This master should be used by designers working on Port of Portland construction projects and by designers working for PDX tenants (“Tenants”). Usage notes highlight a few specific editing choices, however the entire section should be evaluated and edited to fit specific project needs.

Use this section for projects requiring the Contractor to provide a formal commissioning program with dedicated commissioning manager(s) and commissioning plan. This section can utilize the Port’s on-call commissioning authority.

SECTION 019100 - GENERAL COMMISSIONING REQUIREMENTS

1. GENERAL
	* + 1. DESCRIPTION
				1. Commissioning is the systematic process of ensuring all site and building components, equipment, systems, and interfaces among systems perform in accordance with the contract documents. The commissioning process encompasses and supplements the traditionally separate functions of system, equipment, and component installation, checkout, startup, calibration, operational testing, adjustment and balancing, functional performance testing, development of O&M manuals, development of system manuals, development of as-constructed drawings, operation and maintenance training, final acceptance testing, and deferred functional performance and seasonal testing.
				2. Objectives of Commissioning:

Ensure applicable equipment, systems, and components are properly installed and adequately checked out according to the manufacturer’s recommendations, industry accepted standards, and the contract documents, prior to startup.

Ensure applicable equipment, systems, and components are started up, calibrated, operationally tested (statically and dynamically), adjusted and balanced, and functionally tested per the contract documents, prior to initiating operation and maintenance training and final acceptance testing.

Ensure operation and maintenance manuals, system manuals, as-constructed drawings, and other required documentation are developed, updated, and submitted in accordance with the contract documents.

Ensure Port operation and maintenance personnel are adequately trained prior to substantial completion of the work to provide routine operation and maintenance.

* + - * 1. Coordinate commissioning work with requirements called out in all of the specification sections of the contract documents.
				2. Systems to be Commissioned: In general, systems, equipment and components, and interfaces among systems specified in the following divisions shall be commissioned:

Edit list as appropriate.

Division 8 – Openings

Division 11 – Equipment

Division 12 – Furnishings

Division 13 – Special Construction

Division 14 – Conveying Equipment

Division 21 – Fire Suppression

Division 22 – Plumbing

Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)

Division 26 – Electrical

Division 27 – Communications

Division 28 – Electronic Safety and Security

Division 32 – Exterior Improvements

Division 33 – Utilities

Division 34 – Transportation

* + - * 1. Contractor’s Commissioning Responsibilities:

Under the direction of the Port-provided commissioning authority (CxA), the Contractor is responsible for commissioning all systems specified within the contract documents.

Commissioning shall be completed for all mechanical, electrical, plumbing, and renewable energy systems and assemblies in accordance with ASHRAE Guideline 0‑2005 and ASHRAE Guideline 1.1-2007 for HVAC&R systems as they relate to energy, water, indoor environmental quality, and durability. Exterior enclosures (building envelope) shall be commissioned in accordance with NIBS Guideline 3-2012.

Review, understand, and assist with implementation tasks performed by the CxA.

Generate a weekly project commissioning progress report when pre-operational checkout and startup begins. Provide updated reports to the CxA at scheduled construction progress review meetings.

Provide completed test plans test plans, procedures, and checklists as required by the CxA-provided commissioning plan (Cx plan).

* + - 1. COMMISSIONING AUTHORITY
				1. The Port will provide a CxA to oversee the commissioning and commissioning processes and to provide direction and oversight to the Contractor and the Contractor’s commissioning manager.
				2. The CxA will also:

Review the Port’s project requirements and basis of design.

Develop and implement the Cx plan.

Confirm incorporation of Cx plan requirements into the contract documents.

Develop a template for construction checklists.

Develop system test procedures.

Verify system test execution.

Maintain an issues log throughout the commissioning process.

Prepare a final commissioning process report.

Document all findings and recommendations, and report directly to the Port throughout the commissioning process.

Perform additional LEED V4 Enhanced commissioning tasks based on project goals.

