SECTION 01 91 00 –GENERAL COMMISSIONING REQUIREMENTS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

1.1.1. The Contractor's attention is specifically directed, but not limited to, the Uniform General and Supplementary General Conditions for University of Texas System Building Construction Contracts (UGC) for other requirements.

1.1.2. Specifications throughout all Divisions of the Project Manual, which pertain to operable and non-operable equipment and/or building systems, are directly applicable to this Section, and this Section is directly applicable to them.

1.2. SUMMARY

1.2.1. This Section establishes general and administrative requirements pertaining to commissioning of equipment, devices, and building systems installed on renovation and new construction projects delivered under various contracting methodologies. Technical requirements for commissioning of particular systems and components are established in the Contract Documents.

1.2.2. It is of primary concern that all operable systems installed in the Project perform in accordance with the Contract Documents and the specified Owner's operational needs. During Commissioning, the Contractor systematically demonstrates to the Owner that the operable systems are properly performing in strict accordance with the Contract Documents.

1.2.3. Commissioning requires cooperation and involvement of all parties throughout the construction process. The Contractor shall deliver a successful Commissioning process. Successful Commissioning requires that installation of all building systems complies with Contract Document requirements and that full operational check-out and necessary adjustments are performed prior to Substantial Completion, with the exception of deferred tests approved in advance by Owner.

1.2.4. Commissioning will encompass and coordinate traditionally separate functions of system documentation, installation checkout, Prefunctional Checklists and start-up, control system calibration and point-to-point checkout, testing, adjusting, and balancing, Functional Performance Tests, Integrated System Tests, Contractor demonstration to the Owner, and training of Owner’s personnel. This requires assembling all related documentation into one cohesive collection. Commissioning is intended to achieve the following specific objectives of the Contract Documents.

1.2.4.1. Verify and document proper installation and intended performance of equipment, systems, and integrated systems.

1.2.4.2. Ensure that operating and maintenance and Commissioning documentation requirements are complete.

1.2.4.3. Provide Owner with functional buildings and systems that meet the Contract Document requirements at Substantial Completion.

1.3. DEFINITIONS

1.3.1. Building Automation System: System and components associated with the Building Automation System.

1.3.2. Commissioning: A systematic process confirming that building systems have been installed, properly started, and consistently operated in strict accordance with the Contract Documents, that all systems are complete and functioning in accordance with the Contract Documents at Substantial Completion, and that Contractor has provided Owner adequate system documentation and training. Commissioning includes deferred and/or seasonal tests as approved by Owner.

1.3.3. Commissioning Consultant: Party having a contractual agreement with the Owner to provide third party commissioning services as defined herein under Commissioning Consultant's Role and Responsibilities. Commissioning Consultant may represent the Owner and is authorized to act on behalf of the Owner. Commissioning Consultant does not have authority to alter design or installation procedures without the written approval of Owner.

1.3.4. Commissioning Plan: A document that provides the structure, schedule, and coordination plan for the Commissioning process from the construction phase through the warranty period. The Commissioning Plan will describe the project and systems to be commissioned, Commissioning process activities, procedures to follow throughout the process, roles and responsibilities for each participant, and general description of testing and verification methods. The Commissioning Plan must satisfy the Owner's Test Requirements.

1.3.5. Commissioning Team: Working group made up of representative(s) from the Architect/Engineer, Contractor, Test, Adjust, and Balance Firm, Building Automation System vendor, specialty manufacturers and suppliers, Owner, and Commissioning Consultant, if hired by Owner. Contractor will provide ad-hoc representation of subcontractors on the Commissioning Team as required for implementation of the Commissioning Plan.

1.3.6. Datalogging: Monitoring flows, current, status, pressures, etc. of equipment using stand-alone dataloggers or the Building Automation System as acceptable to Owner.

1.3.7. Deferred Tests: Functional Performance or Integrated System Tests performed after Substantial Completion due to partial occupancy, partial equipment acceptance, seasonal requirements, design, or other Site conditions that prohibit the test from being performed prior to Substantial Completion.

1.3.8. Deficiency: Condition of a component, piece of equipment, or system that is not in compliance with the Contract Documents.

1.3.9. Factory Testing: Testing of equipment at the factory, by factory personnel with an Owner's representative present, if deemed necessary by Owner.

1.3.10. Functional Performance Test: Test of dynamic function and operation of equipment and systems executed by Contractor. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Functional Performance Tests are executed after start-ups and Prefunctional Checklists are complete.

1.3.11. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configuration and steps required to determine if the system is performing and functioning properly.

