

SPECIAL SPECIFICATION

SECTION 01710S

COMMISSIONING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings and general provisions of the contract, including general and supplementary conditions, and Division 1 specification sections, apply to this section.
- B. The Construction Phases Commissioning Plan
- C. Basis of Design/Design Intent documents
- D. Sections 0171HSS, 13995S, 15995, and 16995

1.2 SUMMARY

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent, basis of design, construction documents and SNL's system operational needs. This is achieved by beginning in the design phase, documenting design intent/basis of design and continuing through construction, building acceptance and the warranty period with actual verification of performance. The commissioning process shall coordinate what have traditionally been separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and SNL training.
- B. Provide the services of a qualified **Test Engineer Firm** (TE) with commissioning expertise as described in this section with the following general requirements:
 - 1. **The TE shall furnish labor and material to develop and implement commissioning requirements** to accomplish building commissioning as specified herein.
 - 2. Requirements of this specification and associated specific commissioning procedures shall be accomplished by a qualified TE, as specified in this document.
 - 3. Unless noted otherwise, functional performance tests (FPT's) described under Acceptance Criteria in the various sections of this document apply to all equipment and systems identified under Systems to Be Commissioned.
 - 4. Develop and perform functional performance testing and troubleshooting of equipment and systems.
 - 5. Manage the quality, coordination, scheduling, and execution of commissioning activities.
- C. **The responsibilities of the Commissioning Authority are indicated, for information only, in this document.**

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Divisions 1, 13, 14, 15, and 16 sections requiring functional performance testing.
- B. Division 17 commissioning will be provided under the Division 17 contractor.
- C. Refer to section 01715S for:
 - 1. Common abbreviations and definitions used in the specifications and in the Construction Phase Commissioning Plan.
 - 2. Related specification index for additional Contractor responsibilities relative to the commissioning process.
- D. Refer to sections 15995 and 16995 for additional mechanical and electrical division commissioning responsibilities.
- E. Refer to Sections 13852 and 15310 for additional Fire Protection Division Commissioning Responsibilities.

1.4 COMMISSIONING TEAM

- A. Coordination and management: The Test Engineer Firm (TE) shall provide overall coordination and management of the commissioning program as specified herein.
- B. The commissioning process will require cooperation of the Contractor, subcontractors, vendors, Architectural Engineering firm, Commissioning Authority and SNL.
- C. The commissioning team shall be comprised of the following:
 - 1. Contractor: Project manager, MEP coordinator and TE.
 - 2. Subcontractors: As required by the prime contractor.
 - 3. Manufacturers' factory engineers: As specified elsewhere.
 - 4. Commissioning authority
 - 5. Sandia Delegated Representative
 - 6. Construction Management Engineer
 - 7. SNL System Engineer
 - 8. SNL Construction Observers
 - 9. Architectural Engineering Representatives

1.5 TEST ENGINEER FIRM (TE) QUALIFICATIONS

- A. The TE shall meet the following minimum qualifications:
 - 1. A minimum of 3 years documented experience specifically in building commissioning.
 - 2. Documentable experience in Commissioning Central Utility Plants, Microelectronic FAB's and research and development Labs.
 - 3. Documentable experience in startup and troubleshooting HVAC, hot water heating, chilled water, steam, plumbing, fire suppression, electrical, emergency power, fire alarm, life safety, lab fume hood systems, clean rooms, specialty process systems, high purity piping, and telecommunications systems of similar complexity to those contained in these documents.
 - 4. A demonstrable working knowledge of complex environmental, fire alarm, electric power control and facility control systems; be capable of understanding control vendor's operating system and control code; be capable of troubleshooting control code and recommending necessary modifications.
 - 5. Competency in system design and intent.
 - 6. Knowledge of the test and balance of air and hydronic systems.
 - 7. Excellent communication and writing skills, organizational skills, and ability to work well with management and trades contractors.
 - 8. Provide day to day project management by a registered professional engineer with extensive practical field experience and knowledge of the commissioning process. The technical training and experience with extensive practical field experience of all field personnel will also be reviewed.
 - 9. Be a full member of the Building Commissioning Association
- B. The TE shall not be an employee of, or financially associated with any of the Division 1 through Division 16 contractors.
- C. The TE shall not be the project superintendent, foreman, safety officer, MEP coordinator or hold other duties that would keep him/her from fulfilling the responsibilities of TE.

