ATTACHMENT C: SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for commissioning of the project equipment and systems as specified herein. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, operation and occupancy meet the Owner's project requirements as defined in the project contract documents. The commissioning process and related work shall conform to the requirements of all applicable specification sections and drawings issued as a part of the overall project construction contract.

B. The generator sets and automatic transfer switches (ATS) that are included in the commissioning process under this specification section will be purchased directly by the Owner from a manufacturer’s authorized distributor for installation by the construction contractor (“Contractor”) under this contract.

C. The Uninterruptible Power Supply (UPS) units and data center in-row air conditioning units that are included in the commissioning process under this specification section will be purchased directly by the Owner from a manufacturer’s authorized distributor ("Supplier") for installation by the Supplier under a separate contract. The Owner furnished Supplier installed equipment will be installed during the project construction phase. The Owner will schedule the Supplier’s equipment installation so as not to interfere with the Contractor’s operation. However, the Contractor shall coordinate project work and commissioning activities with the Owner furnished Supplier installed equipment.

D. The Contractor shall have primary responsibility for conducting the commissioning process. However, the equipment supplier and construction contractor shall coordinate with each other in completion of the work specified herein to provide a complete and operable system.

E. The commissioning process specified herein does not modify the responsibilities of the equipment suppliers of the equipment purchased directly by the Owner as described above to provide a complete and operable system. The equipment suppliers of the equipment purchased directly by the Owner shall maintain full participation in the commissioning process, and shall be responsible for all documentation requirements, testing personnel services and related test equipment/tools, resolution of testing issues, test reports, and compliance with all commissioning requirements specified herein, including achieving fully operational status of equipment supplied for this project in compliance with the project contract requirements. All documentation and test reports required by this specification shall be submitted by the equipment suppliers to the Contractor for collection and coordination with other documentation for the required project submittals.

1.2 COMMISSIONED SYSTEMS AND EQUIPMENT SUMMARY

Abbreviations:
OFI: Owner furnished Contractor installed.
OFOI: Owner furnished Owner installed.
OFI: Owner furnished Supplier installed.
CFCI: Contractor furnished Contractor installed.

A. Mechanical/HVAC:

1. In-row cooling unit IRC-1 & condenser unit IRCU-1 (OFI)
2. In-row cooling unit IRC-2 & condenser unit IRCU-2 (OFSI)
3. In-row cooling unit IRC-3 & condenser unit IRCU-3 (OFSI)
4. In-row cooling unit IRC-4 & condenser unit IRCU-4 (OFSI)
5. UPS AC unit AC-1 & condenser unit CU-1 (CFCI)
6. UPS AC unit AC-2 & condenser unit CU-2 (CFCI)
7. Equipment room AC unit FC-1 & condenser unit CU-1 (CFCI)
8. HVAC system controls for all HVAC equipment

B. Electrical:

1. Generator “A” (OFCS)
2. Generator “B” (OFCS)
3. ATS “A” (OFCS)
4. ATS “B” (OFCS)
5. Uninterruptible Power Supply UPS-A (OFSI)
6. Uninterruptible Power Supply UPS-B (OFSI)
7. Panelboards: MDP, HC, HA, HB, HC, LA, LB, and all related accessories and metering (CFCI)
8. Transformers: TX-A, TX-B and all related accessories (CFCI)
9. Power monitoring systems (CFCI)

C. Summary of Commissioning Level Phases: Below is a summary of the commissioning activities related to the equipment listed above; these requirements are not all inclusive and additional requirements are specified herein:

Level 1: Factory Witness Testing (FWT) Summary:
Factory witness testing (FWT) consists of Owner/CA/AE-witnessed testing of equipment at the factory, by factory personnel. FWT is not required for this project; however, factory testing and related test reports for factory testing required by the specifications shall be included in the commissioning process.

Level 2: Component Quality Assurance (CQA) Summary:
Component quality assurance (CQA) includes inspection and verification of individual system components and equipment at the site upon delivery for compliance to the design specifications, drawings, and approved project submittals; it includes inspection of system components and equipment for shipping damage and missing items.

Level 3: Startup Verification (SUV) Summary:
Startup verification testing (SUV) includes review and conducting startup procedures and testing in accordance with the commissioning plan and manufacturer procedures.

Level 4: Functional Performance Testing (FPT) Summary:
Functional performance testing (FPT) includes demonstration that each system is operating according to the contract document requirements, manufacturer operational control sequences, and the commissioning plan; it includes bringing the systems from a state of individual substantial installation completion to full dynamic operational completion as individual systems.

Level 5: Integrated Systems Testing (IST) Summary
Integrated systems testing (IST) includes demonstration that each system is operating seamlessly in an integrated manner coordinated with all other related systems in the project, so that the facility as a
whole meets the Owner requirements for reliability and availability; it includes bringing the systems from a state of individual operational completion to full-scale operation of systems as a cohesive integrated system.

D. Owner/Supplier Furnished Supplier Installed Equipment (OFSI)

1. Data center equipment furnished by the Owner and installed by the equipment Supplier (OFSI) indicated in the listing above is in the scope of the commissioning process. Refer to specification paragraphs “Scope” and “Responsibilities” herein for additional requirements for coordination of work.

E. Data Center Monitoring Systems (OFOI)

1. Data center monitoring (DCM) systems provided by the Owner (OFOI) for overall data center monitoring will interface with the monitoring provisions specified for the data center equipment, and will be provided by the Owner. Commissioning of the Owner data center monitoring systems is not in the scope of this contract. However, the Owner will be installing monitoring equipment and related work during the project construction phase. The Owner will be testing the DCM system concurrently with the commissioning work specified herein, and will schedule the Owner’s data center monitoring work so as not to interfere with the Contractor’s operation. However, the Contractor shall coordinate project work and commissioning activities with Owner monitoring system installation and testing operations.