1.3.12. Integrated System Test: Test of dynamic function and operation of multiple systems. Integrated System Tests are tested under various modes, such as fire alarm and emergency situations, life safety conditions, power failure, etc. Systems are integrally operated through all specified sequences of operation. Components are verified to be responding in

accordance with Contract Documents. Integrated System Tests are executed after Functional Performance Tests are complete and prior to Substantial Completion. Integrated System Tests provide verification that the integrated systems will properly function according to the Contract Documents.

1.3.13. Integrated System Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configurations and steps required to determine if the interacting systems are performing and functioning properly.

1.3.14. Indirect Indicators: Indicators of a response or condition without direct physical linkage, such as a reading on a control system display reporting a damper to be 100 percent closed.

1.3.15. Manual Test: Use of hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing trend data to make the "observation").

1.3.16. Overwritten Value: Writing over a sensor value in control system to see response of a system (e.g., changing outside air temperature value from 52°F to 72°F to verify economizer operation). See also "Simulated Signal".

1.3.17. Prefunctional Checklist: A list of static inspections and material or component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.). The word Prefunctional refers to before Functional tests. Prefunctional Checklists must include the manufacturer's start-up checklist(s). Contractor shall sign Prefunctional Checklists as complete and submit with the Request for Start-Up/Functional Performance Test Form.

1.3.18. Simulated Condition: Condition created to test component(s) and system(s) responses. (e.g., applying heat to space temperature sensor to monitor response of a terminal unit).

1.3.19. Simulated Signal: Disconnecting a sensor and using a signal generator to send voltage, amperage, resistance or pressure to transducer and/or direct digital control system to simulate a value to the Building Automation System to test the system and component response.

1.3.20. Start-up: The activities where equipment is initially energized, tested and operated. Start-up is completed prior to Functional Performance Tests.

1.3.21. Test, Adjust, and Balance Firm: The Owner may engage a Test, Adjust, and Balance Firm directly. Test, Adjust, and Balance responsibilities are contained in Technical Specifications and in the Test, Adjust, and Balance Firm's contract.

1.3.22. Test Requirements: Requirements specifying what systems, modes and functions, etc. must be tested. Test requirements are not detailed test procedures. Test requirements and acceptance criteria are specified in the Contract Documents.

1.3.23. Training Plan: a detailed plan prepared by the Contractor that outlines the training activities, instructors, time durations, and system requirements in accordance with the Contract Documents and the Training Program.

1.3.24. Training Program: A document prepared by Owner or Commissioning Consultant that outlines the specific objectives of the Owner Training conducted by the Contractor as applicable to the individual project and the systems installed. This document is a guide for the Contractor to produce the Training Plan for each building system as specified in the Contract Documents.

1.3.25. Trending: Data collection of monitoring points using the Building Automation System or dataloggers.

1.4. COORDINATION

1.4.1. Commissioning Team:

1.4.1.1. Members appointed by Owner:

1.4.1.1.1. Owner's Project Manager and any other designated representatives of Owner's staff.

1.4.1.1.2. Commissioning Consultant (if hired by Owner).

1.4.1.1.3. Architect/Engineer.

1.4.1.1.4. Test, Adjust, and Balance Firm.

1.4.1.2. Members appointed by Contractor:

1.4.1.2.1. Individuals, each having authority to act on behalf of the entity they represent, explicitly organized to implement the Commissioning process through coordinated actions.

1.4.1.2.2. Representatives of Contractor, including but not limited to, Project Manager and Commissioning coordinator, subcontractors, installers, and equipment suppliers. Owner must approve Contractor's Commissioning coordinator.

1.4.2. Scheduling:

1.4.2.1. Contractor shall integrate all Commissioning activities into the Project Schedule. All parties will address scheduling problems and make necessary notifications in a timely manner to expedite the Commissioning process.

1.4.2.2. Contractor shall provide the initial schedule of primary Commissioning activities at the Pre-Commissioning Meeting. Prior to the first Start-up or Prefunctional Checklist test occurring, Contractor shall have incorporated and integrated all Commissioning activities into the Project Schedule with appropriately linked predecessors and successors.

1.5. ROLES AND RESPONSIBILITIES

1.5.1. Roles and responsibilities of Commissioning Team members are provided in this Section to clarify the Commissioning process.