1.6 COMMISSIONING RESPONSIBILITIES

- A. Test Engineering Firm (TE): The TE Responsibilities include, but are not limited to:
 - 1. General Tasks:
 - a. Coordinate, schedule and manage the commissioning activities.
 - b. Assist the Contractor to coordinate all Sub Contractor commissioning activities.
 - c. Obtain, assemble and submit commissioning documentation.
 - d. Attend periodic on-site commissioning activities

2. Commissioning Documentation Development Tasks:
 - a. Develop the commissioning plan and schedule.
 - b. Develop detailed pre-functional check lists.
 - c. Develop detailed functional performance test procedures.
 - d. Coordinate locations of test ports required for Commissioning on P&ID's, shop drawings and during installation.
 - e. Conduct and coordinate the installation verification inspections with the Engineer, AE, CME, CA and SNL Construction Observers.
 - f. Prepare and submit the Commissioning Reports.
 3. Pre-Functional Testing Tasks:
 - a. Assist and witness the start-up activities and pre-functional testing.
 - b. Monitor the performance of the Test, Adjust and Balance contractor.
 - c. **The Contractor is expected to verify the functional readiness of systems to be tested prior to performing the tests in the presence of the witnesses.**
 4. Functional Performance Testing Tasks:
 - a. Direct the functional performance testing. Provide testing of all systems to provide complete confidence in the systems. The tests will include the interaction between individual components, sub-systems and complete building systems under both normal and emergency power conditions **as well as emergency shutdown (Fab).**
 - b. Ensure that necessary test instrumentation is available during functional performance testing and instruments meet quality and calibration requirements and are in good working order.
 - c. Enforce system compliance and recommend modifications to the system design that will correct or enhance the system performance.
 - d. Coordinate witnessing of the tests.
 - e. Track commissioning deficiencies until correction and retesting are successfully completed. Assist the Commissioning Team in determining the cause of failure.
- B. Commissioning Authority (CA):
1. This section is provided for the Contractor's information only. The Contractor is not responsible for the hiring or supervision of the Commissioning Authority.
 2. SNL will appoint a Commissioning Authority, under the direction of SDR.
 3. The duties of the Commissioning Authority include, but are not limited to, the following:
 - a. Review and recommend approval of the Contractor's commissioning plans and schedules.
 - b. Review and recommend approval the Contractor's functional performance test procedures.
 - c. Witness, verify, and recommend approval for satisfactory completion of functional performance tests.
 4. Coordinate participation of SNL's personnel involved in functional performance testing and required training.
 5. When commissioning has been successfully completed, recommend final acceptance to the SNL. **The SDR/DPM is the final approving authority for all PFT's and FPT's.**
 6. The Commissioning Authority is expected to communicate as follows:
 - a. The Commissioning Authority will formally communicate with the Contractor via approved project channels. It is expected, however, that informal communication and coordination will be conducted directly with the TE.
 - b. The Commissioning Authority will keep SNL advised regarding commissioning activities, progress, problems that may develop solutions to problems, systems performance, and schedules.
 - c. **The CA will have final approval of the TE selection.**
 7. **The CA will hold commissioning meetings as outlined under Section 1.11 commissioning meetings.**

- C. Sandia National Labs (SNL):
 - 1. Commissioning procedures and results will be observed by the SNL's designated witnesses, including SDR, Inspection and System Engineers.
- D. Architect Engineering Firm (A/E)
 - 1. Attend the commissioning scope meeting and selected commissioning team meetings.
 - 2. Coordinate resolution of system deficiencies (which are related to possible design deficiencies) identified during commissioning, according to the contract documents.
 - 3. Provide any design narrative and sequences documentation requested by the TE. The designers shall assist (along with the contractors) in 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.
- E. General Contractor (GC)
 - 1. Obtain the services of a TE firm.
 - 2. Facilitate the coordination of the commissioning work by the TE, and ensure that commissioning activities are being scheduled into the project's master CPM schedule.
 - 3. Include the cost of commissioning in the total contract price.
 - 4. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
 - 5. Ensure that all Subcontractors execute their commissioning responsibilities according to the Contract Documents and commissioning plan and schedule.
 - 6. A representative shall attend a commissioning scope meeting scheduled by the TE and other necessary meetings scheduled by the TE to facilitate the Cx process.
 - 7. Coordinate the activities of all contractor, subcontractor and vendor personnel, required to complete training of SNL personnel in accordance with the requirements of the Specifications and the Training Agenda.
 - 8. Prepare and submit the O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- F. Division 15 And Division 16 Contractors
 - 1. Under the direction of the GC, the Division 15 and Division 16 Contractors shall provide the services outlined in this paragraph.
 - a. Cooperate with the TE to complete commissioning activities.
 - b. Include the cost of commissioning in the total subcontract price.
 - c. Assist in equipment testing per the requirements of these specifications.
 - d. Provide for the use of all proprietary tools, software or instruments required for testing and commissioning of the installed mechanical/electrical equipment at no additional cost.
 - e. Provide information requested by TE regarding equipment sequence of operation and testing procedures.
 - f. Review final construction phase commissioning plan procedures for equipment installed, training and functional testing required under the particular subcontract.
 - g. Provide training services as required
 - h. Perform commissioning on all fire sprinkler and standpipe systems in accordance with NFPA 13, NFPA 14, and NFPA 25.**
 - i. Perform commissioning on all clean agent fire suppression systems in accordance with NFPA 2001.**
 - j. Perform commissioning on all fire alarm and air sampling smoke detection systems in accordance with NFPA 72.**
 - k. Twelve (12) weeks prior to performing specified tests, the Subs provide the TE full details of the procedures.**