1.3 RELATED DOCUMENTS

A. All Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

C. Related Sections include, but are not limited to, the following:

1. Individual Division 21, 22, 23, and 26 Sections contain requirements related to the commissioning process.

1.4 SUMMARY

A. An independent Commissioning Agent (CA) has been retained to implement and coordinate the commissioning process for this project.

B. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, operation and occupancy meet the Owner's project requirements as defined in the project contract documents. The objectives of the commissioning process, as they relate to this specification, are to:

1. Verify that the performance of the mechanical and electrical systems provided under this contract meet contract requirements and Owner criteria.
2. Verify that O&M documentation left on site is complete.
3. Verify that the Owner’s operating personnel are adequately trained.
C. This section defines the members of the commissioning team (CxT) and outlines the responsibilities of each member of the CxT. All CxT members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.

D. The commissioning process does not modify or reduce the responsibilities of the project Architect/Engineer (A/E) or Contractor of contractual obligations related to this project.

E. Participating CxT entities shall each include the cost to complete their work of the commissioning process in their proposal.

1.5 DEFINITIONS

A. Acceptance: A formal action, taken by a person with appropriate authority (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

B. Basis of Design (BoD): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

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

D. Commissioning (Cx): A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner’s project requirements.

E. Commissioning Agent (CA): The entity identified by the Owner who plans, schedules, and coordinates the commissioning team to implement the commissioning process.

F. Commissioning Levels 1-5 activities are defined as:
   Level 1: Factory Witness Testing (FWT)
   Level 2: Component Quality Assurance (CQA)
   Level 3: Startup Verification (SUV)
   Level 4: Functional Performance Testing (FPT)
   Level 5: Integrated Systems Testing (IST)

G. Commissioning Plan: A document that provides the organization, schedule, and coordination planning for the commissioning process.

H. Commissioning Process Activities: Components of the commissioning process.

I. Commissioning Process Progress Report: A written document that details activities completed as part of the commissioning process and significant findings from those activities, which is continuously updated during the course of a project.
J. Commissioning Request for Information (RFI): Form used by the CA to request information from the design and construction team.

K. Commissioning Team (CxT): The individuals who through coordinated actions are responsible for implementing the commissioning process.

L. Coordination Drawings: Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers’ recommended maintenance clearances.

M. Deferred Performance Tests (DPTs): Performance tests that are performed, at the discretion of the CA, after Substantial Completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that do not allow the test to be performed.

N. Deficiency: A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents.

O. Document Request Log: A log maintained by the CA to list and track documents requested from the design and construction team.

P. Factory Testing: Testing of equipment on-site or at the factory, by factory personnel, with or without an Owner’s Representative present.

Q. Functional Performance Test: A written protocol that defines methods, personnel, and expectations, for tests conducted on components, equipment assemblies, systems, and interfaces among systems.

R. Integrated System Testing: A written protocol that defines methods, personnel and expectations for tests conducted to verify proper interface and interaction between HVAC, building automation, electrical, and fire systems. In addition to testing the response of these systems to a building power outage and restoration, HVAC equipment is tested to verify that modules of capacity are brought on automatically in response to added heat load.

S. Issues Log: A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the commissioning team during the course of the commissioning process.

T. Non-Compliance: See Deficiency.

U. Non-Conformance: See Deficiency.

V. Owner’s Project Requirements (OPR): A written protocol that details the functional requirements of a project and the expectations of how it will be used and operated. This includes project and design goals, measurable performance criteria, and supporting information.

W. Phased Commissioning: Commissioning that is completed in phases as required by the phasing plan as approved for the Project and other scheduling issues.

X. Pre-Functional/Start-Up Checklist: A form used by the Contractor to verify that appropriate components are on-site, ready for installation, correctly installed, and functional.
Y. Seasonal Performance Tests: Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.

Z. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

AA. Systems Manual: A system-focused document that refers to reference materials and their physical location and bound information that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operation phase.

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

CC. Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project requirements.

1.6 SUBMITTALS

A. General: The Contractor shall submit electronically to the CA for concurrent review along with the A/E and the Owner submittals for all electrical and mechanical equipment required in the respective specification sections for the equipment. In addition, the Contractor shall submit electronically to the CA for concurrent review along with the A/E and the Owner all submittals specified herein.

B. The CA will review submittals for conformance to the contract documents as it relates to the commissioning process, to the performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance test procedures and only secondly to verify compliance with equipment specifications. Review of submittals by the CA does not relieve the contractor of compliance with all contract requirements, whether identified by the CA or not. CA will submit submittal review comments to the Owner, A/E, and Contractor. The Owner will determine if CA review comments require resubmission of submittals.

C. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

D. Submittals to be submitted for CA review:

1. Submittals shall include all mechanical systems, electrical systems, and related work and control systems. Include a complete bill of material of equipment used indicating quantity, manufacturer and model number and other relevant technical data.

2. Manufacturer’s description and technical data, such as performance curves, performance test procedures, product specification sheets, schedules, settings and installation, narrative description of control sequences of operation, as-built wiring schematics, sub-system interfaces, interlocks, operation and maintenance instructions, and detailed startup/testing procedures.
3. Equipment outline dimensions, layout details, operating and maintenance clearances and sufficient engineering data to indicate compliance with the specifications.
4. Layout and coordination drawings for all equipment, drawn accurately to a scale sufficiently large to show all pertinent aspects of the item and its method of connection to the work.
5. Each piece of equipment shall be identified by the number shown in the schedules and specification article number pertaining to the item. Shop drawings shall be prepared by the Contractor for the project and not reproduced from the A/E’s Drawings.
6. When manufacturer’s cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project will be highlighted or clearly indicated by other means. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.
7. O&M manual documentation. Submittals to the CA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CA will review them.