1.5.2. Owner's Role and Responsibilities:

1.5.2.1. Review Architect/Engineer's Technical Specifications containing Commissioning requirements.

1.5.2.2. Provide Owner's Test Requirements to Contractor.

1.5.2.3. Approve the Commissioning Plan, Training Program and Contractor's schedule of Commissioning activities.

1.5.2.4. Assign Owner's representatives and schedule them to participate in Commissioning activities, including the following:

1.5.2.4.1. Commissioning Team meetings.

1.5.2.4.2. Review and approval of Commissioning Plan, Training Program, Prefunctional Checklists, Functional Performance Test Procedures, Functional Performance Tests, Integrated System Test Procedures, Integrated System Tests, Deferred Tests, Trending, Training Plan and other Commissioning documents.

1.5.2.4.3. Attendance at Contractor's training sessions in operation and maintenance of systems and equipment.

1.5.2.4.4. Observation of Contractor's demonstration of systems and equipment operation.

1.5.3. Commissioning Consultant's Role and Responsibilities (if hired by Owner):

1.5.3.1. Prepare the Commissioning Plan with Contractor's input and for execution by Contractor.

1.5.3.2. Review and comment on Contractor's schedule of Commissioning activities.

1.5.3.3. Participate in Contractor-led Pre-Commissioning Meeting.

1.5.3.4. Conduct and document Commissioning Team meetings.

1.5.3.5. Perform site visits as necessary or in conjunction with Commissioning Team meetings to observe component and system installations. Attend selected Project progress meetings to obtain information on construction progress.

1.5.3.6. Review and comment on shop drawing submittals and coordination drawings applicable to systems being commissioned.

1.5.3.7. Review and comment on Contractor-prepared Prefunctional Checklist and other Contractor-prepared documents, including Operating and Maintenance Manuals and Training Plan.

1.5.3.8. Prior to equipment Start-ups, review the control sequences and coordinate with the Contractor and Project Architect/Engineer in order to prepare the Functional Performance Test and Integrated System Test procedures.

1.5.3.9. Witness equipment Start-ups as executed by Contractor.

1.5.3.10. Write Functional Performance Test Procedures and Integrated System Test Procedures for Contractor's execution of tests.

1.5.3.11. Witness, verify, and document results of Functional Performance Tests and Integrated System Tests.

1.5.3.12. Coordinate resolution of Deficiencies identified during Commissioning, Deferred Tests, and during the warranty period.

1.5.3.13. Prepare Owner's Training Program.

1.5.3.14. Compile Commissioning documentation for Contractor-prepared Commissioning and Closeout Manual including test documentation, Deficiency reports and solution results; non-compliance issue tracking; and recommendations on continuous commissioning, best practices, and preventive maintenance.

1.5.4. Architect/Engineer's Role and Responsibilities:

1.5.4.1. Specify control sequences of operation within the Contract Documents.

1.5.4.2. Attend Commissioning Team meetings.

1.5.4.3. Review Commissioning Plan, Training Program, Prefunctional Checklist, Functional Performance Test Procedures, Functional Performance Tests, Integrated System Test Procedures, Integrated System Tests, Deferred Tests, and other Commissioning documents.

1.5.4.4. Review Contractor's Training Plan.

1.5.4.5. Review Test, Adjust, and Balance plan.

1.5.4.6. Approve technical requirements for correction of Deficiencies identified during Commissioning, Deferred Tests, and during the warranty period.

1.5.4.7. Review Operating and Maintenance Manuals.

1.5.4 Contractor's Role and Responsibilities:

1.5.4.1 Produce for Owner's approval the Commissioning Plan, Prefunctional Checklist, Functional Performance Test Procedures, Integrated System Test Procedures, Request for Start-Up/Functional Performance Test Form, Equipment Matrix of all devices, systems and equipment supplied, and other Commissioning documents.

1.5.4.1.1 Commissioning Consultant, if hired by Owner, will produce the Commissioning Plan, project-specific Functional Performance Test Procedures, and project-specific Integrated System Test Procedures.

1.5.4.1.2 Contractor shall review and provide comments on documents produced by the Commissioning Consultant, and shall accept the Commissioning Plan, Functional Performance Test Procedures, and Integrated System Test Procedures as approved by Owner.

1.5.4.2 As the Project progresses, add specific checklists, test procedures, schedules, recorded results, action lists, signoff sheets and other documents for the Commissioning and Close-out Manual. Administer updates to the Commissioning and Close-out Manual with the intent that all Commissioning Team members will have up-to-date documentation as the Commissioning progresses.