* + - 1. COMMISSIONING MANAGEMENT
				1. To ensure commissioning objectives are met, the Contractor shall employ the services of one or more commissioning managers (the commissioning manager), as appropriate, to oversee and guide commissioning activities.

Replace Northwest Engineering, Inc., or delete the last sentence as appropriate for the project. If a CxA has not been determined, delete the last sentence.

Should the Contractor choose to subcontract commissioning activities to a commissioning specialist, it shall not be the CxA provided by the Port. The CxA for this project is Northwest Engineering, Inc.

Edit the following article as appropriate.

* + - * 1. The commissioning manager shall have current and demonstrated knowledge of the following systems, equipment, and components:

Site Construction:

Water systems.

Storm and sanitary sewer systems.

Automated gates.

Doors and Windows:

Coiling doors and grilles.

Automated entrance door and revolving vestibules.

Equipment:

Sterilizers.

Fueling system and related equipment.

Cathodic protection system.

Static ground system.

Loading dock equipment.

Sewage lift station.

Passenger boarding bridges, including all associated equipment and elements such as pre-conditioned air units, 400Hz ground power units, and potable water hose reel cabinets.

Furnishings:

Motorized blinds and shades.

Conveying Systems:

Hydraulic and geared traction elevators.

Escalators.

Moving walks.

Baggage conveyor systems.

Mechanical:

Piping systems (high pressure steam, low pressure steam, heating hot water, pumped condensate, chilled water, condenser water, domestic hot and cold water, non-potable water, pumped sewage, grease waste, fire protection, natural gas, and refrigeration).

Piping specialties.

Valves.

Expansion compensation.

Gauges.

Pumps.

Seismic restraints.

Noise, vibration, and seismic control.

Fire protection.

Plumbing equipment.

Water treatment.

Hot water boilers and steam generators.

Steam and condensate specialties.

Heat transfer and heat exchangers.

Water chillers.

Packaged air conditioners and computer room air conditioners.

Air handling units.

Fans.

Air cleaning equipment.

Ductwork and accessories.

Air terminal units.

Air outlets and inlets.

Variable speed controllers.

Energy management and control systems.

Electrical:

Power and emergency power wirings and cables.

Emergency generators.

Unit substations.

Switchgear and circuit breakers.

Medium voltage interrupter switches.

Secondary distribution system.

Grounding, ground fault, and service grounding.

Transformers.

Bus ducts.

Panelboards and switchboards.

Motor controls, motor control centers, and motor starters.

Airfield and apron lighting and signing.

Building lighting.

Lighting control system.

Uninterruptible power supply system.

Fire alarm system.

Security access system.

Telephone and data communication systems.

Public paging and address systems.

Audio/video surveillance systems.

Microprocessor power monitoring and metering equipment.

Security screening equipment and related devices such as panic buttons and microphones.

* + - * 1. Qualifications for the commissioning manager shall include:

Experience as a commissioning manager on at least three projects of similar complexity and size as this project.

Experience in preparation of commissioning plans, schedules, checklists, test procedures, training plans, operation and maintenance manuals, system manuals, and record drawings.

Experience in system, equipment, and component checkout, startup, calibration, operational (static and dynamic) testing, adjustment and balancing, and final acceptance testing.

Demonstrated working knowledge of complex fire alarm, electric power control, and facility management systems; ability to understand control system manufacturer’s operating system and control code; ability to troubleshoot control code and recommend necessary modifications.

Excellent communication and writing skills; highly organized work habits.

* + - 1. SUBMITTALS
				1. The commissioning manager:

Submit resumes and qualifications briefs, including:

Name, address, phone, and facsimile numbers.

Current title and job description.

History of employment with present and past firms for the past 7 years.

Relevant work experience. Provide position name and description of responsibilities, including name and current telephone number of immediate supervisor or reporting entity.