1.7 COMMISSIONING TEAM

A. Members appointed by Contractor: Individuals, each having expertise and authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CA.

B. Members Appointed by Owner:

1. CA: An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner has engaged the CA under a separate contract.
2. Owner representatives of the facility user and maintenance organizations.

C. Members of the Commissioning Team, at minimum, shall include:

1. Owner’s Representative
2. Architect/Engineer (A/E)
3. Electrical, HVAC, plumbing, and fire protection equipment suppliers, including suppliers of Owner-Furnished equipment that is procured directly by the Owner. Refer to paragraph “Scope” above for delineation of contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.
4. General Contractor
5. Fire Protection Sub-contractor
6. Plumbing Sub-contractor
7. Mechanical Sub-contractor
8. Electrical Sub-contractor
9. BMS Sub-contractor
10. All control system Sub-contractors
11. Test and Balance Subcontractor
12. Electrical Test Subcontractor
13. Commissioning Agent
D. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

1.8 RESPONSIBILITIES

A. All Cx team Members:

1. Follow the commissioning plan.
2. Attend preconstruction commissioning meeting and additional commissioning meetings as necessary.
3. Cooperate with all other Cx team members to carry out commissioning process.
4. Include the price of commissioning responsibilities/tasks in each Cx team member’s proposal.

B. Commissioning Agent (CA):

1. Develops a commissioning plan outlining the organization, schedule, and documentation requirements of the commissioning process. CA oversees implementation of commissioning plan.
2. Plans the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, updated timelines and schedules, and technical expertise.
3. The CA will develop specific commissioning documentation. This commissioning documentation will be kept in electronic format and three ring binders. The CA-developed commissioning documentation shall include the following documentation subject to Owner approval:
   a. Commissioning plan.
   b. Commissioning schedule.
   c. Commissioning RFI's.
   d. Commissioning issues log.
   e. Commissioning checklists.
   f. Commissioning test procedures.
   g. Commissioning progress reports.
   h. Commissioning team meeting minutes.
   i. Final commissioning report.
4. CA documentation will be developed for review by the Cx team after submission and review of proposed project equipment submittals.

C. Owner:

1. Defines the Owner’s Project requirements (OPR), provides interpretations and clarifications to the OPR, and provides OPR document to CA and Contractor for information and use.
2. Manages the contract of the A/E (A/E) and Contractor.
3. Provides the approved basis of design documents (BoD) to the CA and Contractor.
4. Facilitates the coordination of the commissioning work by the CA, and, with the Contractor and CA, within the overall construction schedule.
5. Assigns operations and maintenance personnel and arranges for them to participate in the Cx meetings and testing.
6. Reviews, comments and approves the documentation prepared by the CA.

D. Architect/Engineer (A/E):

1. Provides design and construction phase support services as contracted to the Owner.
2. Prepares construction contract documents.
3. Specifies and verifies adequate maintenance access for each piece of equipment in design, Shop Drawings, and actual installation.
4. Provides system design parameters to Owner and obtains approval.
5. Provides any design narrative documentation requested by the CA. This includes clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
6. Notifies the CA of substantive changes to the contract documents.
7. Reviews and comments on documentation prepared by the CA.

E. Contractor:

1. Supports all commissioning activities and coordinates all commissioning activities of his sub-contractors and equipment suppliers, as required.
2. Facilitates the coordination of commissioning work by the CA and integrates activates of the Contractor, his sub-contractors, and all other CxT member commissioning tasks/activities into the construction schedule.
3. Submits electronically all construction documents, addenda, change orders, requests for information, submittals related to commissioned equipment/systems to CA.
4. Includes requirements for submittal data, O&M data, commissioning tasks and training in each purchase order or subcontract written.
5. Performs review of submittals for completeness and accuracy prior to forwarding submittals on the the Cx team for review.
6. Provides qualified personnel for performing all test procedures, including testing identified by CA.
7. Coordinates training of Owner personnel. Develops training agenda, training materials, conducts training sessions. Schedules sub-contractors, equipment suppliers, etc. to participate in training the Owner’s personnel. Coordinates with Owner schedule for training Owner operating personnel. Provides training agenda, materials and schedules to CA for review and comment.
8. Attends CxT meetings.
9. Provides functional and seasonal testing plan in accordance with procedures supplied by the CA.
10. Responds to and addresses items documented in the issues log.
11. Notifies the CA four weeks in advance of all equipment startup, Contractor directed testing, and testing required by contract documents.
12. Certify that equipment/systems have been installed per manufacturer’s instructions.
13. Notifies the CA when systems and assemblies are ready for CA witnessed testing.
14. Remedies any deficiencies identified in the Cx testing and notifies CA when deficiencies have been addressed.
15. Coordinates and facilitates the resolution of non-compliance, deficiencies and discrepancies identified in all phases of commissioning.
16. Prepares O&M manuals, according to the contract documents, including clarifying and updating the original sequences of operation to as-built conditions. Submits O&M manuals to CA for review prior to Owner operating personnel training. O&M manuals are to be used in training sessions.