1.5.4.3 Provide an individual, subject to Owner's approval, experienced in construction and Commissioning of building systems to organize, schedule, conduct, and document the Commissioning Plan and the Commissioning process. The Contractor shall assign this individual to act as the Contractor's Commissioning Coordinator. The Contractor's Commissioning Coordinator may have additional duties such as MEP Coordinator, but not as Project Manager or Superintendent. Submit qualifications demonstrating the Commissioning Coordinator's technical expertise and experience to the Owner for approval. In the event that Contractor chooses to subcontract its Commissioning obligations, then Contractor must submit the subcontractor's qualifications and personnel to Owner for Owner's approval.

1.5.4.4 Furnish and install systems that meet all requirements of the Contract Documents. Perform construction inspections, Start-ups, Prefunctional Checklists, Functional Performance Tests, and Integrated System Tests in accordance with the Contract

Documents and Commissioning Plan. Correct any deficiencies identified during these processes.

1.5.4.5 Ensure that Commissioning activities are incorporated into the Project Schedule.

1.5.4.6 Submit inspection and Start-up documentation to Owner in accordance with this Section – 01 99 00 General Commissioning Requirements, Section 01 45 00 – Project Quality Control, Section 01 77 00 – Project Close-out Procedures, Technical Specifications, and the Commissioning Plan.

1.5.4.7 Cooperate with Owner's representative(s), provide access to Work and provide adequate labor, resources, and time for Commissioning.

1.5.4.8 Furnish copies of all shop drawings and submittals, manufacturers' literature, maintenance information, and any other information required for the Commissioning process. Contractor must submit to Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians. Cross-reference Section 01 31 00 – Project Administration and Section 01 77 00 – Project Close-out Procedures (Operating and Maintenance Manuals) for additional required documentation.

1.5.4.9 Schedule and conduct pre-installation meetings and pre-commissioning meetings with subcontractors and equipment suppliers related to Commissioning. Contractor must invite Architect/Engineer and Owner to attend the pre-installation meetings and pre-commissioning meetings.

1.5.4.10 Provide qualified personnel, including subcontractors as required, to fully perform the testing and operational demonstrations required by the Contract Documents and the Commissioning Plan, including any deferred tests or re-testing related to warranty work.

1.5.4.11 Correct deficiencies identified during any stage of the Commissioning process.

1.5.4.12 Provide training to Owner. Coordinate subcontractor/vendor participation in training sessions.

1.5.4.13 Perform Deferred Tests and make necessary amendments to Operating and Maintenance Manuals and as-built drawings for applicable issues identified during the Deferred Tests.

1.5.4.14 Contractor shall be responsible for the following activities, and may contract with a Building Automation System vendor for these activities.

1.5.4.14.1 Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct controls deficiencies identified during Commissioning. Contractor must provide final record documents reflecting correction of controls deficiencies identified during Commissioning.

1.5.4.14.2 Provide instrumentation, computer, software and communication resources necessary to demonstrate compliance with the Contract Documents and the Commissioning Plan during the Prefunctional Checklist activities, Functional Performance Tests and Integrated System Tests of Building Automation System equipment.

1.5.4.14.3 Attend pre-commissioning meetings and Commissioning meetings including seasonal, post occupancy, or deferred Commissioning meetings

and activities as deemed appropriate to the Owner. Prepare training plans with Commissioning Team and perform training as specified in Contract Documents and Commissioning Plan.

1.5.4.14.4 Maintain comprehensive system calibration and checkout records. Submit records to Owner and Commissioning Team.

1.5.4.14.5 Set up, capture, analyze, and report trend logs as requested by Owner to substantiate proper systems operation.

1.5.5 Test, Adjust, and Balance Firm's Role and Responsibilities:

1.5.5.1 Attend pre-commissioning meetings and Commissioning Team meetings including seasonal, post occupancy, or deferred Commissioning meetings and activities as deemed appropriate to the Owner.

1.5.5.2 Submit Test, Adjust, and Balance Plan and forms describing methodology for performance of Test, Adjust, and Balance procedures specific to this Project to Owner for review.

1.5.5.3 Cooperate with Contractor and Contractor's Building Automation System vendor, if any, during Commissioning.

1.5.5.4 Re-balance any Deficiency identified during Commissioning.

1.5.5.5 Provide Test, Adjust, and Balance data to Contractor and Commissioning Team before Contractor begins Functional Performance Tests.

1.6 EQUIPMENT DOCUMENTATION REQUIREMENTS

1.6.1 Equipment Matrix:

1.6.1.1 Contractor shall submit a complete listing of all equipment, devices, and systems, with certain information as herein noted, within twenty-one (21) days of issuance of the Notice to Proceed with Construction and at least seven (7) days prior to submission of the first application for payment. This listing shall be referred to as the Equipment Matrix. Download an electronic version of this spreadsheet in Microsoft Excel format to use as a template for submittal purposes at the following website:

http://www2.mdanderson.org/depts/cpm/standards/templates/EquipmentMatrixTemplate.xlsx

1.6.1.2 Contractor shall coordinate Contractor's response to this requirement with Contractor's preparation of the Project Schedule, Submittal Schedule, Schedule of Values, and list of all equipment. Refer to Section 01 32 00 – Project Planning and Scheduling and Section 01 31 00 – Project Administration.