Description of candidate’s experience as a principal commissioning agent on at least three projects of similar complexity and size within the past 7 years.

Current and demonstrated knowledge of systems, equipment, and components. List systems, equipment, and components, and related skills and capabilities.

Education and technical training. List relevant degrees, certifications, and professional affiliations.

Reference names and phone numbers of former clients.

* + - * 1. Contractor’s Commissioning Management Plan:

Within 60 days following the Notice to Proceed, submit the commissioning management plan for approval.

The commissioning management plan shall be based on the Cx plan and shall include, but not be limited to:

Details of the commissioning scope.

Commissioning team contact information.

Commissioning team task matrix, identifying roles and responsibilities of each team member.

Communication and reporting protocols.

Commissioning management process overview.

Listing of each system or subsystem to be commissioned as described in the project commissioning progress and turnover report section. The detailed individual test reports for the pre-operational tests, startup and operational tests, functional tests, and final acceptance tests shall be submitted when specified in those sections.

Listing of systems for which operation and maintenance training will be provided.

Making references to the Cx plan.

* + - * 1. Commissioning Schedule:

Submit a detailed commissioning schedule within 60 days following Notice to Proceed.

Submit weekly, rolling three-week look-ahead schedules once installation is complete and pre-operation checkout and startup begins.

Include commissioning in the overall construction schedule.

For each item to be commissioned, include the following information:

Tag number, name, and subcontractor or vendor.

Task duration and schedule completion dates for the following activities:

Installation of systems, equipment, and components.

Pre-operational checkout.

Startup and operational (static and dynamic) testing.

Testing, adjustment, and balancing.

Functional performance testing.

Operation and maintenance training.

Final acceptance testing.

Deferred functional performance testing.

1. PRODUCTS
	* + 1. TEST EQUIPMENT
				1. All testing and data logging equipment required to perform installation, checkout, startup, operational (static and dynamic) testing, functional performance testing, and final acceptance testing shall be provided by the Contractor.
				2. Special test equipment, tools, and instruments specific to a piece of equipment but only available from the vendor, shall be provided by the Contractor.
				3. Data logging equipment and software required to test systems, equipment and components, and interfaces among systems shall be provided by the Contractor.
				4. Test equipment and instrumentation shall be calibrated in accordance with the following frequency:

Field Instruments: Analog, 6 months maximum; Digital, 12 months maximum.

Laboratory Instruments: 12 months.

Leased Specialty Equipment: 12 months where accuracy is guaranteed by lessor.

* + - * 1. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system equipment and component performance within the tolerances specified in the technical specifications and on the drawings. If not otherwise given, the following minimum requirements shall apply:

Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5ºF and a resolution of ±0.1ºF.

Pressure sensors shall have an accuracy of ±2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year.

Calibrate all equipment according to the manufacturer’s recommended intervals and recalibrated when dropped or damaged.

Calibration tags shall be affixed and dated or certificates made readily available.

1. EXECUTION
	* + 1. MEETINGS
				1. Scoping Meeting: Within 30 days of Notice to Proceed, the Contractor shall schedule, plan, and conduct a commissioning scoping meeting with the Port. During this meeting, the overall scope and process of the commissioning effort shall be reviewed, issues and suggestions from all parties given, management and reporting protocols finalized, and the project schedule discussed. From information gathered in this meeting, the Contractor, with the guidance of the CxA and the Port, shall prepare and submit the commissioning management plan and schedules. The Contractor shall distribute meeting minutes to all parties.
				2. Commissioning Kick-Off Meeting: Within 60 days prior to initiation of pre-operational checkout and startup of systems, equipment, and components, the Contractor shall schedule, plan, and conduct a commissioning kick-off meeting with the entire commissioning team in attendance, including the mechanical, electrical, test, adjusting and balancing, and other appropriate subcontractors, the CxA, and Port personnel. One week prior to this meeting the Contractor shall distribute the Port-approved overall commissioning management plan and schedule to all members for their review. The overall commissioning management plan, process, and general responsibilities of each team member, reporting and communication protocols, and next steps shall be discussed. The Contractor shall distribute meeting minutes to all parties.
				3. Commissioning Meetings: Once commissioning begins, weekly job site commissioning meetings shall be planned and conducted by the Contractor. These meeting may become part of the weekly construction meetings. These meetings shall cover coordination issue resolution and planning issues, and shall include the CxA and the Port. The Contractor shall distribute meeting minutes to all parties.
			2. INITIAL CHECKOUT, STARTUP, AND CONSTRUCTION CHECKLISTS
				1. Static Elements: For static systems or assemblies with no startup or testing requirements, the Contractor may utilize simplified construction checklists to confirm installation meets contract requirements.
				2. Dynamic Elements: For dynamic systems, equipment, and components, the Contractor shall develop detailed installation, checkout, and startup plans, and shall ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed and the systems, equipment, and components are ready for operational and functional testing.

