioning authority will be engaged, they must be hired sufficiently early in the planning phase to ensure the Owner Project Requirements are translated accurately. They will formally review the design as it evolves, confirming that it will achieve the owners' project requirements, and that the systems are arranged to permit commissioning to be implemented effectively.

5.5 BID DOCUMENTS AND COMMISSIONING PROCESS

A critical subset to the commissioning plan is the documentation of the commissioning process in the specifications portion of the bid documents. When the commissioning requirements are clearly defined in the bid documents, the contractor is contractually bound to the process, and bidders are fully informed at the tender stage. The PMSP will ensure that the format for commissioning specifications set out in the commissioning plan is accurately translated by the design team into the bid documents.

5.6 CMMS INVENTORY PROCESS

The Computerized Maintenance Management System (CMMS) is a database operated by the PLMSP that records all life cycle data logged against an item of equipment or system. This is an important feature as it permits the PLMSP to determine service and replacement intervals and carry out cost efficiency analysis. The Project Services process methodology for commissioning requires the completion of CMMS forms and handover requirements from the PMSP to the PLMSP (ioepr@cbre.com) before the substantial completion meeting

6. EXECUTION PHASE

6.1 OBJECTIVE

The overall objective during this phase is to ensure that all building systems, or in the case of smaller projects, all systems in the area of work, are integrated and function as intended and that stakeholders are trained to operate the systems correctly, and that all objectives set out in the commissioning plan are achieved at Substantial Performance.

6.2 COMMISSIONING UP TO SUBSTANTIAL PERFORMANCE

In the later stages of the construction work, systems and assemblies are installed, inspected, tested and placed into service to meet the project design requirements. The key steps in the execution phase with the participation of a commissioning authority, in order to achieve Substantial Performance, are:

- Ongoing refinement of the commissioning plan – within the limits permitted by the contractor's construction contract includes:
    - HVAC systems including air handling units, boiler, chiller or major BAS upgrade projects.
    - At least 10% of field input/output devices must be commissioned along with 100% of sequences of operation.
    - Performance and reliability run for 15 days in appropriate season. During this test period, the complete system must operate. If there is any interruption due to any fault or adjustment, the test period will restart. If this is not achievable, it will be considered seasonal commissioning
- Building Automation System (BAS) related projects with potential analytic software shall include:
    - The project will affect the open BACnet object point names that are being monitored by the diagnostic systems if any point names are added, modified or BAS system software is updated or replaced.
    - The project will include for an order issued for reconfiguration of any new or changed points on the BAS system as a result of this project. Upgrade to latest version of software is required if not already existing.
    - All points on the BAS control system used for control and monitoring, including points in any terminal units, and set points, need to be full exposed open BACnet objects on the BAS network. This is required by the IO Guidelines for all BAS systems.
- Complete set of design drawings, including incorporated red lines, shop drawings, delegated design to enable final deficiency inspection to reflect the site conditions (this might change from the final)
- Orderly startup, pre-functional, and functional performance verification of designated systems
- Correction of deficiencies, including those identified during commissioning
- Coordination and compilation of the commissioning documentation during startup, verification and performance testing stages, and completion of the CMMS verification forms for new systems installed. (Schedule D)
- Stakeholder training (Schedule G)
- Submitting and approval of O&M manuals. (Schedule B)
- Written TSSA inspection, including "PASS" certificate.
- ESA field inspection sticker including written confirmation
- Completion of activities necessary to achieve LEED certification, where applicable
- Completion of Instrument 3.2.1 T1 - Commissioning Verification Form (Schedule E)
- Completion of Instrument 3.1.4 T2 - Project Handover Checklist (Schedule H)

7. CLOSE-OUT PHASE

POST OCCUPANCY COMMISSIONING:

Post Occupancy Commissioning during the close out phase of the project begins at substantial performance and may continue through to the end of the contractual warranty/correction period. It is required where additional performance testing is needed because of seasonal changes, or varying building occupancy loads, or occasionally where all parties have agreed that substantial performance can occur before all systems have been constructed. Similarly, post occupancy commissioning in a registered LEED project may only be managed by an independent commissioning authority.