17. Submits complete set of record drawings to CA for review.

F. Equipment Suppliers:

1. Provides all submittal data required in the contract documents, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assists in equipment testing per agreements with Contractor.
3. Includes all special tools and instruments required for testing equipment according to these contract documents.
4. Reviews specified products and requests clarifications as needed from the A/E.
5. Provides information requested by CA regarding equipment sequence of operation and testing procedures.
6. Reviews and coordinates test procedures for equipment installed by factory representatives.
7. Provides personnel, services, documents, tools, etc. for all project requirements and testing that are applicable to equipment suppliers.

G. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

1.9 COORDINATION

A. The CA shall receive a copy of all construction documents, addenda, change orders, and appropriate approved submittals and Shop Drawings related to commissioned system/equipment directly from the Contractor.

B. The CA shall disseminate written information and documents to all responsible parties relative to the nature and extent of the communication.

C. The CA is primarily responsible to the Owner and, as such, shall regularly apprise the Contractor and the Owner of progress, pending problems and/or disputes, and shall provide regular status reports on progress with each system. Any potential change in the contractual and/or financial obligations of the Owner (credits, change orders, schedule changes, etc.) shall be identified by the Contractor and submitted to the Owner for review in a timely fashion to support the overall project schedule.

D. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

1.10 SCHEDULE

A. The Contractor shall coordinate the schedule of commissioning activities with the construction schedule. It is possible that some procedures will be completed before the entire system is completed. Contractor schedules and scheduling is the responsibility of the Contractor. The CA shall provide commissioning scheduling information to the
Contractor for review and planning activities. CA developed commissioning activities shall be integrated into the construction schedule by the Contractor.

B. The schedule shall incorporate sufficient time for the commissioning process steps specified herein.

C. The Contractor shall integrate all commissioning activities into the overall construction schedule. All parties shall address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

D. Problems observed shall be addressed immediately, responsible parties notified, and actions taken to correct deficiencies coordinated in a timely manner.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All test equipment, special tools, ladder/lifts, two way radios and equipment required for performing the specified tests shall be provided by the Contractor for Contractor-furnished equipment, and shall be provided by the Supplier for Owner-furnished Supplier installed equipment, as approved by the CA. The Owner shall furnish necessary utilities for the commissioning process.

B. All portable or hand-held setup/calibration devices required to initialize the control system shall be provided by the control system sub-contractor and equipment supplier for testing.

C. The instrumentation used in the commissioning process shall meet the following standards:

1. Be sufficient quality and accuracy to test and/or measure system performance within the tolerances required.
2. Be calibrated at the manufacturer’s recommended intervals with calibration tags permanently affixed to the instrument.
3. Be maintained in good repair and operating condition throughout the duration of use on this project.
4. Be immediately recalibrated, repaired, or replaced if dropped and/or damaged in any way during use on this project.

D. Proprietary test equipment and software required by any equipment manufacturer for programming and/or startup, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

d. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

2.2 LOAD BANKS
A. All load banks required for commissioning will be furnished by the Owner for Contractor use in testing in accordance with the Cx plan, and shall be returned in fully operable original condition to the Owner upon completion of load bank testing. Contractor shall be responsible for connection and operation of load banks.

PART 3 - EXECUTION

3.1 COMMISSIONING PLAN

A. The CA will develop a commissioning plan with the information specified below for the project:

1. Contact directory of key commissioning team personnel
2. Communications protocol for project
3. Listing of equipment/systems to be commissioned
4. Sampling strategy to be used for equipment and systems for applicable commissioning process.
5. Responsibilities for each party involved with the commissioning process
6. Commissioning milestones and schedule
7. Listing of key deliverables associated with the commissioning process
8. Note that the commissioning plan will be incorporated into the commissioning report so that one document will be used throughout the commissioning process and when the process is completed this documents will be called the final commissioning report.
9. Listing of exhibits to the commissioning plan/report.

3.2 MEETINGS

A. The CA will schedule, plan and conduct an initial commissioning meeting with the Contractor. The Contractor and its responsible parties are required to attend.

B. Other meetings will be planned and conducted by the CA as construction progresses. The meetings will cover coordination, deficiency resolution, and planning issues. These meetings will be held at least monthly, until the final three months of construction, when they may be held as frequently as once per week.

C. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

3.3 CONSTRUCTION OBSERVATION

A. CA construction observation is an additional and separate activity from that provided by the design team. Construction observation is required as part of the commissioning and coordination process to be provided by the CA.

3.4 TEST AND BALANCE (TAB)
A. Air and water test and balance shall be accomplished by a test and balance firm as specified by the A/E.

3.5 COMMISSIONING PHASE LEVELS

A. Refer to the commissioning systems and equipment summary specified herein for guidance on general requirements for each phase of the commissioning process. More detailed information will be included in the commissioning plan that will be developed by the CA.

B. Commissioning phase levels are defined as:
   Level 1: Factory Witness Testing (FWT)
   Level 2: Component Quality Assurance (CQA)
   Level 3: Startup Verification (SUV)
   Level 4: Functional Performance Testing (FPT)
   Level 5: Integrated Systems Testing (IST)

C. Summary of Commissioning Level Phases: Below is a summary of the commissioning activities related to the equipment listed above; these requirements are not all inclusive and additional requirements are specified herein:

3.6 LEVEL 1 - FACTORY WITNESS TESTING (FWT)

A. Factory Witness Testing (FWT) consists of testing of equipment at the factory, by factory personnel, and includes demonstration of features, attributes and capacity of the equipment at the factory to verify the manufactured equipment is operating in accordance with the manufacturer’s published specifications.

B. FWT normally includes witnessing of factory testing by representatives from the Owner, CA, and A/E. However, FWT is not required for this project. However, factory testing and related test reports for factory testing required by the specifications shall be included in the Cx process.