1.7 SUBMITTALS

- A. General: Submit the following in accordance with general and supplemental conditions of the contract and Division I.
1. TE resume and statement of qualifications: Submit the TE's resume for approval of the commissioning authority within 30 days of contract award with following information:
 - a. A description of the firm with services offered and percentage of business dedicated to commissioning.
 - b. Resumes of all commissioning personnel proposed for the project including education and technical training.
 - c. References of a minimum of five (5) projects of similar size and complexity.
 - d. A description of the firm's approach to commissioning and quality control. SNL and the CA reserve the right to personally interview the TE candidate prior to accepting placement in the position. Final approval of the TE will be by the commissioning authority.
 2. Commissioning Plan – Construction Phase :
 - a. Submit a preliminary construction phase commissioning plan within 60 calendar days of notice to proceed. The preliminary construction phase commissioning plan shall be based on the draft construction phase commissioning plan included in the contract documents and shall also include:
 - 1) A completed list of all members of the commissioning team.
 - 2) A completed mechanical/electrical/process systems overview.
 - 3) A detailed list of all proposed pre-functional checklists (PFC's) with sample forms.
 - 4) A detailed list of all proposed functional testing procedures (FTP's) with sample forms
 - 5) Submit a copy of all proposed commissioning forms to be utilized on the project.
 - b. Submit the final construction phase commissioning plan within 60 days after approval of the preliminary commissioning plan. This shall include all items submitted in the preliminary in addition fully detailed PFC's & FTP's as listed in the preliminary commissioning plan.
 3. Commissioning schedule: Submit within 90 calendar days of notice to proceed.
 4. Test equipment identification list: For each instrument, sorted according to intended use: Manufacturer; model number; serial number; calibration certification; range; accuracy; resolution; and intended use.
 5. Operations and maintenance manuals: Submit prior to the start of training.
 6. Test, adjust, and balance (TAB) Information including:
 - a. TAB Data forms
 - b. TAB procedures:
 - c. TAB report.

1.8 COMMISSIONING PLAN – CONSTRUCTION PHASE

- A. Finalize the draft commissioning plan – construction phase to identify how commissioning activities will be integrated into general construction and trade activities. The plan is the key means for the TE to inform all parties as to how each system functions, independently and with respect to other systems. The plan shall be updated regularly and redistributed to the commissioning team for review and comment. The intent of this plan is to evoke questions, expose issues, and resolve them with input from the entire commissioning team early in construction. The commissioning plan shall identify how commissioning responsibilities are distributed. Include the following:
1. Executive Summary: Provide a description of the Commissioning Plan contents
 2. Commissioning Team: Provide a listing of all commissioning team members including the names, addresses, email addresses, and office/fax/cell phones number of SNL, the

commissioning authority, architect, mechanical engineer, electrical engineer, general contractor, mechanical contractor, electrical contractor, controls contractor, fire alarm system contractor and test & balance contractor.

- a. Include an organizational chart showing lines of communication and authority of the TE relative to key general contractor positions and to key subcontractors.
 - b. Identify who will be responsible for producing the various procedures, reports, SNL notifications, and forms required in this division
3. System Overview: Provide a listing of all design parameters including design weather data and all mechanical system equipment data.
4. Commissioning schedule.
5. Pre-Functional Testing Checklists: Provide pre-functional testing checklist forms to the **commissioning** team for each individual piece of mechanical equipment. The forms shall describe all events required to fully start-up a piece of equipment. Include the following:
- a. Start-up plan: For each piece of equipment or system for which formal start-up is specified elsewhere in this division. Obtain approval of the start-up plan prior to beginning start-up activities.
 - 1) Start-up schedule.
 - 2) Names of firms/individuals required to participate.
 - 3) Detailed start-up procedures.
 - 4) Pre-functional checklist forms.
 - b. Start-up procedures: Submit start-up procedures for equipment for which formal start-up are specified elsewhere. These procedures will be reviewed for technical depth, clarity of documentation, and completeness.
 - c. Start-up data forms: Submit start-up data forms for equipment for which formal start-up is specified elsewhere.
6. Functional Testing Procedures & Data Forms: Provide complete and detailed functional performance testing procedures required to fully test the entire system including the following:
- a. Identify which subcontractors will participate in each of the tests.
 - b. Identify instrumentation required for each test.
 - c. Identify who will provide instrumentation for each test.
 - d. Operational description: This shall include, for example, the design criteria, design intent/basis of design, code requirements, specifics of the equipment to be provided, sequences of operation, operating priorities, protocols, etc. Some of these items will be provided to the TE with the construction package and may be copied or referenced.
 - e. Each procedure shall have a unique alphanumeric designator consisting of the applicable functional performance test procedure designator followed by a dash digit suffix to distinguish multiple repetitions of the same procedure.
 - f. The same procedure may be applied to multiple identical pieces of equipment or systems.
 - g. Procedures shall reference the applicable specification section upon which the procedure is based.
 - h. These procedures will be reviewed for technical depth, clarity of documentation, compliance with acceptance criteria specified elsewhere, and completeness.
 - i. Identify the value for all setpoints and inputs, positions of adjustable devices, valves, dampers, and switches.
 - j. Identify the range of acceptable results for each condition tested.
 - k. FPT procedures shall be detailed test instructions, written with sufficient step-by-step information to allow a test to be repeated under identical conditions with repeatable results.
 - l. Include space to record: Description of the procedure; whether the form is for a retest of a failed procedure; identification and location of the equipment being tested; identification of instrumentation used by serial number; observed