The activities of all participants in the commissioning process throughout the execution phase will generally follow the principles set out in ASHRAE Commissioning Guideline 0, other than situation-specific differences for IO projects noted herein.

The key steps to achieve this with the participation of a commissioning authority are:

- Oversight of the commissioning activities by the commissioning authority
- Witness orderly startup, verification and testing of designated systems for equipment installed during the Post Occupancy Commissioning.
- Correction of remaining deficiencies, including those identified during commissioning.
- Coordination and compilation of the commissioning documentation during the fine tuning and performance testing stages, and completion of any outstanding CMMS Asset Update forms. (Schedule D)
- Completion of any remaining stakeholder training (Schedule G)
- Submittal of remaining items for the O&M manuals (Schedule B)
- Completion of activities necessary to achieve LEED certification where applicable
- Completion of Instrument 4.1.3 T1 - Post Occupancy Commissioning Verification Form (Schedule F)
- Update of Instrument 3.1.4 T2 - Project Handover Checklist (Schedule H) – Completed earlier in Execution Phase

If the project is registered for LEED certification, in accordance with the Government directive on LEED, the O&M manuals must include a re-commissioning manual that prescribes on going testing to maintain the performance levels established for LEED certification.

The commissioning reports for post occupancy will be submitted under the cover of a "Post Occupancy Commissioning Verification Form" downloaded from the PMO Web Portal.

SCHEDULE A: COMMISSIONING FRAMEWORK – THRESHOLDS

CONTRACTOR COMMISSIONING	COMMISSIONING AUTHORITY	
General Contractor and Trades	Design Consultant(s) is the Commissioning Authority	Independent Commissioning Authority
No Design Consultant Engagement	Construction cost up to $1,000,000	Construction cost over $1,000,000

DEFAULT CONDITION Commissioning via the contractor and trades is required where no Design Consultant is needed by the project, except for BAS projects. • Every new Building System or assembly of Systems installation shall be commissioned according to this guideline. • Unless the PSM in conjunction with PLMSP and PMSP determines that commissioning is not required. • The PSM in conjunction with PLMSP and PMSP may over-ride any threshold at the project charter and decide that an independent commissioning authority is required.	**DEFAULT CONDITION** Commissioning under the direction of the project Design Consultant(s), as defined within this document, is required • Unless the PSM in conjunction with PLMSP and PMSP determines that an independent commissioning authority is required. • Unless the PSM in conjunction with PLMSP and PMSP determines that commissioning is not required.	**DEFAULT CONDITION** Commissioning under the direction of an independent commissioning authority, as defined within this document, is required • Unless the PSM in conjunction with PLMSP and PMSP may determine at project charter that commissioning by the Design Consultant will be adequate for a project where the services of an independent commissioning authority are not necessary.

SCHEDULE B: OPERATING AND MAINTENANCE MANUALS

"The PMSP shall coordinate the development of the operations and maintenance manual (O&M Manual) in a timely manner with the support of the PMSPs General Contractor and Consultant so that these documents are provided to IO at substantial performance of the contract. The PMSP shall also provide IO the validation certificate from the Consultant as proof that the O&M Manual has been reviewed and that the content included in the submission complies with the as-built acceptance criteria as defined in the specifications and contract documents. IO Project Services and property management stakeholders must be consulted and the O&M manual must be submitted to IO in order to be able to properly operate the facility before release of the certificate of substantial performance"

The O&M manual shall be submitted to the client, IO and the PLMSP in a form acceptable to IO, at least a week prior to Substantial Performance of the Project.

1.0 HOW THE MANUAL IS USED

This initial section shall be a guide to the contents, structure and layout of the manual. This section will enable the reader to comprehend the scope and purpose of the document and to identify readily where specific information can be obtained.