C. Contractor shall submit factory test reports in accordance with contract documents and the Cx plan for review and approval.

3.7 LEVEL 2: COMPONENT QUALITY ASSURANCE (CQA)

A. CQA consists of inspection and verification of individual system components and equipment at the site upon delivery for compliance to the design specifications, drawings, and approved project submittals. CQA shall also include inspection of system components and equipment for shipping damage and missing items. CQA shall be conducted by the Contractor and associated subcontractors that will be installing the equipment in accordance with contract documents and the Cx plan, prior to unloading and storage of equipment and system components, and will be observed by the Owner.

B. Contractor shall submit CQA reports in accordance with contract documents and the Cx plan for review and approval.
C. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

3.8 LEVEL 3: STARTUP VERIFICATION TESTING (SUV)

A. SUV consists of review of the equipment startup and testing plans and procedures developed by the contractor and associated equipment manufacturers, followed by conducting startup procedures and testing in accordance with the Cx plan and manufacturer procedures. SUV includes an evaluation of interconnection between components, physical arrangement, support and anchoring, access provisions, clearance, and verification of the overall construction completion of the equipment and systems for compliance with the contract documents and manufacturer instructions.

B. SUV shall be conducted after preparation of startup and testing plans and procedures, and after completion of installation by the Contractor with verification of equipment installation completion. As a part of SUV, prefunctional/startup checklists shall be completed in accordance with the Cx plan as specified below.

C. SUV shall be conducted by the Contractor and the equipment manufacturer factory-certified technicians and observed by the CA and Owner.

D. Upon CA approval of the SUV test reports, the equipment/system shall be considered ready for Functional performance testing (FPT), as specified below.

E. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

3.9 PRE-FUNCTIONAL/STARTUP CHECKLISTS

A. The following procedures apply to all equipment/systems to be commissioned.

B. Pre-functional/startup checklists shall be used to verify that the equipment and systems are installed, fully connected and ready to operate in accordance with contract documents, so that performance testing may proceed without unnecessary delays. The pre-functional/startup checklist for a given system must be successfully completed and approved prior to formal performance testing of equipment or subsystems of the given system.

C. The CA will coordinate with Contractor and his sub-contractors for the commissioned equipment/system to create a pre-functional/Start-up checklist that is specific to the particular equipment/system. The intent of the pre-function/startup checklist is to incorporate the manufacturer’s startup routines and CA’s initial checkout and startup requirements.

D. The Owner will approve the final content and documentation format for all pre-functional/startup checklists used for commissioned equipment/systems on this project.

E. The Contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and transmit the checklist to the responsible sub-contractors. Each checklist form may have more than one trade responsible for its execution. The Contractor and his sub-contractors shall provide the services of personnel to implement the pre-functional/startup checklists. The Contractor shall provide for all equipment the
manufacturer’s startup and testing procedures, shop drawings, equipment cut sheets, control system schematics, narrative description of control sequences of operation, as-built wiring schematics, sub-system interfaces, and interlocks.

F. The equipment manufacturer shall provide all tools and test equipment required to complete the manufacturer’s startup and testing procedures.

G. Execution of Pre-functional/Startup Checklists:

1. Four weeks prior to the scheduled startup, the Contractor shall coordinate startup and checkout with the Owner, A/E and CA. The execution of the pre-functional and startup checklists, startup, and checkout shall be directed and performed on 100% of the equipment/systems by the personnel of the Contractor, sub-contractors and/or equipment suppliers. Signatures are required of personnel performing pre-functional/startup checklist tasks for verification of completion of their work.
2. The Owner will observe the execution of pre-functional/startup checklists. The A/E will observe the execution of pre-functional/startup checklists, if requested by the Owner.
3. The CA will observe execution of pre-functional/startup checklists in accordance with the commissioning plan.
4. The Contractor, sub-contractors, and equipment suppliers shall execute startup and Contractor shall provide the CA, with a signed and dated copy of the completed pre-functional/startup checklists.
5. Only personnel of the Contractor (technicians, engineers, tradesmen, equipment suppliers, etc.) who have direct knowledge and witnessed that a line item task on the pre-functional/startup checklist was actually preformed shall check off that item. It is not acceptable for witnessing supervisors to fill out these forms.
6. CA will review and approve pre-functional/startup checklists submitted by Contractor.

H. Pre-functional/startup checklists filled out by the appropriate personnel, signed and approved by the CA will be included in the commissioning report.

I. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

3.10 LEVEL 4: FUNCTIONAL PERFORMANCE TESTING (FPT)

A. Functional performance testing (FPT) shall be conducted by the Contractor as specified by the CA in the Cx plan to demonstrate that each system is operating according to the contract documents, manufacturer operational control sequences, and the Cx plan. Functional performance testing shall achieve bringing the systems from a state of individual substantial installation completion to full dynamic operational completion as individual systems.

B. Functional performance test forms (FPTFs) will be developed by the CA. The basis of the FPTFs shall be the control sequence of operation for the equipment/system.

C. Control sequences of operation specified by the A/E or as proposed by the equipment supplier shall be provided by the Contractor or Supplier as appropriate, and shall include all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
D. Before test procedures are finalized, the Contractor shall provide to the A/E and the CA all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical specifications, the CA shall update/develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Contractor, sub-contractors, and equipment suppliers, as appropriate, shall provide assistance to the CA in developing the final procedures. Prior to finalization, the Owner and A/E will review the test procedure.