conditions at each step of the procedure; acceptable results as specified elsewhere; date of the test; names of technicians performing the procedure; name and signature of the TE; name and signature of the Commissioning Authority or SNL-designated witness (signature of witness shall only indicate concurrence with reported results and observations; acceptance of the results will be reported separately by the Commissioning Authority after review of the FPT data forms).

7. Deficiencies and Issues Log: Provide a sample functional performance test deficiency report form. Include space to record: Associated functional performance test data form number; date of test; name of person reporting the deficiency; description of the observations associated with the failure of the test; cause of the failure, if apparent at the time of the test; date and description of corrective action taken; name and signature of person taking corrective action; and schedule for retest.
8. Daily Log: Provide a blank log as an example

1.9 SCHEDULE

- A. Commissioning schedule: Integrate functional performance testing and commissioning requirements into the Critical Path Method (CPM) master construction schedule **within 90 calendar days of notice to proceed**. Commissioning scheduling is the responsibility of the Contractor.
 1. Prior to the beginning of start-up or functional performance testing activities, update the schedule of commissioning activities monthly.
 2. Two weeks prior to the beginning of start-up or functional performance testing activities, provide a detailed two-week look-ahead schedule. Thereafter, update the two-week look-ahead schedule weekly for the duration of commissioning for that construction phase. The two-week look-ahead schedule shall identify the date, time, beginning location, contractor personnel required, and anticipated duration for each startup or test activity.
- B. Commissioning of systems shall proceed per the criteria established in the specific sections that follow, with activities to be performed on a timely basis. Commissioning of systems may proceed prior to final completion of systems. The TE must be available to respond promptly to avoid delay to the CPM schedule.
- C. Problems observed shall be addressed immediately, in terms of notification to responsible parties and actions to correct deficiencies.
- D. **At least 60 days prior to startup of the primary equipment, the TE meets with the GC and CA and reviews the final commissioning schedule.**

1.10 COORDINATION WITH SNL'S REPRESENTATIVE WITNESS

- A. The SNL will witness all start-up and test activities specified in this division. The CA will designate witnesses and alternates for each activity.
- B. Notify the CA and the designated witnesses in writing of the date, time, location, and anticipated duration of start-up and test activities as required in Schedule above.
- C. Provide written timely notice to the CA and the designated witnesses of any changes in date, time, location, or anticipated duration of start-up and test activities. For the purpose of this paragraph, written notice shall be received by them a minimum of 72 hours in advance to be considered timely notice.
- D. Obtain the signature of designated witnesses on all data forms. If a witness is unavailable at the scheduled time and location of the activity, so note, and proceed per schedule without the witness.

1.11 COMMISSIONING MEETINGS

- A. Attend **the following meetings in addition to the TE/sub meetings**.
 1. Prior to the beginning of start-up or functional performance testing activities, the (CA) will hold commissioning meetings at least monthly. These meetings may be held concurrently with the general construction meetings.

2. Beginning two weeks prior to the commencement of start-up or functional performance testing activities, whichever is earlier, the (CA) will hold commissioning meetings at least weekly. Thereafter, and for the duration of commissioning for that construction phase, commissioning meetings will continue to be held at least weekly. These meetings may be held concurrently with the general construction meetings.
3. The (CA) may require additional meetings if the commissioning process appears to be behind schedule or if there are coordination problems. The TE may also request in writing additional meetings.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Division contractor for the equipment tested provides all standard or proprietary testing equipment required to perform startup and initial checkout and required functional performance testing. For example, the mechanical contractor of Division 15 is ultimately responsible for all standard or proprietary testing equipment for the Facility Controls System (FCS) in Division 15, except for equipment specific to and used by TAB in their commissioning responsibilities. The Division contractor provides two-way radios.
- B. Include special or proprietary equipment, tools, software and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents in the base bid price to the Contractor and left on site, except for stand-alone data logging equipment used by the TE.
- C. The TE will provide data logging equipment and software required to test equipment.
- D. Provide all testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Contract Documents. If not otherwise noted, the following minimum requirements apply:
 1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F.
 2. 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.
- E. Calibrate all equipment according to the manufacturer's recommended intervals and when dropped or damaged. Affix calibration tags or have certificates readily available.