2.0 CONTRACTUAL AND LEGAL GUIDES

The contractual and legal records shall include:

- The name and address of the installation
- Details of ownership, leases;
- Details of local and public authority consents;
- Details of the design teams, consultants, commissioning authorities, installation contractors and associated subcontractors;
- Dates for the start of the installation, for handover (practical completion) and for the expiry of the defects liability period; (Warranty)
- Information of all guarantees affecting components, systems/plant items, together with expiry dates and names, addresses and telephone numbers of relevant contacts.

For each item of plant and equipment installed within the building and contained in the list of services covered by the O&M manual, copies of the following documents shall also be provided, where applicable:

- Test certificates;
- Manufacturers' guarantees and warranties;
- Insurance inspection reports;
- Safety and fire certificates

A clear statement shall be made in this section concerning those hazards and safety precautions of which the operators and maintainers of the installations need to be made aware. They shall include the following:

- Any known feature or operational characteristic of the equipment or systems installed which may produce a hazard;

- Any known hazards against which protection must be provided; including site specific detailed lock out/tag out requirements for all equipment installed as part of this project.
- Any mandatory requirements relating to safety;
- Any other safety requirements which should be observed;
- Any other relevant warnings

3.0 OVERALL PURPOSE

This section shall provide a general overview of the original design intent. It shall include a summary for each engineering system installed giving

- The parameters and conditions within which it has been designed to operate, including known hazards;
- The type of each service (gas, water, electricity etc) required to operate the system;
- The intended method of control

4.0 DESCRIPTION

This provides a detailed description of each engineering system installed. It shall include

- The system type (e.g. cold water supply, chilled water supply)
- System location and what it serves
- What the system depends upon in order to function;
- Design data, basic design parameters, basic assumptions made during design;
- Reasons for selecting particular plants;
- Expected service life (where applicable)
- Planned operational efficiency
- Copy of all reviewed as-built shop drawings

5.0 EQUIPMENT SCHEDULE

The type, model number and serial number of all component items within the system should be listed, together with the names of their respective manufacturers or suppliers, including copies of CMMS forms for all new equipment here.

6.0 PARTS IDENTIFICATION AND RECOMMENDED SPARES

This shall comprise a parts identification list detailing and identifying replaceable assemblies, sub-assemblies and components. It shall include suppliers' recommendations for both spares and 'running spares' (i.e. parts required for scheduled replacement due to wear or deterioration).

Items normally held in stock by a supplier, or for which a refurbishment service is available, shall be identified separately.

7.0 COMMISSIONING DATA

The results of all commissioning work and associated tests shall be provided, this shall include

- Measured data and Measurement points;
- Test equipment used;
- Calibration certificate details;

- A statement confirms that weather design requirements were achieved.

8.0 OPERATION

Instructions must be given for the safe and efficient operation, under normal, maintenance and emergency conditions, of each engineering systems installed. These will be in addition to manufactures' literature for plant items and shall include

- A recommended strategy for operation and control;
- An outline of the general operation mode;
- Control data (location, effect, object, sequence, limits of capability, modes, set points)
- Procedure and sequences for start-up, running and shut down, under both normal and emergency conditions;
- Operating procedure for stand-by plant;
- Precautions necessary to overcome known hazards;
- The means by which potentially hazardous plant may be made safe;
- Target figures for both energy consumption and energy use;
- Forms for recording plant running hours, energy consumption and the energy costs

9.0 MAINTENANCE INSTRUCTIONS

The manufacturer's recommendations and instructions for maintenance must be detailed for each item of plant and equipment installed. Clear distinction shall be made between planned tasks (preventive maintenance) and work done on corrective basis. Instructions shall be given on each of the following, as appropriate:

- The isolation and return to service of plant and equipment;
- Adjustments, calibration and testing;
- Dismantling and assembly;
- The exchange of components and assemblies;
- Dealing with hazards which may arise during maintenance;
- The nature of deterioration and defects to be looked for;
- Special tools, test equipment and ancillary services.

