# General

**RoD SPEC NOTE:** Commissioning requirements vary greatly from project to project, so this Section may need to be modified significantly for each project.

## Summary

* + 1. The Work of this Section includes, but is not limited to the following:
       1. Commissioning, testing and documentation.
       2. Audit testing and the commissioning auditor.

## Definitions

* + 1. Commissioning: Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet the original Project requirements established by the Owner.
       1. The Commissioning process begins at Project inception (during the pre-design phase) and continues through the life of the facility.
       2. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the owner's Project requirements.
    2. Commissioning agent: The commissioning agent is a contracted independent agent, hired directly by the Owner and at the Owner’s expense, who directs and coordinates the Project commissioning activities and the reports to the Commissioning Team.
       1. The Owner may, at its sole discretion, use separate commissioning agents for different disciplines.
    3. Commissioning team: All commissioning team members Work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Commissioning team consists of:
       1. Commissioning agent(s);
       2. Owner;
       3. Consultant (including their Architect and Design Engineers as appropriate);
       4. Contractor and, as applicable, their Subcontractors for:
          1. Mechanical;
          2. Electrical;
          3. Testing and balancing (TAB);
          4. Control;
          5. Any other installing Subcontractors or Suppliers of equipment.
       5. Facility operating staff.
    4. Commissioning auditor: Party engaged by the Owner to audit or verify results assembled by the Commissioning Team.
    5. LEED consultant: A consultant hired by the Owner dedicated to monitoring and auditing energy activated equipment, to address LEED criteria for operating equipment efficiency.
    6. Testing agency: Specialty agency engaged by the Owner to perform tests on components or systems to verify conformance to Owner's requirements and Contract Documents.

## Reference standards

* + 1. ASHRAE Guideline 0-2019.

## Methodology

* + 1. The commissioning agent shall develop a commissioning plan, including as a minimum the management of commissioning meetings, and the management of Project-specific commissioning documents.
    2. Commissioning plan to include:
       1. Assembly of owner's requirements, including design criteria, performance goals, budgets, and schedules.
       2. Scheduling and chairing of commissioning meetings between team members.
       3. Development of static and operating check certificates for individual equipment.
       4. Assembly of commissioning reports, including testing and balancing reports, Operations and Maintenance Manuals, start-up reports, and testing reports.
       5. Verification of data by testing agency.
       6. Audit procedure, to be performed in the event of dispute or failure.
       7. Execute the commissioning plan.

## Regulatory requirements

* + 1. Arrange for regulatory authorities to witness those commissioning start-up procedures which are also required by regulatory authorities.
    2. Obtain certificates of approval and for compliance with regulations from authorities having jurisdiction; include copies of certificates with start-up reports.

## Contract commissioning requirements

* + 1. Perform pre-functional and functional performance tests after all relevant and related equipment, systems, structures and areas are complete.
    2. Perform testing and balancing after the pre-functional tests have been completed and documented.
    3. Witnessing: Allow commissioning team members to witness starting, testing, adjusting, and balancing procedures.
    4. Allow commissioning agent and commissioning auditor free access to the site.
    5. Costs: Pay costs associated with starting, testing, adjusting, and relevant instruments and supplies required to perform those duties.
    6. Employ experienced personnel for equipment start-up and commissioning, who are able to interpret results of readings and tests and report the system status in a clear and concise manner.
    7. Provide all equipment required to perform testing, balancing, and commissioning of systems. Calibrate instruments used in start-up as accurate; provide calibration certificates if requested by the commissioning agent.
    8. Utilize equipment check certificates and other commissioning documents required by the commissioning manager.
    9. Verify that equipment is installed in accordance with Contract Documents, and reviewed Shop Drawings. Sign and date static check certificates.
    10. Do not start up equipment unless static check sheets have been completed and submitted.
    11. Complete, in detail, and sign operating check certificates.

## Responsibilities

**RoD SPEC NOTE:** M&E Commissioning Agent may be separate or the same entity. Leave separate within this Section to limit editing of this Section when in use.