1.6.1.2.1 To the extent practical, Contractor should minimize redundant efforts in favor of a single, organized approach to all documentation required for Project equipment, systems, and devices.

1.6.1.3 The Equipment Matrix shall be formatted as a spreadsheet per Owner's template, with capability for printing various selected data columns to meet documentation requirements at various stages of construction, and for different purposes as required by various Technical Sections. The Equipment Matrix shall be updated as the Project progresses and submitted periodically as requested by Owner. Provide Owner with an electronic version of the final approved Equipment Matrix at or before project Close-out.

1.6.1.3.1 Contractor may elect to combine the Submittal Schedule and Equipment Matrix into one spreadsheet (with multiple tabbed sheets) that Contractor updates as the Project progresses.

1.6.1.4 The Equipment Matrix shall identify all operable devices and equipment grouped by the Construction Specification Institute (CSI) Master Format under the system they are primarily categorized under. When sorted by the column for system identification, the resulting printout must identify all system components, regardless of whether they are mechanical, electrical, or otherwise.

1.6.1.5 Contractor shall submit the Equipment Matrix in draft form prior to the first pre-commissioning meeting. Contractor shall continue to update the Equipment Matrix for each device or system and include the updated Equipment Matrix as an attachment to the Contractor's submission of the Request for Start-Up/Functional Performance Test Form for requesting Start-up and Functional Performance Tests of particular devices or systems. Owner shall assist the contractor in collecting information on equipment which were provided by the owner and installed by the contractor. The Equipment Matrix shall include the following column headings, as a minimum, for each device:

1.6.1.5.1 Equipment Plan Designation: Equipment Naming Convention (equipment acronym and sequential number) from Contract Documents.

1.6.1.5.2 Specification section.

1.6.1.5.3 Building ID: Shall be obtained from Owner's Data Management Group

1.6.1.5.4 Location / Room Number: Owner's Wayfinding Codes from Owner's Space Management database referring to room number or building location.

1.6.1.5.5 Asset Short Description: The asset short description is to be a very short textual description. Type a brief, identifying description for the asset followed by a comma then the "Equipment Plan Designation".. If multiple units, of same type, include equipment ID number from the Construction Documents. This field is limited to 80 characters. Example= Pump, Secondary Chilled Water, SCHWP-01-2B.

1.6.1.5.6 Asset Long Description: A more complete description of the asset to make it clearer to the Owner's maintenance group. Include any distinguishing details relevant to identifying the asset from other identical units (color, physical location within a room, and so on. Example: Horizontal split case pump located in North end of room..

1.6.1.5.7 System Level Asset: Type of system that the equipment serves. Contact Owners Building Manager for latest system level assets list. Example: Domestic Hot Water

1.6.1.5.8 Product submittal reference number(s).

1.6.1.5.9 Product submittal approval date.

1.6.1.5.10 Name of installing Subcontractor.

1.6.1.5.11 Installing Subcontractor contact information.

1.6.1.5.12 Equipment Manufacturer.

1.6.1.5.13 Equipment model number.

1.6.1.5.14 Equipment serial number.

1.6.1.5.15 Emergency Power: note equipment served from emergency power system.

1.6.1.5.16 Equipment manufacturer's representative (Vendor).

1.6.1.5.17 Equipment manufacturer's representative (Vendor) contact information.

1.6.1.5.18 Manufacturer's purchase order number.

1.6.1.5.19 Asset Cost: The full asset costs includes: All installation costs to bring asset to full operating condition (vendor commissioning). Cost of controls/panels used to operate the asset. Cost of all supporting infrastructure involved with setting up the asset. Support framework or pad site. Piping and/or conduit runs (chiller supply water/electrical)

1.6.1.5.20 Estimated replacement cost: Replacement cost of the equipment only. This cost may be lower than the initial asset cost, because it does not include certain one-time cost such as piping and or conduit runs, control panels, base pads.