10.0 MAINTENANCE SCHEDULES

Maintenance schedules shall be provided for all preventive maintenance tasks identified in section 9.0. These shall be based on both manufacturers' recommendations and other authoritative sources (e.g. statutory or mandatory requirements) and shall include

- Inspections;
- Examinations and Tests;
- Adjustments and Calibrations;
- Lubrication;
- Periodic overhaul

11.0 FAULT FINDING

Procedure for the logical diagnosis and correction of faults shall be provided for critical components, equipment and systems.

12.0 LUBRICATION

A schedule of all plant requiring lubrication shall be provided together with manufacturers' recommendations on the type of lubricant and the method and frequency of application. Where the type of lubricant is identified by product name, a generic reference (e.g. CSA, ASTM standard) should be given. Information must also be provided on special requirements for the handling and storage of lubricants.

13.0 MODIFICATION INFORMATION

Modifications are authorized changes which may affect the safety, reliability, operation or maintenance of a system or any components.

Information on permitted plant or system modifications allowed for by manufacturers or system designers shall be included for each system. Space must be provided in the manual for the recording of all modifications and changes as they occur (this would initially comprise a series of appropriately headed blank pages).

14.0 DISPOSAL INSTRUCTIONS

Where relevant, information shall be provided detailing

- Any known dangers likely to arise during the disposal of specific items of plant or equipment together with the necessary precautions and safety measures;
- Methods for safely disposing of or destroying the equipment or any part thereof, including packaging, insulation and fluids;
- Sources from which further information can be obtained

15.0 NAMES AND ADDRESSES OF MANUFACTURERS

Details of all manufacturers and suppliers of equipment listed in the manual shall be provided under this heading giving name, address, telephone number, fax number, email and web address. Any additional information likely to help the building operator to make contact with or obtain advice from a manufacturer or supplier shall also be included.

Where appropriate, details of local stocking or spare parts, replaceable assemblies or complete units shall also be provided.

Details shall be arranged in alphabetical order of manufacturer or supplier name to provide a logical information retrieval procedure.

16.0 INDEX OF PLANS AND DRAWINGS

An index shall be provided of all 'as built' drawings supplied during the course of the installation work and on completion, identified by number and title.

The index shall also include a schedule of all drawings issued by manufacturers and suppliers during the course of the installation work and on completion e.g. control panel wiring diagrams.

17.0 EMERGENCY INFORMATION

An important feature of any manual is the emergency information. Located, for ease of reference, at the end of the document, this should include names, address, telephone numbers, fax numbers and emails addresses of the appropriate contacts in the event of fire, theft or burglary, and gas, electricity or water failure/leaks. It shall also list those firms or staff to contact in the event of the failure or breakdown of such plant as lifts, boilers, chillers, building automation system and pumps.

Where applicable, location of firefighting equipment, hydrants and rising mains shall be described.

Special attention shall be given to hazards particular to the building.

Depending on client policy, a note of security installations may also be included.

18.0 MANUFACTURERS LITERATURE

A complete set of all manufacturers' literature shall be provided for the plant and equipment installed, and assembled for each building services systems. (1 copy of all information including as-built drawings on a CD will be provided.)

This literature shall provide the following information:

- Manufactures literature and specifications are to be inserted in the close out documents identifying operating and design temperatures, pressures, flow rates, and differentials.
- The manufacturer and design consultants are to identify in the close out documents all preliminary sequence of operations on major components and equipment.
- Description of the product purchased;
- The cost and date of purchase;
- Performance- behavioral characteristics of the equipment in use;
- Applications- suitability for use;
- Operation and maintenance details;
- Reviewed/as-built shop drawings;
- Site map showing exact location of any meters installed;
- Calibration Certificates and expiry
- Resources of labor, plant, material and space required;
- Methods of operation and control;
- Cleaning and maintenance requirements;
- Protective measures;
- Labor safety and welfare associated with equipment;
- Public safety consideration

Where this data is not adequately provided in manufacturers' literature the author of the manual shall augment the literature as necessary.