2.2 TE REPORTS

- A. Test, adjust and balance (TAB) progress reports: After TAB activities have begun, the TAB shall submit weekly TAB progress reports to the TE who shall in turn submit to the CA. Identify:
 1. Systems or subsystems for which preliminary balancing is complete.
 2. Systems or subsystems for which final balancing is complete.
 3. Status of deficiencies and balancing problems encountered, including corrective actions taken.
 4. Updated schedule of remaining TAB activities.
- B. Installation verification audit: Prior to start-up, the TE shall submit a report of installation verification audit activities to the CA for review and approval. Identify equipment and components verified, deficiencies noted, corrective action taken, and the dates and initials of the persons making the entries.
- C. Start-up deficiency report: Within five days following start-up of each system or equipment, the TE shall submit start-up deficiency report forms to the CA Identify systems and/or equipment started up, deficiencies noted, corrective action taken, and the dates and initials of the persons making the entries.
- D. Functional performance test deficiency reports: At the end of each day, in which functional performance tests are conducted, the TE shall submit functional performance test deficiency report forms to the CA for tests for which acceptable results were not achieved during the day.

1. Identify tests for which acceptable results were not obtained by test number and description, and equipment identification and location. Briefly describe observations about the performance that was associated with failure to achieve acceptable results. Identify the cause of failure if such is apparent.
- E. When corrections have been completed, the TE shall update the functional performance test deficiency report forms. Identify corrective action taken and the dates and initials of the persons making the entries.
- F. Identify the schedule for re-testing.
 1. **Refer to Section 01710S Appendix 1-6 progress reporting and logs.**
- G. Final Commissioning Report: The TE shall prepare and submit a final report with the closeout package. The binding format shall be 8 ½ x 11 bound documents with 11 x 17 fold out. This report shall contain:
 1. The report shall verify performance of equipment and systems.
 2. Document any field modifications to the testing process and why these modifications were made.
 3. The organization of the final commissioning report shall be as follows:
 - a. Executive Summary of each mechanical system and problems encountered and resolved.
 - b. System Overview summarizing the system design.
 - c. Commissioning Plan
 - d. Post Commissioned Controls Sequences and Points Lists.
 - e. Prefunctional Testing Checklists
 - f. Functional Testing Procedures and Results
 - g. Deficiencies and Issues Logs
 - h. Daily report logs.
 - i. Appendix of letters, memo and notes occurring during the commissioning process.
- H. Hardcopy and Electronic Versions:
 1. The Commissioning Plan provided prior to the on-site commissioning and the Final Commissioning Report provided at the conclusion shall be provided in hard copy (2 copies) and electronic on CD (6 copies).
 2. The Commissioning Plan CD shall include files developed in the most current MS Word format.
 3. The Final Commissioning Report CD shall contain scanned copies of all documentation developed and gathered during the Commissioning Process in Acrobat PDF format.

PART 3 - EXECUTION

3.1 COMMISSIONING PROCEDURE

- A. Sequence of testing: Commissioning shall proceed from lower to higher levels of complexity. For each discrete subsystem or system, testing at the lower level shall be completed prior to starting the next higher level of tests. In general, the order of testing from lowest to highest is:
 1. Static tests (such as duct leakage tests).
 2. Component functional performance tests (of motors, actuators, sensors, etc.) and start-up.
 3. Balancing.
 4. System functional performance tests.
 5. Intersystem functional performance tests.
- B. Correction of deficiencies:
 1. Correct functional performance test deficiencies promptly and schedule retest.
 2. Corrections during functional performance tests are generally prohibited to avoid consuming the time of personnel waiting for the test, but not involved in making the correction. Exceptions will be allowed if the cause of the failure is obvious and corrective

action can be completed in less than five minutes. If corrections are made under this exception, the failure shall be noted on the functional performance test data form. A new functional performance test data form, marked “retest”, shall be initiated after the correction has been made. The entire functional performance test procedure shall be repeated.

- C. Delegated witnesses: Witnesses will be designated by the CA to observe the commissioning process. Witnesses shall provide no labor or materials in the commissioning process. The only function of the witnesses shall be to observe and comment on the progress and results of commissioning.
 - 1. Provide access to permit the witnesses to directly observe the performance of the equipment being tested.
 - 2. Provide ladders, scaffolding, and staging as required to permit the witnesses to directly observe the performance of the equipment being tested.
 - 3. Notify the CA of commissioning schedule changes at least 72 hours in advance if a Delegated witness will be involved.
- D. **Re-testing: Repeat, at no additional cost to SNL, the complete functional test procedure for each test for which acceptable results are not achieved. Repeat tests until acceptable results are achieved. The retested systems will not be witnessed by the CA until acceptable results are achieved, documented, reviewed and accepted.**