E. Execution of Functional Performance Testing (FPT)

1. FPT consists of the following tests that will be conducted by the Contractor as specified by the CA in the commissioning plan. FPT shall be conducted after pre-functional/startup checklist process is completed and checklists have been approved by the CA.
2. Air and water system balance shall be completed before performance testing of air or water-related equipment or systems.
3. Contractor shall coordinate with Owner, A/E and CA the start of FPT on the commissioning equipment/systems. FPT shall be scheduled for no sooner than 48 hours from approval from CA of FPT checklists.
4. The CA, Owner, and A/E will observe the execution of FPT.
5. The Contractor shall conduct the FPT in accordance with the approved Cx plan developed by the CA.
6. The contracting team carrying out FPT will include trades necessary to functionally test the equipment/system and its interaction with other equipment/systems. This generally includes mechanical, electrical, temperature control personnel and may also include equipment suppliers and test and balance personnel.
7. The Contractor shall coordinate so that all personnel required to carry out FPT are present and are working together to complete the specified tasks.
8. FPT shall include but not be limited to the following, at a minimum:
   a. Set the system equipment into the operating mode to be tested (e.g. normal shut-down, normal auto position, normal manual position, unoccupied cycle, emergency power and alarm conditions, etc.)
   b. Repeat test for each operating cycle that applies to the system being tested.
   c. Perform operating checks of all safety cutouts, alarms, and interlocks with smoke control and life safety systems during all modes of operation of the mechanical/electrical systems.
   d. Operate each system through all modes of operation where there is a specified system response. Modes of operation include seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, emergency conditions, normal operation, bypass conditions, etc. Proper responses to extreme conditions such as power failure, freezing, low oil pressure, no flow, equipment failure, etc. shall also be tested. Each individual sequence of operation shall be monitored and verified. Functionality shall be verified through manual testing where required, in which the test technician simulates an equipment condition or induces an operational or alarm condition, after which the equipment is monitored and evaluated for the required response.
9. The Contractor shall inspect, verify, and demonstrate the position of each device and interlock identified in the test procedures. Each item shall be signed off as acceptable (yes) or failed (no).

10. FPT shall be completed on 100% of the equipment/systems included in the commissioning process.

11. During FPT, the contracting team completing the testing procedures shall attempt to resolve all problems or equipment/system failures when they appear in the testing process if possible, and shall complete and sign the FPT procedure forms.

12. Failures of the testing shall require retesting on the affected equipment. If extensive work is required to correct deficiencies that cannot be accomplished during the scheduled testing, completion of the testing will be rescheduled for another date and conducted at Contractor’s expense for expenses related to Owner/CA/AE expenses for travel and hourly rates. Retesting on the same date will not incur any charges to the contractor for Owner/CA/AE retesting expenses.

12. Once FPT is complete, all deficiencies resolved, and forms filled out and signed by the appropriate personnel, Contractor shall submit the forms to CA for review and approval.

13. Only individuals of the Contractor (technicians, engineers, tradesmen, equipment suppliers, etc.) who have direct knowledge and witnessed that a line item task on the functional test procedure was actually performed shall check off that line item. It is not acceptable for witnessing supervisors to fill out these forms.

14. Upon CA approval of the FPT reports, the equipment/system shall be considered ready for integrated systems testing (IST), as specified below.

F. Contractor FPT forms filled out by the appropriate personnel, signed and approved by the CA will be included in the final commissioning report.

G. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

3.11 LEVEL 5: INTEGRATED SYSTEMS TESTING (IST)

A. Integrated systems testing (IST) shall be conducted by the Contractor as specified by the CA in the Cx plan to demonstrate that each system is operating seamlessly in an integrated manner coordinated with all other related systems in the project, so that the facility as a whole meets the Owner requirements for reliability and availability. Integrated systems testing shall achieve bringing the systems from a state of individual operational completion to full-scale operation of systems as a cohesive integrated system.

B. Integrated systems testing test forms (ISTFs) will be developed by the CA. The basis of the ISTFs shall be the control sequence of operation for the equipment/system.

C. Control sequences of operation specified by the A/E or as proposed by the equipment supplier shall be provided by the Contractor shall include all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.

D. Before test procedures are finalized, the Contractor shall provide to the A/E and the CA all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical specifications, the CA shall update/develop
specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Contractor, sub-contractors, and equipment suppliers, as appropriate, shall provide assistance to the CA in developing the final procedures. Prior to finalization, the Owner and A/E will review the test procedure.

E. Execution of Integrated Systems Testing (IST)

1. IST consists of the following tests that will be conducted by the Contractor as specified by the CA in the commissioning plan. IST shall be conducted after the IST checklist process is completed and checklists have been approved by the CA.

2. Air and water system balance shall be completed before performance testing of air or water-related equipment or systems.

3. Contractor shall coordinate with Owner, A/E and CA the start of IST on the commissioning equipment/systems. IST shall be scheduled for no sooner than 48 hours from approval from CA of IST checklists.

4. The CA, Owner, and A/E will observe the execution of the IST.

5. The Contractor shall conduct the IST in accordance with the approved Cx plan developed by the CA.

6. The contracting team carrying out IST shall include trades necessary to functionally test the equipment/system and its interaction with other equipment/systems. This generally includes mechanical, electrical, temperature control personnel and may also include equipment suppliers and test and balance personnel.

7. The Contractor shall coordinate so that all personnel required to carry out IST are present and are working together to complete the task.

8. IST shall include the following, at minimum:

   a. Verify that the mechanical, electrical, control and safety systems work as designed during normal operations, as well as during multiple systems failures.

   b. Verify that all of the systems correctly operate in conjunction with one another, and that the project control systems and equipment respond as specified in the event of a loss of equipment, an equipment or system alarm, or loss of utility power.

   c. Verify that electrical, mechanical and control systems return to normal operation after an electrical power system interruption. Testing will also involve the interruption of power to control systems to verify correct default “failsafe” operation of HVAC equipment

9. Systems shall be tested in all operating modes (e.g. normal shut-down, normal auto position, normal manual position, unoccupied cycle, backup power, alarm conditions, etc.)