SCHEDULE C: QUALIFICATIONS OF THE COMMISSIONING AUTHORITY

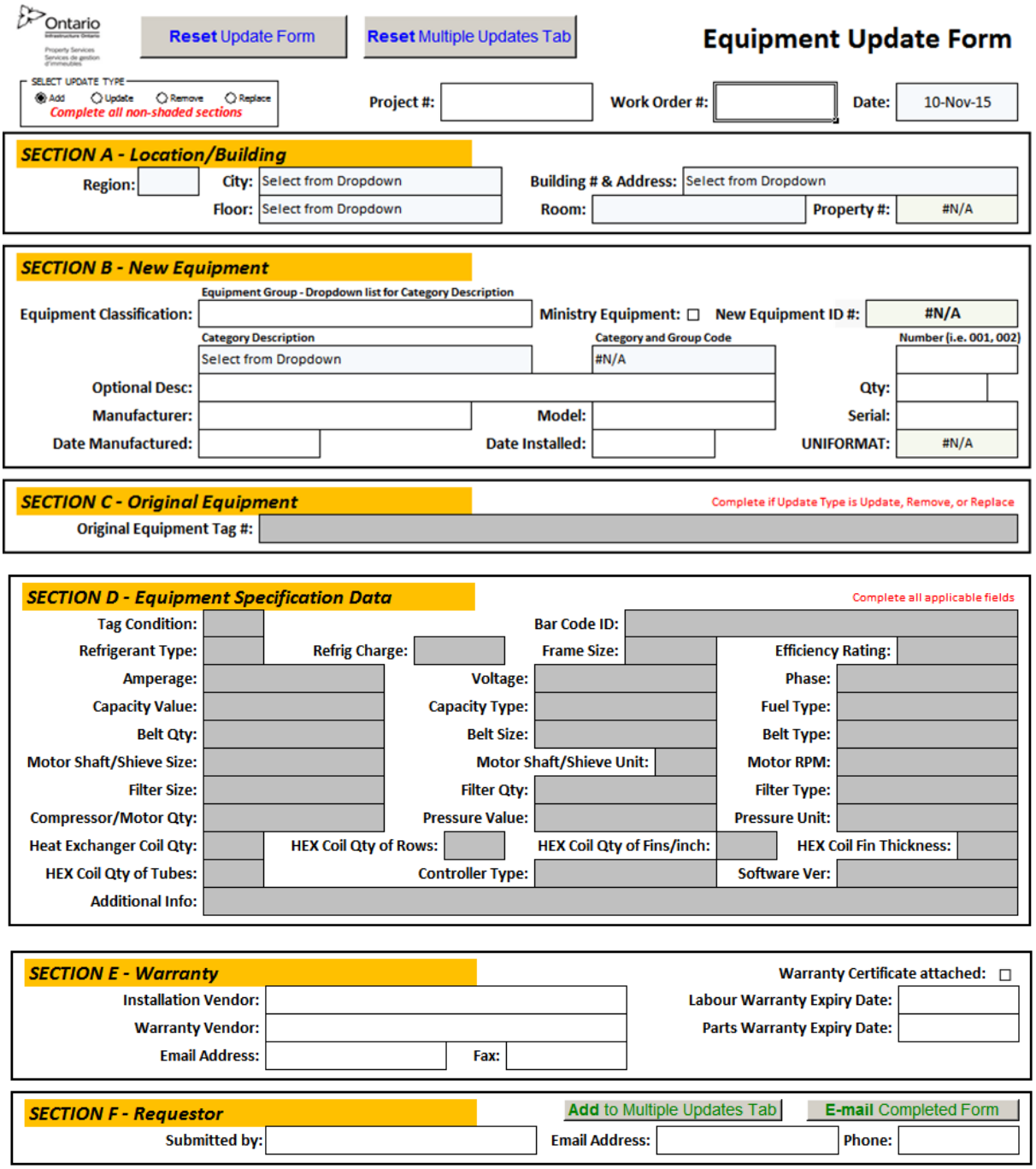
When an independent commissioning authority is required, retaining the commissioning authority is the sole responsibility of the PMSP, and IO needs to be assured that the individual/firm selected is a truly independent specialist, and will be acceptable to the CaGBC if the project is to be LEED certified.