The initial checkout and startup plan shall include, but not be limited to:

The manufacturer’s installation instructions.

The manufacturer’s or vendor’s field checkout and startup sheets (if available).

The construction checklists, as specified below.

Other field quality control requirements listed in the specifications.

Phasing and sequencing of startup for applicable components, equipment, and systems.

Installation instructions may consist of the manufacturer’s detailed installation instructions copied from installation operation and maintenance manuals shipped with the equipment.

Pre-operational checkout and startup sheets may consist of the manufacturer’s field checkout and startup sheets normally used by the manufacturer for startup.

Construction Checklists:

The construction checklists shall contain requirements for calibration and point-to-point checkout of building automation and process instrumentation and controls.

The Contractor shall determine which trade is responsible for executing and documenting each of the line item tasks in the construction checklists and note the required trade on the checklist form.

Calibrations: The Contractor shall calibrate all field-installed analog sensors and gauges, and all actuators (dampers and valves) on all equipment. One-point calibrations are sufficient within the normal expected range of operation of the sensor using a calibrated test instrument, unless explicitly listed otherwise in the specifications. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

Point-to-Point Checkout: The Contractor shall conduct point-to-point checkout of each control or monitoring point tied to a central control or monitoring system. Each point shall be verified to be commanding, reporting, and controlling according to its intended purpose. Points within and controlled by packaged equipment controllers do not require a point-to-point checkout except for actuator positions or other points listed in the specifications or manufacturer’s startup and checkout procedures.

For complex systems or assemblies, the Contactor shall develop a custom narrative description of the proposed startup or concealment process taking into account interactions and impacts on other systems, construction coordination and scheduling, indoor air quality, system cleanliness, equipment warranty, etc.

* + - * 1. Execution of Construction Checklists and Startup:

Each piece of equipment or assembly being commissioned shall receive full construction checkout by the Contractor following the approved commissioning management plan and forms.

For dynamic mechanical or electrical equipment, the Contractor shall complete the checkout procedures in the commissioning management plan prior to starting equipment.

The Contractor shall notify the Port at least 5 days in advance of any equipment startup.

The Contractor shall observe installation checkout and startup of selected systems and assemblies.

The Contractor and the manufacturer’s representatives shall execute startup and shall maintain a signed and dated copy of the completed construction checklists and installation and startup documentation. The Contractor shall clearly note any items that have not been completed and the plan for their completion.

The construction checklists and other procedures from the checkout and startup plan for a given system or assembly shall be successfully completed prior to operational and functional testing of the systems and equipment.

The Contractor shall correct all areas that are deficient or incomplete prior to initiating operational and functional performance testing.

* + - 1. OPERATIONAL AND FUNCTIONAL TESTING
				1. The Contractor shall perform, witness, and ensure testing is completed in accordance with the Cx plan and the contract documents. The Contractor shall document the results.
				2. Testing Requirements: The specific operational and functional testing requirements for all systems are found in the technical sections.
				3. Objectives and Scope:

The objective of operational testing is to verify each component, assembly, equipment item, subsystem, and system is complete and ready for use and performing in accordance with the contract documents, prior to initiating functional testing.