10. IST shall be completed on 100% of the equipment/systems included in the commissioning process.

11. During IST, the contracting team completing the testing procedures shall attempt to resolve all problems or equipment/system failures when they appear in the testing process if possible, and shall complete and sign the IST procedure forms.

12. Any failures of the testing shall require retesting on the affected equipment. If extensive work is required to correct deficiencies that cannot be accomplished during the scheduled testing, completion of the testing will be rescheduled for another date and conducted at Contractor’s expense for expenses related to Owner/CA/AE expenses for travel and
hourly rates. Retesting on the same date will not incur any charges to the contractor for Owner/CA/AE retesting expenses.

12. Once IST is complete, all deficiencies resolved, and forms filled out and signed by the appropriate personnel, submit the forms to CA for review and approval.

13. Only individuals of the Contractor (technicians, engineers, tradesmen, equipment suppliers, etc.) who have direct knowledge and witnessed that a line item task on the integrated systems test procedure was actually performed shall check off that line item. It is not acceptable for witnessing supervisors to fill out these forms.

14. Upon CA approval of the IST reports, the equipment/system is ready for final acceptance review by the Owner.

F. Contractor IST forms filled out by the appropriate personnel, signed and approved by the CA will be included in the final commissioning report.

G. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

3.12 NON-CONFORMANCE AND TESTING FAILURE RESOLUTION PROCEDURES

A. Non-Conformance

1. As tests progress and a deficiency is identified, the CA will review the issue with the Owner, A/E, Contractor, and affected equipment supplier(s).

2. When there is no dispute on the deficiency and the Contractor or Supplier accepts responsibility to correct the issue:

   a. The CA will document the deficiency and the Contractor’s response and intentions. The CA will submit the noncompliance reports to the Owner. The Contractor corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CA.

   b. The Contractor shall reschedule the test; and the test shall be repeated.

3. If there is a dispute about a deficiency, regarding whether or not it is a deficiency:

   a. The dispute shall be documented on the non-compliance form with the Contractor or Supplier response.

   b. Resolutions will be sought at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Owner.

   c. The CA documents the resolution process.

   d. Once the interpretation and resolution have been decided, the Contractor/Supplier corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CA. The Contractor shall reschedule the test and the test is repeated until satisfactory performance is achieved.

4. Cost of retesting a performance test shall be paid by the Contractor for Contractor-provided equipment and paid by the Supplier for Owner-furnished equipment.
5. The Contractor shall submit in writing to the Owner and CA at least as often as commissioning meetings are being scheduled, the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.
   
a. The CA will retain the original non-conformance forms until the end of the project.
b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

B. Failure Due to Manufacturing Defect: If 10% (or three, whichever is greater) of identical pieces of equipment fail to perform to the contract documents (mechanically or substantively) due to a manufacturing defect, not allowing it to meet its submitted performance specification, all identical units may be determined to be unacceptable by the Owner, based on the CA and A/E recommendations. In such case, the Contractor or Supplier as appropriate shall provide the Owner with the following:
   
1. Within one week of notification from the Owner, the Contractor/Supplier with the assistance of the equipment manufacturer’s representative shall examine all other identical units making a record of the findings. The findings shall be provided to the Owner within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractor and Supplier shall provide a signed and dated, written explanation of the problem, cause of failures, etc., and all proposed solutions.
3. The Owner will determine whether a replacement of all identical units or a repair is acceptable, based on recommendations from the A/E and CA.
5. Upon acceptance, the Contractor and/or Supplier as applicable shall replace or repair all identical items, at their expense. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

C. Refer to paragraph “Scope” above for delineation of Contractor and Owner-furnished equipment supplier responsibilities in the commissioning process.

3.13 OPERATING AND MAINTENANCE DATA

A. Refer to Section “Closeout Procedures” for additional requirements.

B. Operations and maintenance data shall cover all systems, equipment, devices, materials and finishes described within these specifications and provided by Contractor or Supplier under this Project.

C. The CA and A/E will review the draft form of the O&M manuals provided by the Division 21, 22, 23, and 26 subcontractors. The review process shall verify that O&M instructions meet specifications and are included for all commissioned equipment/systems provided by the Contractor, and that the information, instructions, and wiring diagrams are specific (edited where necessary) to the actual equipment provided for this Project.

D. The O&M manual review and coordination efforts shall be completed prior to Owner training sessions, as these documents are to be utilized in the training sessions.
E. The CA’s review does not replace the A/E’s review of O&M manuals according to the A/E’s contract.

F. O&M Data Format:

1. O&M data shall be provided in neatly indexed, heavy duty, vinyl, 3-ring binders of manageable size. Binders shall be indexed by specification Section, with additional dividers provided under each specification section if multiple types of equipment and/or systems are defined within a single specification Section. Dividers shall be heavy paper with plastic covered tabs.
2. Fold all oversized sheets to neatly fit within binder. For sheets greater than 11” x 17” provide inserts for storage in binder.
3. Provide a table of contents in each binder. If more than one binder is used, clearly identify in the table of contents which information is contained in each binder.
4. Clearly label each manual with the title “OPERATION AND MAINTENANCE MANUAL – VOLUME _ OF _” and the Project name.