Commissioning of the systems shall be carried out by commissioning authority in compliance to ASHRAE Guide line 0-2005 and in compliance with IO Guidelines. HVAC & R Technical Requirements for The Commissioning Process –ASHRAE Guideline 1.1-2007 or PECI published guidelines will provide guidance.

Whether commissioning is carried out by the contractor, design consultant or an independent commissioning authority, the commissioning authority used shall be certified as a commissioning professional and hold a currently valid certificate from one of the following national and/or international organizations American Society of Heating, Refrigerating & Air Conditioning Engineers Inc.(ASHRAE), Association of Air Balance Council(AABC), National Environmental Balancing Bureau (NEBB), Association of Energy Engineers (AEE), and/or Building Commissioning Association (BCA).

SCHEDULE D: COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM ASSET UPDATE FORM

The Computerized Maintenance Management System (CMMS) is a database operated by the PLMSP that records all life cycle data against a piece of equipment or system. This is an important feature as it permits the PLMSP to monitor the device against manufactures service recommendations to determine service and replacement intervals and carry out cost efficiency analysis. PMSP to ensure CMMS forms are completed and submitted by General Contractor or alternate at substantial completion.



Ontario

Reset Update Form | Reset Multiple Updates Tab

Equipment Update Form

SELECT UPDATE TYPE: (•) Add ( ) Update ( ) Remove ( ) Replace

Complete all non-shaded sections

Project #: | Work Order #: | Date: 10-Nov-15

SECTION A - Location/Building

Region: | City: Select from Dropdown | Building # & Address: Select from Dropdown

Floor: Select from Dropdown | Room: | Property #: #N/A

SECTION B - New Equipment

Equipment Group - Dropdown list for Category Description

Equipment Classification: | Ministry Equipment: ☐ | New Equipment ID #: #N/A

Category Description: Select from Dropdown | Category and Group Code: #N/A | Number (i.e. 001, 002)

Optional Desc: | Qty:

Manufacturer: | Model: | Serial:

Date Manufactured: | Date Installed: | UNIFORMAT: #N/A

SECTION C - Original Equipment

Complete if Update Type is Update, Remove, or Replace

Original Equipment Tag #:

SECTION D - Equipment Specification Data

Complete all applicable fields

Tag Condition:				Bar Code ID:	
Refrigerant Type:		Refrig Charge:		Frame Size:	Efficiency Rating:
Amperage:		Voltage:		Phase:	
Capacity Value:		Capacity Type:		Fuel Type:	
Belt Qty:		Belt Size:		Belt Type:	
Motor Shaft/Sheive Size:		Motor Shaft/Sheive Unit:		Motor RPM:	
Filter Size:		Filter Qty:		Filter Type:	
Compressor/Motor Qty:		Pressure Value:		Pressure Unit:	
Heat Exchanger Coil Qty:		HEX Coil Qty of Rows:		HEX Coil Qty of Fins/inch:	HEX Coil Fin Thickness:
HEX Coil Qty of Tubes:		Controller Type:		Software Ver:	
Additional Info:					

SECTION E - Warranty

Warranty Certificate attached: ☐

Installation Vendor: | Labour Warranty Expiry Date:

Warranty Vendor: | Parts Warranty Expiry Date:

Email Address: | Fax:

SECTION F - Requestor

Add to Multiple Updates Tab | E-mail Completed Form

Submitted by: | Email Address: | Phone:

SCHEDULE E: COMMISSIONING VERIFICATION FORM

Ontario
Infrastructure Ontario

Commissioning Verification Form

Ministry	PS Project #		Project Name
Portfolio ID #	Portfolio Name	Building #	Building Name

COMPONENT(S) / SYSTEM(S):

CONSULTANT/COMMISSIONING AGENT CERTIFICATION

The commissioning verification test(s) of the following equipment have been completed and performance of the component(s) / system(s) complies with the acceptance criteria in the testing of the specifications and contract documents.