For dynamic systems, operational testing shall facilitate bringing the systems from a state of initial startup to full dynamic operation. For static elements, operational testing shall verify the performance of the assembly in its installed state under conditions specified in the testing requirements. During the testing process, identify and correct areas of deficient performance.

The objective of functional performance testing is to verify systems, equipment, and components function and perform interactively in accordance with the written sequences and modes specified in the contract documents, prior to initiating operation and maintenance training and final acceptance testing.

In general, functional testing shall include testing each sequence of operations specified in the contract documents, and other significant modes, sequences, and control strategies not mentioned in the written sequences, including, but not limited to startup, shutdown, unoccupied and manual modes, modulation up and down the unit’s range of capacity, power failure, alarms, component staging and backup upon failure, interlocks with other equipment, and sensor and actuator calibrations. Test all interlocks and interactions between systems and equipment. All larger equipment shall be individually tested. Like units or assemblies that are numerous (many smaller rooftop packaged units, air terminal units, exhaust fans, etc.) may have an appropriate sampling strategy applied.

* + - * 1. Operation and Functional Performance Test Methods:

Operation and functional testing and verification for most dynamic systems, equipment, components, hardware, and software shall be achieved by an appropriate combination of manual testing (persons manipulate the equipment and observe its function visually or via test instrument readings) or by monitoring the performance and analyzing the results using the control system’s trend log capabilities or by stand-alone data loggers.

Simulated Conditions: Simulating conditions by overwriting a value shall be allowed, though timing the testing so equipment experiences actual conditions is encouraged wherever practical.

Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.

Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.

Indirect Indicators: Relying on indirect indicators (building control system readouts or trends) for responses or performance will be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings represent actual conditions and responses.

Setup: Perform each function and test under conditions that simulate actual conditions as close as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc., to produce the necessary flows, pressures, temperatures, etc., necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all building equipment and systems affected by these temporary modifications to their pre-test condition.

Sampling: Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant differences in application and sequence of operation in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. No sampling by the Contractor will be allowed in construction checklist execution.

Testing Order: In general, functional testing shall be conducted only after construction check-listing, startup, and operational testing have been satisfactorily completed. The control system shall be sufficiently tested and confirmed to be operating as intended before it is used for testing, adjusting, and balancing or to verify performance of other components or systems. Complete air balancing and water balancing before functional testing of air-related or water-related equipment or systems. Testing generally shall proceed from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be verified.

Trend Logs and Monitoring: Data loggers and trend logs required to support commissioning shall be set up and executed by the Contractor.

Testing and Project Schedule: Every effort shall be made to expedite the testing process and minimize unnecessary delays, without compromising the integrity of the procedures.

* + - 1. NON-CONFORMANCE ISSUES AND FINAL APPROVAL OF FUNCTIONAL PERFORMANCE TESTS
				1. Non-Conformance:

The Contractor shall record the results of the operational and functional tests on the appropriate procedure or test form. All deficiencies or non-conformance issues will be recorded on a master issues log maintained by the CxA and reported directly to the Port within 3 days of occurrence or sooner when scheduling and coordination require it. The Port, CxA, and the Contractor shall work together to establish the responsible party and a suitable plan for resolution of each issue.

The Contractor shall update the issues log when an issue has been resolved.