1.6.1.5.21 Start-up Date: Date of initial equipment or device start-up by the Contractor.

1.6.1.5.22 Prefunctional Checklist completion date.

1.6.1.5.23 Functional Performance Test completion date.

1.6.1.5.24 Integrated Systems Test completion date.

1.6.1.5.25 Substantial Completion date.

1.6.1.5.26 Manufacturer's warranty start date.

1.6.1.5.27 Warranty End Date: The date on which the asset warranty ends.

1.6.1.6 Owner's Operations and Maintenance Department will furnish the following additional information; allow column headings for this data:

1.6.1.6.1.1 Asset Number

1.6.1.6.1.2 Parent ID

1.6.1.6.1.3 Asset Group Code

1.6.1.6.1.4 Cost Center

1.6.1.6.1.5 Critical Factor

1.6.1.6.1.6 Estimated Asset Life

1.6.1.6.1.7 Asset Status

1.6.1.6.1.8 Work Group

1.6.1.6.1.9 Work Area

1.6.2 Request for Start-Up/Functional Performance Test Form:

1.6.2.1 Contractor must use Owner's Request for Start-Up/Functional Performance Test Form to request: (1) to initially energize or operate equipment and systems; and (2) an inspection of any system or system component for readiness prior to Functional Performance Tests.

Contractor must complete the appropriate section of Owner's Request for Start-Up/Functional Performance Test Form.

1.6.2.1.1 Request for Start-up. Contractor must certify that: (1) electrical and mechanical connections have been installed and are safe for initial Start-up; (2) Contractor has complied with Owner's utilities outage notifications; and (3) Start-up will not harm Owner's daily routine operations.

1.6.2.1.2 Request for Functional Performance Test. Contractor must certify that the Contractor has verified that the installation, Start-up, Prefunctional Checklists, and initial operation of the system or component are in accordance with the Contract Documents and the Commissioning Plan including manufacturer's instructions, manufacturer's requirements for maintenance of warranty, and verification that the system is ready for Functional Performance Tests. Contractor must certify that the manufacturer's representative has verified that the installation, start-up, and initial operation of the system or component are in accordance with the manufacturer's published recommendations.

1.6.2.2 Contractor shall attach to the Request for Start-Up/Functional Performance Test Form the applicable Prefunctional Checklist(s) completed and signed by Contractor, evidencing Contractor's own thorough inspection of the system and completion of start-up activities required by the Contract Documents and the Commissioning Plan. Contractor shall also attach all required supporting documentation, including but not limited to, factory start-up forms, operational testing data, and certifications.

1.6.2.3 Contractor must obtain Owner's signature on the Request for Start-Up/Functional Performance Test Form prior to proceeding with the Start-up or Functional Performance Test.

1.8 PREFUNCTIONAL CHECKLIST

1.8.1 Contractor shall provide a Prefunctional Checklist for each system to Owner and Architect/Engineer for review.

1.8.1.1 Contractor shall provide a draft version of each individual Prefunctional Checklist at a pre-installation meeting for the system. Based on discussions at a pre-installation meeting and subsequent as-constructed conditions, Contractor shall amend and revise each Prefunctional Checklist as appropriate prior to requesting system inspection from the Owner.

1.8.1.2 Contractor shall provide the final approved Prefunctional Checklist and all supporting documentation as an attachment to the Request for Start-Up/Functional Performance Test Form.

1.8.2 In addition to the Request for Start-Up/Functional Performance Test Form, Contractor shall review the installation and Contract Documents for each system and shall provide written confirmation of the following if not included in the Prefunctional Checklist.

1.8.2.1 All required test reports and/or certifications have been submitted and accepted by Owner. If required, Contractor must provide certification of acceptance from manufacturer's representative.

1.8.2.2 Evidence that Architect/Engineer has approved all shop drawings and product data submittals for each component device.

1.8.2.3 All valve charts, wiring diagrams, control schematics, electrical panel directories, etc. have been submitted, approved, and installed in accordance with the Contract Documents.

1.8.2.4 All tabulated data has been submitted for each system and/or device.

1.8.2.5 Each component device has been installed in accordance with applicable codes, the Contract Documents, and manufacturer's written recommendations.

PART 2 - PRODUCTS

2.1. TEST EQUIPMENT

2.1.1. Contractor shall provide all specialized tools, test equipment and instruments required to execute start-up, checkout, and testing of equipment.

2.1.2. All specialized tools, test equipment and instruments required to execute start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

PART 3- EXECUTION

3.1. COMMISSIONING PLAN

3.1.1. Contractor shall submit a draft Commissioning Plan to Owner for review within twenty-one (21) days of issuance of the Notice to Proceed with Construction or within ninety (90) days prior to initial installation of materials or equipment that will undergo Start-up and Functional Performance Tests, as directed by Owner.