Component(s) / System(s):		
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No

Signature: _____ **Date:** _____

Organization: _____

PMSP ACCEPTANCE

Signature: _____ **Date:** _____

Organization: _____

PLEASE PROVIDE THIS COMPLETED FORM TO IO-PS AS A PART OF THE O&M DOCUMENTATION

IO-PS Methodology Sub-Element Reference:

SUB-ELEMENT#
3.2.1 Commissioning

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SCHEDULE F: POST OCCUPANCY COMMISSIONING VERIFICATION FORM

Ontario
Infrastructure Ontario

Post Occupancy Commissioning Verification Form

PS Project #		Project Name	
Portfolio ID #	Portfolio Name	Building #	Building Name

COMPONENT(S) / SYSTEM(S):

CONSULTANT/COMMISSIONING AGENT CERTIFICATION

The commissioning verification test(s) of the following equipment have been completed and performance of the component(s) / system(s) complies with the acceptance criteria in the testing of the specifications and contract documents.

Component(s) / System(s):		
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No
	☐ Yes	☐ No

Exclusions:

Signature: _____ **Date:** _____

Organization: _____

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PMSP ACCEPTANCE
Signature: _____ **Date:** _____ **Organization:** _____ PLEASE PROVIDE THIS COMPLETED FORM TO IO-PS AS A PART OF THE O&M DOCUMENTATION

IO-PS Methodology Sub-Element Reference:

SUB-ELEMENT#
4.1.4 Post Occupancy Commissioning (Seasonal)

SCHEDULE G: TRAINING

Review with PLMSP and adjust the number of training sessions and content to suit the project complexity, size and number of staff to be trained – Project training can be tailored according to the size of the project, any changes to the training needs to be discussed with the PLMS.

- Provide four (4) on-site training sessions including classroom and terminal hands on, half day each, for personnel designated by the owner/owners service provider prior to and at substantial completion or when system starts affecting conditions in tenant spaces that owner/owners service provider must respond to.
- Provide one (1) additional training session at each of 6 and 9 months, following substantial completion. Each session shall be a half day in length and must be coordinated with the building owner/owners service provider.
- Train the designated staff of IO and its representative to enable them to do the following:
- Day-to-day Operators: range of 4 to 8 persons (2 sessions)
    - Proficiently operate the system
    - Understand control system architecture and configuration
    - Understand DDC system components
    - Understand system operation, including DDC system control and optimizing routines (algorithms)
    - Operate the workstation and peripherals
    - Log on and off the system
    - Access graphics, point reports, and logs
    - Adjust and change system set points, time schedules, and holiday schedules
    - Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
    - Understand system drawings and Operation and Maintenance manual
    - Understand the job layout and location of control components
    - Access data from DDC controllers and ASCs
    - Operate portable operator's terminals
- Advanced Operator (in addition to above): 2-4 persons (1 session)
    - Make and change graphics on the workstation
    - Create, delete, and modify alarms, including annunciation and routing of these
    - Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
    - Create, delete, and modify reports
    - Add, remove, and modify system's physical points
    - Create, modify, and delete programming
    - Add panels when required
    - Add operator interface stations
    - Create, delete, and modify system displays, both graphical and others
    - Perform DDC system field checkout procedures
    - Perform DDC controller unit operation and maintenance procedures
    - Perform workstation and peripheral operation and maintenance procedures
    - Perform DDC system diagnostic procedures
    - Configure hardware including PC boards, switches, communication, and I/O points
    - Maintain, calibrate, troubleshoot, diagnose, and repair hardware
    - Adjust, calibrate, and replace system components
- System Managers/Administrator (in addition to above): 2-4 persons (1 session)
    - Maintain software and prepare backups
    - Interface with job-specific, third-party operator software
    - Add new users and understand password security procedures
- Participants may attend one or more of these, depending on level of knowledge required.
- The instructor(s) shall provide one copy of training material per student.
- The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- Training shall include classroom and onsite training, using the installed system working controllers without affecting the space conditions

CONTACT INFORMATION

Should you have any questions or feedback about the IO Building Systems Commissioning Guideline, please contact:

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END OF SCHEDULES