G. O&M Data Content:

1. For the BAS, EPMS, and EPCS (as appropriate to the system), include the following in the O&M manuals:
   a. General/Hardware:
      1) Description of the system including definitions, size, architecture and functionality of each component of the system.
      2) As-built drawings for the system; control diagrams, wiring diagrams, system schematics, etc.
      3) Hardware component manufacturer’s specifications, installation instructions, operating and servicing instructions.
      4) Design data for sensors and control components external to digital controllers. Include manufacturer’s specifications, installation, maintenance and calibration procedures.
      5) Output hardware data. Include manufacturer’s installation, maintenance and operations procedures.
      6) Step-by-step instructions to set controllers from installation to a point they can accept control programs from a computer. Include shop drawings showing cable connections, equipment settings for the operation of each controller.
      7) Interconnection wiring diagrams with system components and device identification.
      8) Step-by-step procedure for diagnosing and installing controller.
      9) Drawings: Project as-built drawings will be included in O&M manuals. Reduce to 11x17 format, provide with reinforced punch binder tab. Bind with text; fold drawings to size of text pages. (Larger drawing will be allowed if 11x17 is unreadable.
     10) Include all submittals, product data and shop drawings updated to as-built conditions.
     11) Spare parts lists for each type of control device.
12) Inspection period, cleaning methods, recommended cleaning materials and calibration tolerances.

b. Software

1) Include step-by-step procedures for uploading and downloading of software programs from and to each controller and the operator station computer.
2) Include documentation for software setup of every physical and virtual point. Include point name, location, type, and any other characteristic to define point.
3) Include step-by-step procedure for making set point and equipment scheduling changes.
4) Include documentation describing running and analyzing controller diagnostics.
5) List alarms and messages programmed into each controller.
6) Provide PID Loop turning procedures for the control system.
7) Include step-by-step procedure for loading operator station software and accessing the control system.
8) Documentation for creating, editing and using graphics.
9) Sequences of operation in English narrative and graphic chart format. Sequences to include normal, emergency and failsafe modes of operation.
10) Include all software documentation updated to as-built conditions.

c. Provide two (2) copies of all job software in electronic format which can be directly loaded by the Owner.

3.14 TRAINING OF OWNER’S OPERATING PERSONNEL

A. The Contractor for CFCI equipment and the Supplier for OFCI/OFSI equipment shall provide training coordination, scheduling of sub-contractors, and ensure that training is completed. All training shall be coordinated through the Owner and with review by the A/E and the CA. Refer to Section “Closeout Procedures” for additional requirements. If approved by the Owner, training may be conducted in coordination with FPT and IST.

B. The Contractor shall ensure that each sub-contractor and equipment supplier (mechanical, plumbing, fire, electrical, specialty, etc) shall have the following responsibilities:

1. Provide to the CA a training plan sixty days before the planned training covering the following elements:
   a. Equipment
   b. Intended audience
   c. Location of training
   d. Objectives
   e. Subjects covered (description, duration of discussion, special methods, etc)
f. Duration of training on each subject

g. Instructor for each subject

h. Methods (classroom lecture, manufacturer’s quality video, site walk-through, actual operational demonstrations, written handouts, etc).

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.

3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated at another scheduled time, if necessary.

5. The appropriate trade or manufacturer’s representative shall provide the instructions on each major piece of equipment. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.

6. Monitoring and controls sub-contractors shall attend sessions other than their specific requirements for training, to discuss the interaction of the controls system as it relates to the equipment being discussed.

7. The training sessions shall follow the outline in the table of contents of the O&M manual and illustrate whenever possible the use of the O&M manuals for reference.

8. Training shall include:

a. Use of the printed installation, operation and maintenance instruction material included in the O&M manual.

b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.

c. Discussion of relevant health and safety issues and concerns.

d. Discussion of warranties and guarantees.

e. Common troubleshooting problems and solutions.

f. Explanatory information included in the O&M manuals.

g. Discussion of any peculiarities of equipment installation or operation.

h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

i. Hands-on training shall include startup, operation in all modes possible, including manual, shut-down, alarms, power failure and any emergency procedures, and preventative maintenance for all pieces of equipment.

9. The Contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the main control systems.

C. At the discretion of the CA, training may occur before performance testing is complete if required by the facility operators to assist the CA in the performance testing.
D. Videotaping of the training sessions will be provided by the Contractor and added to the O&M manuals. In addition, factory training videos identifying key troubleshooting, repair, service and/or replacement techniques shall be provided and reviewed with the Owner.

3.12 RECORD DOCUMENTS

A. Refer to Section “Closeout Procedures” for additional requirements.

B. The Contractor for CFCI equipment and the Supplier for OFCI/OFSI equipment shall maintain at the site one record copy of all drawings, specifications, addenda, approved Shop Drawings, change orders, and other modifications, in good order and marked to record all changes applicable to the work made during construction. All changes from design made during construction shall be recorded by the Contractor. Contractor/Supplier shall be responsible for sufficient detail and accuracy of all changes made.

C. Contractor record documents will be periodically reviewed and verified during construction by the CA. Discrepancies in the record documents will be documented in site visit reports and the Contractor shall be responsible to verify and correct the record documents against the installed system for specified and all similar problems noted.

D. Contractor shall supply draft copy of complete record documents to the A/E and Owner prior to initial training session.

3.13 WARRANTIES

A. Refer to Section “Closeout Procedures” for additional requirements and individual warranty sections in commissioned systems specifications.

B. Contractor for CFCI equipment and the Supplier for OFCI/OFSI equipment shall supply a complete copy of all warranties applicable to the Project, the terms of maintenance for each warranty, and the inception and expiration dates for each warranty. This information will become part of the O&M data.

END OF SECTION 01 91 13