3.1.2. Contractor shall allow in the Work Progress Schedule a minimum of twenty-one (21) days after Owner's receipt of the draft Commissioning Plan for Owner to submit initial review comments to Contractor.

3.1.3. Contractor shall incorporate Owner's initial review comments and resubmit the revised Commissioning Plan to Owner within fourteen (14) days of receipt of Owner's initial review comments.

3.1.4. Contractor shall allow in the Project Schedule an additional fourteen (14) days for Owner's approval of the resubmitted Commissioning Plan that incorporates Owner's initial review comments.

3.2. PRE-COMMISSIONING MEETING

3.2.1. Upon obtaining Owner's approval of the Commissioning Plan, Contractor shall schedule, plan, and conduct a Pre-Commissioning Meeting with all parties involved in the Commissioning process. This meeting should include the major subcontractors, specialty manufacturers/suppliers, Architect/Engineer, Test, Adjust, and Balance Firm, Commissioning Consultant (if hired by Owner), and Owner's representatives as participants.

3.2.2. Contractor shall prepare for the Pre-Commissioning Meeting by creating drafts of the following documents with input from the Owner. Commissioning Consultant, if hired by Owner, will prepare the Commissioning Plan, Functional Performance Test Procedures and Integrated System Test Procedures.

3.2.2.1. Approved Commissioning Plan including the Equipment Matrix and the Close-out and Documentation Matrix and defined in Section 01 77 00 – Project Close-out Procedures.

3.2.2.2. Project Schedule incorporating Commissioning activities.

3.2.2.3. Prefunctional Checklists.

3.2.2.4. Functional Performance Test Procedures.

3.2.2.5. Integrated System Test Procedures.

3.2.3. Contractor and / or Commissioning Consultant shall conduct the Pre-Commissioning Meeting and review all aspects of the Commissioning Plan. All documentation will be discussed and all test procedures and forms reviewed for approval with the Owner. Contractor shall prepare an outline noting responsibilities of the various parties involved in the Commissioning process for review at this meeting.

3.2.4. The Commissioning Plan shall be reviewed with all attendees and the scope of work discussed. Contractor should be prepared to distribute copies of the pertinent sections to the various subcontractors involved in the Commissioning process.

3.2.5. Contractor shall present Commissioning target dates for the Project. These dates and durations shall be incorporated in the Project Schedule in accordance with Section 01 32 00 – Project Planning and Scheduling.

3.2.6. Contractor shall provide updates to the Project Team on the Commissioning process during all Project Progress Meetings.

3.3. REPORTING

3.3.1.1. Contractor shall provide status reports to Owner at frequencies directed by Owner.

3.3.1.2. Contractor shall communicate at least monthly with all members of the Commissioning Team, keeping them apprised of Commissioning progress and scheduling changes.

3.3.1.3. Contractor shall submit non-conformance and Deficiency reports to Owner within five (5) days of the non-conformance or Deficiency occurrence. This includes responses to items noted by the Commissioning Consultant.

3.3.1.4. Contractor shall provide final Commissioning documentation to Owner in accordance with Section 01 77 00 – Project Close-out Procedures, which will become part of the Commissioning and Close-out Manual.

3.4. INITIAL START-UP

3.4.1. Start-up of Independent Devices:

3.4.1.1. Prior to Start-up, Contractor shall not energize or activate, or allow to be energized or activated, any operable device until Contractor has verified to Contractor's own satisfaction that all Contract Document requirements for the operable device have been met and have been documented in the Prefunctional Checklists or other documentation.

3.4.1.2. Contractor may energize and/or start-up independent devices for operational check-out and testing only after Contractor and manufacturer's representative and/or engineering technician (if required by the Contract Documents) have inspected and accepted the

installation. The installation must not vary from provisions of the applicable Specifications and the manufacturer's written recommendations for Start-up.

3.4.1.3. When Start-up of equipment or systems have the potential to impact Owner's daily operations or when the Contract Documents require the Owner to witness Start-up, Contractor must provide advance notice to Owner in accordance with the procedures outlined in the Contract Documents prior to Start-up. Contractor may not proceed with Start-up without the Owner's written approval.

3.4.2. Start-up of Building Systems:

3.4.2.1. Contractor shall not energize or activate any building system until the following conditions have been met:

3.4.2.1.1. Contractor has verified that all wiring and support components for equipment are complete and have been tested in accordance with the technical specifications and/or the manufacturer's written recommendations.

3.4.2.1.2. Contractor has verified that each component device has been checked for proper lubrication, vibration isolation, drive rotation, belt tension, control sequence, or other conditions that may cause damage.