* + 1. All parties:
       1. Follow the commissioning plan.
       2. Attend commissioning meetings.
    2. Commissioning agent - mechanical:
       1. Verify pre-functional and functional performance of HVAC systems for compliance with design intent as specified in the appropriate technical trade Sections.
       2. Provide the documentation with standard pre-functional and functional performance reports on completion of the testing.
       3. Verify submissions for HVAC system operation and operations and maintenance manuals, as-built documents, spare parts listing, special tools listing, and other items as may be specified.
       4. Coordinate and direct training of personnel for operation and maintenance of HVAC systems and equipment.
       5. Coordinate and direct each step of the commissioning process and recommend acceptance or non-acceptance to the Owner.
       6. Prepare, in writing, documentation of any deficiencies discovered during the commissioning process. Submit to Contractor and Owner.
       7. The commissioning agent (mechanical) is not responsible for:
          1. Contracting methods;
          2. Health and safety;
          3. Product liability/warranties;
          4. Maintenance long-term building operation;
          5. System functions which have changed since commissioning;
          6. Problems which arise out of recommended resolutions which are not implemented;
          7. Testing the operation of each and every component (e.g. shutoff valve, breaker, etc.);
          8. Normal wear and tear on equipment and systems.
    3. Commissioning agent (electrical):
       1. Verify pre-functional and functional performance of electrical and miscellaneous systems for compliance with design intent as specified in the appropriate technical trade Sections.
       2. Provide the documentation with standard pre-functional and functional performance reports on completion of the testing.
       3. Verify submissions for electrical and miscellaneous systems operation and operations and maintenance manuals, as-built (record) documents, spare parts listing, special tools listing, and other items as may be specified.
       4. Coordinate and direct training of personnel for operation and maintenance of electrical and miscellaneous systems and equipment.
       5. Coordinate and direct each step of the commissioning process and recommend acceptance or non-acceptance to the Owner.
       6. Prepare, in writing, documentation of any deficiencies discovered during the commissioning process. Submit to Contractor and Owner.
       7. The commissioning agent (electrical) is not responsible for:
          1. Contracting methods;
          2. Health and safety;
          3. Product liability warranties;
          4. Maintenance long-term building operation;
          5. System functions which have changed since commissioning;
          6. Problems which arise out of recommended resolutions which are not implemented;
          7. Testing the operation of each and every component (e.g. breaker, etc.);
          8. Normal wear and tear on equipment and systems.
    4. Contractor:
       1. Facilitate the coordination of the commissioning Work by the commissioning agent and ensure that commissioning activities are being scheduled into the master schedule on a monthly basis.
       2. Provide detailed start-up procedures.
       3. No later than forty-five (45) Working Days prior to start-up of the first piece of major equipment, meet with the commissioning agent, Consultant and Owner to finalize the detailed commissioning procedures/schedule.
       4. Provide all tools or the use of tools to start, check-out and test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the commissioning agent.
       5. Review construction checklists provided by the commissioning agent.
       6. Complete electronic construction checklists as Work is completed and provide update to the commissioning agent as required.
       7. Verify completeness of the building envelope, perimeter, and interior items which affect proper operation and control of HVAC, electrical and miscellaneous systems equipment and systems.
       8. Appoint commissioning team members from Subcontractors and specialty trades.
       9. Assure participation and cooperation of Subcontractors and specialty trade Contractors (e.g. mechanical, electrical, TAB, building management, etc.) under the Contractor’s jurisdiction as required for the commissioning process.
       10. Be responsible for the actual system pre-functional and functional performance testing. Any changes to the supplied test procedures must be approved by the commissioning agent.
       11. Review commissioning progress and deficiency reports and correct deficiencies identified.
       12. Provide assistance for seasonal or deferred performance testing, performed by the commissioning agent, according to the Contract Documents.
       13. Correct deficiencies and make necessary adjustments to operation and maintenance manual and as-built Drawings for applicable issues identified in any seasonal testing.
    5. Mechanical consultant:
       1. The mechanical consultant shall provide the design intent documentation for commissioning.
       2. The mechanical consultant shall observe (pre-functional and functional performance testing), where they deem necessary.
       3. The mechanical consultant shall provide technical capabilities for resolution of deficiencies where required.
    6. Electrical consultant:
       1. The electrical consultant shall provide the design intent documentation for commissioning.
       2. The electrical consultant shall observe (pre-functional and functional performance testing), where they deem necessary.
       3. The electrical consultant shall provide technical capabilities for resolution of deficiencies where required.