3.2 SYSTEMS TO BE COMMISSIONED BY CONTRACT (AS APPLIES)

- A. General: The systems to be commissioned shall generically include:
 - 1. Division 13 Systems
 - 2. **Division 14 Process Piping Systems**
 - 3. Division 15 Systems
 - 4. Division 16 Systems
- B. CUB-1 Systems (See 01710S-Appendix 1e):
 - 1. Chilled Water System: Chillers and Chilled Water Systems including:
 - a. Chillers
 - b. Pumps
 - c. Towers
 - d. Heat exchangers
 - e. VFC's
 - f. Miscellaneous piping components.
 - 2. Heating Water System: Boilers and Heating Hot Water Systems including:
 - a. Boilers
 - b. Pumps,
 - c. Heat exchangers
 - d. VFC's
 - e. Miscellaneous piping components
 - 3. Air Handling Systems
 - a. HVAC Air Handling Systems
 - 4. Terminal Units
 - a. Fancoils
 - b. Miscellaneous Unit heaters, radiation and heating coils.
 - 5. Exhaust and Supply Systems:
 - a. General
 - b. Refrigerant purge
 - 6. Facility Control System (Building Automation)
 - 7. Energy Metering Systems
 - 8. **Compressed Air Systems**
 - a. **Compressors**

- C. CUB-2 (See 01710S – Appendix 1f):
1. Chilled Water System: Chillers and Chilled Water Systems including:
 - a. Chillers
 - b. Pumps
 - c. Towers
 - d. Heat exchangers
 - e. VFC's
 - f. Miscellaneous piping components.
 2. Heating Water System: Boilers and Heating Hot Water Systems including:
 - a. Boilers
 - b. Pumps,
 - c. Heat exchangers
 - d. VFC's
 - e. Miscellaneous piping components.
 3. Air Handling Systems
 - a. HVAC Air Handling Systems
 4. Terminal Units
 - a. Fancoils
 - b. Miscellaneous Unit heaters, radiation and heating coils.
 5. Exhaust and Supply Systems:
 - a. General
 - b. Refrigerant purge
 6. Facility Control System (Building Automation)

- D. MFAB (See 01710S Appendix 1d):
1. Distributed Utility Heating & Cooling Systems:
 - a. Chilled water pumps & VFC's
 - b. Heating water pumps & VFC's
 - c. Heat Exchangers
 2. Air Handling Systems
 - a. VAV and CV HVAC Air Handling Systems
 - b. FAB Makeup Air and Recirculation Air Units
 - c. Heat recovery systems
 - d. Fan Filter Systems**
 3. Terminal Units
 - a. Variable & Constant Air Volume Boxes
 - b. Fancoils
 - c. Miscellaneous Unit heaters, radiation and heating coils.
 - d. Computer room air conditioning units (CRAC)
 4. Exhaust and Supply Systems:
 - a. General & Toilet
 - b. Pressurization
 - c. Solvent
 - d. Scrubbed Air
 - e. Ammonia (Scrubbed Air Systems)
 - f. Smoke
 - g. Ventilation
 5. Facility Control System (Building Automation)
 6. Plumbing Systems:
 - a. Waste Systems
 - 1) Sanitary
 - 2) Awn
 - 3) HF

- b. Domestic H/C Water
 - c. Lift Pumps
 - 7. Process Systems
 - a. RO/DI Water Systems
 - b. Reclaim & Recycle Water
 - c. Low & medium temperature CHW system
 - d. Process Chilled Water System (PCS)
 - e. Specialty Gases (O2, N2 (4 systems), LN2, LPH2, HPH2, Toxic Gas Systems)
 - f. Vacuum Systems (house & process)
 - g. Compressed Air Systems (CDA)
 - 8. Electrical system power quality, grounding, etc.
 - a. MCC's & Panel Boards
 - b. Switch Gear
 - c. Transformers and Substations
 - d. Power Distribution Units
 - e. Automatic lighting & occupancy controls
 - f. Air Ionization Systems
 - 9. Emergency power system
 - a. Emergency Generator & Transfer Switching
 - b. UPS
 - c. **Emergency Shutdown**
 - 10. Life Safety Systems:
 - a. Fire Alarm System
 - b. Smoke Control System
 - c. Fire Protection Systems
 - d. Emergency Monitoring Systems
 - e. **HPM Monitoring Systems**
 - 11. Miscellaneous Systems:
 - a. Energy Metering Systems
 - b. Chemical Room Dispensing Systems
- E. MLAB (See 01710S Appendix 1c):
 - 1. Distributed Utility Heating & Cooling Systems:
 - a. Chilled water pumps & VFC's
 - b. Heating water pumps & VFC's
 - c. Heat Exchangers
 - 2. Air Handling Systems
 - a. VAV and CV HVAC Air Handling Systems
 - b. Lab Fume Hood Systems
 - c. Heat recovery systems
 - 3. Terminal Units
 - a. Variable & Constant Air Volume Boxes
 - b. Variable Fume Hood Valves
 - c. Fancoils
 - d. Miscellaneous Unit heaters, radiation and heating coils.
 - e. Computer room air conditioning units (CRAC)
 - 4. Exhaust and Supply Systems:
 - a. General & Toilet
 - b. Fume Hood Exhaust
 - c. Process
 - d. Smoke
 - 5. Facility Control System (Building Automation)
 - 6. Plumbing Systems:
 - a. Waste Systems (Sanitary, AWN)