Any required retesting by the Contractor will not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

* + - * 1. Final Approval of Functional Tests: Final approval of an entire test will not be given until there are no outstanding issues for the system, equipment, or assembly in the issues log, and all related operation and maintenance training and final acceptance testing is complete.
			1. OPERATION AND MAINTENANCE TRAINING
				1. The Contractor shall train and instruct Port maintenance personnel in the operation, adjustment, and preventative maintenance procedures of all systems and equipment.
				2. The Contractor, with assistance from the CxA and the Port, shall develop appropriate training plans and orientation agendas for equipment and assemblies, and shall provide skilled trainers and training materials, including operation and maintenance manuals, system manuals, and as-constructed drawings, for the sessions.
				3. The Contractor shall obtain Port authorization to proceed with training prior to initiating training unless approved otherwise.
				4. Authorization to proceed with training will not be granted until the following criteria are met:

Functional performance testing of applicable systems, equipment, and components is complete.

All punch list items discovered during functional testing have been remedied.

Operation and maintenance manuals, system manuals, and as-constructed drawings for applicable systems, equipment, and components are at least 95 percent complete, have been submitted to the Port for review, and the Port has approved preparation of final operation and maintenance manuals, system manuals, and as-constructed drawings.

* + - * 1. The Contractor shall allow the Port to video tape the training sessions.
				2. The Contractor shall divide maintenance training between classroom (where applicable) and on-the-job “hands on” training.
				3. Training sessions shall include identification of parts, description, servicing, and troubleshooting in the training sessions. Special emphasis shall be given to first response repair of system components.
				4. The Contractor shall conduct training sessions with factory-trained field engineers or technicians.
			1. DEFERRED TESTING
				1. Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition, or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Port.
				2. Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system’s design) specified in the testing requirements shall be completed as part of this contract. The Contractor, with the guidance of the CxA and the Port, shall coordinate this activity. Tests will be executed, documented, and deficiencies corrected by the Contractor. The Contractor shall make needed final adjustments to the operation and maintenance manuals, systems manual, and as-constructed drawings due to the testing results.
				3. Testing Systems in Transitory Areas: Systems located in or serving areas that are later significantly remodeled prior to their final state and final turnover to the Port shall be fully tested, including documentation, prior to initial occupancy. Such systems may require retesting.

Life-safety systems shall undergo complete retesting to ensure all systems are fully functional at final turnover to the Port.

Non-altered portions of non-life-safety systems do not require complete retesting, except at the discretion of the Port. Portions of the systems that have been altered or interfaced within the alterations shall be fully tested and documented.

The Port will determine what is “significantly remodeled” and give final direction of what systems require retesting after review of the Contractor’s phasing and test plans.

* + - * 1. Testing Incomplete Systems: Systems or equipment that are partially complete or partially set up and put into operation to serve an occupancy and then later altered or completed prior to final turnover to the Port require testing.

Life-safety systems, even if only partially set up, shall undergo complete testing and documentation prior to initial occupancy. All altered portions of the system and portions of the original system that may have been adjusted shall be tested prior to final turnover to the Port. At the Port’s discretion, the Contractor shall test and document performance of the entire system prior to final turnover.

The Contractor may use either of the following two methods for testing non-life-safety systems and equipment:

Systems and equipment shall be sufficiently tested by the Contractor to ensure delivery of the required service. Detailed documentation will not be required of this initial testing. During the period the system is partially complete; the Contractor shall be responsible for troubleshooting the system operation for the Port. Upon final completion of the system, the entire system shall be fully tested and documented, prior to turnover to the Port.

Incomplete systems and equipment shall be fully tested and documented to be functioning properly prior to occupancy. During the period the system is partially complete, the Port will be responsible for troubleshooting until a construction deficiency is identified. Upon final completion of the system, the portions of the system that were not initially tested and any areas of interface with those portions shall be fully tested and documented by the Contractor.

* + - 1. FINAL ACCEPTANCE TESTING
				1. The objective of final acceptance tests is to demonstrate to the CxA, the Port, and other authorities having jurisdiction that systems and equipment are substantially complete and ready for use.
				2. The Contractor, with the guidance of the CxA and the Port, shall execute final acceptance tests in accordance with the approved final acceptance test plans, procedures, and checklists.

END OF SECTION 019100