# Products

## Test equipment

* + 1. All testing equipment required to perform start-up and initial checkout and required performance testing shall be provided by the Contractor for the equipment being tested.
    2. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply:
    3. Temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards within the past year to accuracy of 0.5 °C and a resolution of + or - 0.1 °C.
    4. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
    5. All equipment shall be calibrated according to the manufacturer’s recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

# Execution

## Commissioning process

* + 1. Commissioning process shall follow ASHRAE Guideline 0-2013: The Commissioning Process, and all addenda thereto.
    2. Commissioning process shall encompass and coordinate the following areas:
       1. System documentation;
       2. Equipment start-up and performance testing (pre-functional testing);
       3. Testing and balancing;
       4. Control system calibration;
       5. System start-up and performance testing (functional testing);
       6. Training. Refer to Section 01 79 00;
       7. Deﬁciency documentation and resolution.
    3. The commissioning process will not:
       1. Preclude the duties and responsibilities described in the Contract Documents nor the requirements and obligations of the Contract.
       2. Circumvent any required warranties.
       3. Relieve the Contractor from warranty requirements, responsibilities, or obligations.
    4. Operation and maintenance (O&M) manuals for HVAC equipment and systems:
       1. Furnish operation and maintenance manuals to the commissioning agent (mechanical) for review ten (10) Working Days prior to the functional performance tests.
    5. Operation and maintenance (O&M) manuals for electrical equipment and systems:
       1. Furnish operation and maintenance manuals to the commissioning agent (electrical) for review ten (10) Working Days prior to the functional performance tests.
    6. Start-up (pre-functional performance test):
       1. Be responsible for the pre-functional performance tests. These tests ensure that all equipment and systems are installed in accordance with the Contract Documents and manufacturers’ requirements.
       2. Coordinate scheduling for pre-functional tests of various equipment and systems.
       3. In the pre-functional test, check all HVAC mechanical systems and sub-system elements, including control devices, for the following:
          1. Verify that each element has been properly installed, properly identifies, and that all connections have been made correctly.
          2. Verify that each element has been checked for proper lubrication, drive rotation, belt tension, control sequence, flow direction, or other conditions which may cause damage or reduce system performance.
          3. Verify that tests, meter readings, and specific mechanical performance characteristics agree with those required by equipment or system manufacturer.
          4. Test format shall be supplied, witnessed and completed by the commissioning agent (mechanical).
          5. Pre-functional performance tests shall be completed prior to starting functional performance tests.
          6. Pre-functional performance tests need to be performed once only, if there are no deficiencies, as determined by the commissioning agent. Re-testing of corrected items shall be the responsibility of the Contractor.
          7. Completion of the pre-functional performance test shall be the responsibility of the Contractor who shall also sign and date each test.
    7. In the pre-functional test, check all electrical and miscellaneous systems and sub-system elements, including devices, for the following:
       1. Verify that each element has been properly installed, properly identified, and that all electrical connections have been made correctly.
       2. Verify that each element has been checked for proper switches, starters, circuit breakers or other conditions which may cause damage or reduce system performance.
       3. Verify that tests, meter readings, and specific electrical performance characteristics agree with those required by equipment or system manufacturer.
       4. Test format shall be supplied, witnessed and completed by the commissioning agent (electrical).
       5. Pre-functional performance tests shall be completed prior to starting functional performance tests.
       6. Per-functional performance tests need to be performed once only, if there are no deficiencies, as determined by the commissioning agent. Re-testing of corrected items shall be the responsibility of the Contractor and shall be completed at his expense.
       7. Completion of the pre-functional performance tests shall be the responsibility of the Contractor who shall also sign and date each test.
    8. Testing, adjusting and balancing of mechanical systems (TAB):
       1. Commence TAB immediately following the pre-functional testing and in accordance with the construction schedule.
       2. Assist the TAB agency with equipment and/or manpower to allow their testing of dampers, actuators, and motors to be performed in a timely manner.
       3. Submit one draft copy of the TAB report to the commissioning agent (mechanical) and provide the necessary reviews prior to the functional testing.
       4. Submit one copy of the final TAB reports to the commissioning agent (mechanical).
    9. Testing and (load) balancing of electrical systems (TAB-E):
       1. Commence the TAB-E immediately following the pre-functional testing and in accordance with the construction schedule.
       2. Submit one draft copy of the TAB-E report to the commissioning agent (electrical) and provide the necessary reviews prior to the functional testing.
    10. Control commissioning and calibration:
        1. To be completed by the Contractor prior to the functional testing and in accordance with this Section.
    11. Functional performance tests:
        1. Be responsible for the functional performance tests. These tests ensure that all equipment and systems operate in accordance with design intent. The tests are dynamic tests and test the systems through all possible modes of operation.
        2. Coordinate the functional performance tests for the HVAC mechanical systems and sub-systems; electrical and miscellaneous systems and sub-systems.
        3. In the functional performance tests, check all HVAC mechanical systems, including control systems, electrical and miscellaneous systems for the following:
           1. Verify that each system and sub-system is operating and complies with the Contract Documents and the design intent document through the entire range of operating conditions.
           2. Test format for HVAC mechanical systems shall be supplied by the commissioning agent (mechanical).
           3. Test format for electrical and miscellaneous systems shall be supplied by the commissioning agent (electrical).
           4. Notify the mechanical and electrical commissioning agents and mechanical and electrical consultants, in writing, at least ten (10) Working Days prior to date of functional performance tests.
           5. Re-testing of corrected items shall be the responsibility of the Contractor.
           6. The following parties shall be present during functional performance testing:

Contractor;

Mechanical and controls Subcontractor(s) as relevant to specific test;

Commissioning agent.

* + - * 1. The Owner and Consultant may be present for some or all functional performance testing.
        2. Deficiencies in system, sub-system, or element performance will be brought to the attention of the commissioning team. Deficiencies will be resolved on a case-by-case basis.
    1. Control verification:
       1. Verify operation of controls in conjunction with the functional performance testing and in accordance with the Contract Documents.
    2. Reports:
       1. The commissioning agent (mechanical) and commissioning agent (electrical) shall be responsible for recording and maintaining detailed inspection and testing data on the test documentation reports. The data record shall be comprehensive and concise.
       2. All data must be recorded as soon as possible during the course of the inspection and testing.
       3. All documentation shall have the date, time, and names of persons participating in the inspection and testing.
       4. All test instruments shall be documented for valid calibration.
       5. The recording Work sheets, inspection check lists, and performance testing plans must all be approved by the mechanical and electrical consultants and the mechanical and electrical commissioning authorities prior to the start of functional performance testing.
       6. The mechanical and electrical commissioning agent shall prepare and submit a final report.

## Commissioning testing

* + 1. Allow for Work, effort, and associated costs necessary to assist an Owner appointed and remunerated commissioning agent, for fulfilment of a commission testing process of the facility and Work.
    2. Coordinate, cooperate, and harmonize efforts with the commissioning agent.
    3. Commission testing will include a random testing and evaluation process as determined by the commissioning agent.
    4. System and device checks to be suitably logged, tabulated, signed, and incorporated into Project operation and maintenance manuals:
       1. Prior to start of testing, provide a complete set of up-to-date Contract Documents (Drawings and Specifications) in electronic format, including addenda and approved change notices to the commissioning agent.
    5. Coordinate site visits by the commissioning agent and the affected parties during warranty periods.
    6. Prior to commissioning testing, provide copies the following to the commissioning agent for components and assemblies to confirm Contract Document compliance:
       1. Static test certificates.
       2. Equipment operating certificates.
       3. Electronic copy of valve tag list.
       4. Inspection certificates from authorities having jurisdiction.
       5. Required copies of Shop Drawings.
       6. Manufacturer's operating and maintenance brochures of all major equipment.
    7. Ensure all systems have been started, adjusted to design criteria, and are functionally operational, ready for independent testing.
    8. Cooperate with the commissioning agent in advance of activating operating systems.
    9. Test results that reveal failure to conform to the Contract Documents, will result in a second series of tests performed by a commissioning auditor.