- b. Domestic H/C Water
- c. Lift pumps
- 7. Process Systems
 - a. RO/DI Water Systems
 - b. Process Chilled Water Systems (PCW)
 - c. Specialty Gases (N2)
 - d. House and Process Vacuum Systems
 - e. Compressed Air Systems (CDA)
- 8. Electrical system power quality, grounding, etc.
 - a. MCC's & Panel Boards
 - b. Switch Gear
 - c. Transformers and Substations
 - d. Power Distribution Units
 - e. Automatic Lighting/occupancy controls
- 9. Emergency power system
 - a. Emergency generator
 - b. UPS
- 10. Life Safety Systems:
 - a. Fire Alarm System
 - b. Smoke Control System
 - c. Fire Protection Systems
 - d. TGMS
- 11. Energy Metering Systems

F. WIF (See 01710S Appendix 1b):

- 1. Distributed Utility Heating & Cooling Systems:
 - a. Chilled water pumps & VFC's
 - b. Heating water pumps & VFC's
 - c. Heat Exchangers
- 2. Air Handling Systems
 - a. VAV and CV HVAC Air Handling Systems
 - b. Fume Hood Systems
 - c. Heat recovery
- 3. Terminal Units
 - a. Variable Air Volume Boxes
 - b. Fancoils
 - c. Miscellaneous Unit heaters, radiation and heating coils.
 - d. Computer room air conditioning units (CRAC)
- 4. Exhaust and Supply Systems:
 - a. General & Toilet
 - b. Fume hood systems
 - c. Process
 - d. Smoke control
- 5. Facility Control System (Building Automation)
- 6. Plumbing Systems:
 - a. Waste Systems (Sanitary, AWN)
 - b. Domestic H/C Water
 - c. Lift pumps
- 7. Process Systems
 - a. DI
 - b. Process Chilled Water Systems (PCW)
 - c. Compressed Air Systems (CDA)
- 8. Electrical system power quality, grounding, etc.
 - a. MCC's & Panel Boards

- b. Switch Gear
- c. Transformers and Substations
- d. Power Distribution Units
- e. Automatic Lighting & occupancy controls
- 9. Emergency power system
 - a. Emergency generator
 - b. UPS
- 10. Life Safety Systems:
 - a. Fire Alarm System
 - b. Smoke Control System
 - c. Fire Protection Systems

3.3 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- A. Assist the Contractor in reviewing the O&M manuals prepared by other divisions of the work related to commissioning for compliance with the requirements of Division 1.
 - 1. Incorporate the standard technical literature into a systems -specific document: concise, to the point, and above all, tailored specifically to this facility.
 - 2. Obtain the equipment manufacturer's standard technical literature relevant to the operation and maintenance of the provided equipment. The literature shall be specifically oriented to the equipment provided, indicating all operation and maintenance procedures, parts lists, assembly/disassembly diagrams, and related information. Wiring diagrams must be complete and specific to the equipment provided.
- B. Submit the draft document for review by the CA to ensure completeness, proper written communications, and compliance with each reviewer's knowledge of the significant requirements.
- C. Have all of these materials available for the training sessions.

3.4 INSTALLATION VERIFICATION

- A. During construction, assist the Contractor and coordinate the AE's observation of the work of the Contractor and subcontractors to ensure that all installations are being made in accordance with the intent of the contract documents.
- B. Before system start-up begins, coordinate and attend a final installation verification audit with the AE. The audit shall include, but not be limited to, a check of:
 - 1. Piping specialties including balance, control, and isolation valves.
 - 2. Ductwork specialty items including turning devices; balance, fire, smoke, and control dampers; and access doors.
 - 3. Control sensor types and locations.
 - 4. Identification of piping, valves, starters, gauges, thermometers, etc.
 - 5. Documentation of pre-start-up tests performed, including manufacturers' factory tests.
 - 6. Accessibility to equipment in 1-3 above.
- C. If any work is found to be incomplete, inaccessible, incorrect, or non-functional, make note of deficiencies and correct the deficiencies before system start-up work proceeds.

3.5 SYSTEM START-UP

- A. Assist the Contractor in the development a start-up plan and deficiency list. Commence with system start-up after approval has been given to the start-up plan and the pre-functional checklists have been signed off by the Contractor and subcontractors. The TE and/or delegated representative shall witness system start-up and list all system and equipment deficiencies noted during start-up. The Contractor shall take corrective action on all system deficiencies noted and demonstrate suitable system operation to the TE.

- B. Prepare start-up deficiency list forms to report deficiencies discovered in conjunction with system start-up. Start-up deficiency forms shall indicate the system being started up; the location and identification of the deficient equipment/material; date of observation; initials of the observer; observed deficiency; date of correction; initials of person making the correction; and corrective action taken.
- C. Issue start-up deficiency report forms to the Contractor for corrective action, and to the CA for follow-up. The Contractor shall advise the TE and CA when all start-up deficiency list items have been corrected.
- D. Notify the CA of start-up activities schedule as defined in Part 1 of this section. At the CA's option, the CA, SNL and/or delegated witnesses may physically witness start-up procedures.

3.6 TEST, ADJUST, AND BALANCE (TAB)

- A. Assist the Contractor in the coordination the air and hydronic balancing. Advise the TAB firm when systems are complete and ready for balancing. Start TAB as early as possible following systems start-ups and component functional performance tests, in order to be essentially complete prior to system functional performance tests. Coordinate TAB activities with other construction schedule activities.
- B. Verify the accuracy of the TAB work prior to commencing any FPT activities that may be adversely affected by improper balancing.

3.7 CLEAN ROOM CERTIFICATION

- A. Assist the Contractor in the coordination the air clean room certification. Advise the responsible contractor when systems are complete and ready for certification. Start as early as possible following systems start-ups and component functional performance tests, in order to be essentially complete prior to system functional performance tests. Coordinate certification activities with other construction schedule activities.

3.8 FUNCTIONAL PERFORMANCE TEST PROCEDURES

- A. The TE shall develop as a part of the construction phase commissioning plan submittal, the functional performance test (FPT) commissioning procedures and documentation to be used. Personnel experienced in the technical aspects of each system to be commissioned shall be enlarged if necessary to augment the expertise of the TE. Include functional performance test procedures and functional performance test data sheets for each system based upon actual system configuration. Emphasis shall be placed on testing procedures that will conclusively determine actual system performance and compliance with the design.
 - 1. The test procedures shall fully describe system configuration and steps required for each test, appropriately documented so that another party can repeat the tests with virtually identical results.
- B. The FPT procedures must confirm the performance of systems to the extent of the design intent/basis of design and applicable code under which the project was permitted. When a system is accepted, the CA must be assured that the system is complete, works as intended, is correctly documented, and that the designated SNL staff is trained in the operation and maintenance of the system.
- C. The majority of mechanical equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met. This could include adequate oil pressure, proof-of-flow, non-freezing conditions, maximum head pressure, etc. Functional performance test procedures shall demonstrate the actual performance of safety shutoffs in real or closely simulated conditions of failure.
- D. Systems may include safety devices and components that control a variety of equipment operating as a system. Interlocks may be hard-wired or installed via software. Functional performance test procedures shall demonstrate these interlocks.

- E. The TE shall inform appropriate subcontractors and vendors before commissioning is started as to what the test and expected results will be. Whereas some test results and interpretations may not become evident until the actual tests are performed, all participants should have a reasonable understanding of the requirements. The commissioning plan must address the requirements and be distributed to all participants involved with that particular system.

3.9 REVIEW SOFTWARE DOCUMENTATION

- A. The TE shall review vendor/contractor/SNL-provided detailed FCS software documentation. This includes obtaining FCS program documentation, a review of the programming approach, interface with other systems (such as lighting, fire alarm, security, clock, emergency generator monitoring, sump pumps, and utility metering), and a review of the specific software routines as applied to this project. Discrepancies in programming approaches shall be resolved to provide SNL with the most appropriate, simple, and straightforward approach to software routines.

3.10 TRAINING

- A. Assist the Contractor in the preparation and submission a training plan for approval. The training plan shall include for each training session:
 - 1. Dates, start and finish times, and locations.
 - 2. Outline of the information to be presented.
 - 3. Names and qualifications of presenters.
 - 4. List of texts and other materials required to support training.
- B. Obtain assistance from appropriate subcontractors and vendors to provide training for the delegated SNL operations staff as specified in Divisions 15, 16, and 17.
- C. Provide videotape documentation of training of the SNL staff for each system. Training will be in a classroom setting with the appropriate schematics, handouts, and audio/visual training aids.
- D. Catalog training videotapes and deliver to the CA with the O&M manuals as part of the closeout package.
- E. Host each training session:
 - 1. Provide program overview and curriculum guidance.
 - 2. Obtain signatures of attendees on a sign-in list.
- F. Equipment vendors provide training on the specifics of each system and philosophy, troubleshooting, maintenance recommendations and repair techniques as specified in the relevant sections of this specification.
- G. Installation subcontractors provide training on peculiarities specific to this project and job-specific experience as specified in the relevant sections of this specification.
- H. O&M Manuals shall be available for the training sessions.**

3.11 RECORD DRAWINGS

- A. Review record documents to verify **changes made during commissioning have been incorporated.**

3.12 EXCLUSIONS

- A. The Commissioning Authority is not responsible for construction means, methods, job safety, or any management function related to commissioning on the job site.
- B. The Contractor shall provide all technician services requiring tools or the use of tools to test, adjust, or otherwise bring equipment into a full operational state.
- C. The contractor and TE are not responsible for any Civil or Structural testing required. All testing in this area will be provided by SNL to verify conformance with the contract documents.