## Mechanical system commissioning

* + 1. General requirements:
       1. Test operating equipment and systems in the presence of the commissioning agent (and the mechanical consultant - at the mechanical consultant's option) to demonstrate compliance with Contract Documents. To minimize the time of commissioning team members, testing shall be done in four seasonal single blocks of time insofar as possible.
       2. Notify the commissioning agent, in writing, ten (10) Working Days in advance of tests being performed.
       3. Conduct test under specified design operating conditions as recommended or approved by the commissioning agent and mechanical consultant and outlined in the pre-functional and functional performance tests.
       4. Test all elements of systems to demonstrate that total systems satisfy requirements of the Contract Documents.
       5. Perform testing on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by any inter-ties of other major systems.
       6. Provide a copy of all test reports and records to the commissioning agent (mechanical).
    2. Test procedure and test documentation:
       1. Commissioning agent will provide the Contractor with pre-functional and functional test procedures and test documentation reports. Contractor may propose alternate documentation and may alter the test procedures and test documentation to suit as-built conditions, however, the Contractor will be expected to co-operate to the level of detail and general approach of the provided test procedures and test documentation.
       2. Commissioning agent shall verify test and air balance (TAB) readings for at least 10% of the supply (maximum and minimum primary air), return, and exhaust diffusers, registers and grilles. If more than 20% of these readings differ from the documented TAB readings by more than 10%, then TAB shall be repeated in its entirety. TAB agency shall pay all the extra costs.
       3. The verification testing procedures shall address all operating characteristics of all mechanical equipment and systems.
    3. Deficiency resolution for HVAC mechanical system commissioning:
       1. If acceptable performance cannot be achieved, carry out the necessary corrective measures to bring system into compliance.
       2. The allocation of cost of deficiency resolution shall be determined by the commissioning team on a case-by-case basis.

## Electrical and miscellaneous system commissioning

* + 1. General requirements:
       1. Operating equipment and systems shall be tested in presence of the commissioning agent (electrical) and the electrical consultant (at the electrical consultant’s option) to demonstrate compliance with specified requirements.
       2. Notify the commissioning agent, in writing, ten (10) Working Days in advance of tests being performed.
       3. Conduct test under specified design operating conditions as recommended or approved by the commissioning agent (electrical) and electrical consultant and outlined in the pre-functional and functional performance tests.
       4. Test all elements of systems to demonstrate that total systems satisfy requirements of the Contract Documents.
       5. Perform testing on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by any inter-ties of other major systems.
       6. Provide a copy of all test reports and records to the commissioning agent (electrical).
    2. Deficiency resolution for electrical system commissioning:
       1. If acceptable performance cannot be achieved, carry out the necessary corrective measures to bring system into compliance. The electrical consultant and/or the Contractor should issue appropriate directions in this regard.
       2. The allocation of cost deficiency resolution shall be determined by the commissioning team, on a case-by-case basis.

## Audit testing and the commissioning auditor

* + 1. In the event on non-compliance or test failure described in the commission testing process above, comply with the following requirements:
       1. Allow for Work, effort, and associated costs necessary to assist an Owner appointed and remunerated auditor, for fulfilment of a further audit testing of the facility and Work.
       2. Coordinate, cooperate, and harmonize efforts with the auditor.
       3. Audit testing will include further random testing and evaluation as determined by the Owner, the auditor, and the commissioning agent.
    2. Suitably log, tabulate, and incorporate signed system and device check certificates into operating and maintenance manuals.
    3. Coordinate site visits by the auditor, commission agent and the affected parties during warranty periods.
    4. The audit process will not:
       1. Preclude the duties and responsibilities described in the Contract nor the requirements and obligations of the Contract.
       2. Circumvent any required warranties.
       3. Relieve the Contractor from warranty requirements, responsibilities, or obligations.
    5. Cooperate with the auditor prior to testing of operating systems.
    6. Test results that demonstrate failure to conform to the Contract Documents, may result in the following, at the Owner's sole discretion:
       1. Complete rejection of the subject component, assembly, or system;
       2. Removal of defective items from the Work;
       3. An adjustment credit to the Contract Price for the Owner's estimated value of the subject item plus remuneration for associated damages and inconvenience;
       4. Provision of a suitable substitute Product in place of the defective Product.
          1. Substituted Products will be required to be commissioned and audited and undergo the same scrutiny as described for commission testing and audit testing described above.

End of section