3.4.2.1.3. Contractor has verified that all tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer and are in compliance with applicable Contract Documents.

3.4.2.1.4. Contractor has received documented approval of Owner's building system final inspection reports. Refer to Section 01 45 00 – Project Quality Control.

3.4.2.1.5. Contractor has provided the Owner and Architect/Engineer with a written seven (7) day notice of intent to start-up the system for operational check-out. The notification procedures outlined in the Contract Documents and / or the Commissioning Plan shall be utilized. The Request for Start-Up/Functional Performance Test Form <u>without attachments</u> shall be used for this notification.

3.4.2.2. Contractor shall perform Start-up under supervision of the responsible manufacturer's representative in accordance with manufacturer's instructions and specification requirements.

3.4.2.3. Contractor shall coordinate and schedule system(s) Start-up in a timely manner so that each component or system can operate for a period of time that is sufficient to evaluate and adjust performance as necessary. All building systems shall be operational and must have been successfully inspected by Owner's representatives, through attendance and concurrence with results of the Prefunctional Checklists or as otherwise approved by Owner, prior to the Contractor proceeding with Functional Performance Tests.

3.4.2.4. Contractor shall clearly list outstanding items or initial Start-up and Prefunctional Checklists not completed successfully. Contractor shall obtain from Subcontractor completed forms documenting any outstanding Deficiency within five (5) days of completion of such test procedures.

3.4.2.5. Contractor shall review completed Deficiency forms to determine if outstanding items prevent execution of the Functional Performance Tests and shall issue any necessary responses to the Owner and / or Commissioning Consultant.

3.4.2.6. Owner may backcharge Contractor for any incomplete Prefunctional Checklist or Deficiency that subsequently causes delays during Functional Performance Test.

3.5. FUNCTIONAL PERFORMANCE TESTS

3.5.1. Objective and Scope:

3.5.1.1. The objective of a Functional Performance Test is to demonstrate that each system operates according to the Contract Documents.

3.5.1.2. Contractor shall operate each system through all modes of operation (occupied, unoccupied, warm-up, cool-down, etc.) for specified system responses. Contractor is required to demonstrate to Owner's satisfaction each operational sequence.

3.5.2. Development of Functional Performance Test Procedures:

3.5.2.1. The purpose of a Functional Performance Test is to verify and document compliance with the stated criteria of acceptance. Contractor or Commissioning Consultant, if hired by Owner, shall develop specific script-type test procedures and associated test forms to verify and document proper operation of each piece of equipment and system.

3.5.2.2. Contractor shall prepare Functional Performance Test Procedure forms as part of the Commissioning Plan. Once approved by Owner, Contractor shall utilize the forms for all testing activities.

3.5.2.3. Functional Performance Test Procedure forms must include the following.

3.5.2.3.1. System and equipment or component name(s).

3.5.2.3.2. Equipment location and identification number as identified in the Equipment Matrix.

3.5.2.3.3. Unique test identification number and reference to unique Prefunctional Checklist identification numbers for the equipment.

3.5.2.3.4. Date and time of test.

3.5.2.3.5. Project name.

3.5.2.3.6. Participating parties.

3.5.2.3.7. Specific sequence of operation or other specified parameters, including performance data being verified.

3.5.2.3.8. Instructions for setting up a Functional Performance Test.

3.5.2.3.9. Specific script-type, step-by-step procedures to perform a Functional Performance Test, in a clear, sequential and repeatable format that is customized for the system being tested.

3.5.2.3.10. A Pass / Fail checkbox (or data entry box as appropriate) for clearly indicating whether or not proper performance of each part of a Functional Performance Test was achieved and space for actual readings.

3.5.2.3.11. Section for comments.

3.5.2.3.12. Signatures and date block for participants and Owner approvals.

3.5.3. Contractor shall operate, or cause to be operated, each system, device, or equipment item, both intermittently and continuously, for a duration period as indicated in the Specification Section(s) for each item and/or in accordance with the manufacturer's written recommendations, the Contract Documents and the Commissioning Plan.

3.5.4. Contractor shall operate each component device and each building system to the full extent of its capability, from minimum to maximum, and under automatic control and manual control.

3.5.5. Contractor and manufacturer's representatives shall supervise and coordinate adjustments and balancing of all devices and systems for proper operation prior to requesting a Functional Performance Test(s).

3.5.5.1. Where final balancing of a system is to be performed by Owner or Owner's consultants, such as final air balancing, Contractor shall provide all services indicated in the applicable Technical Sections and under this Section including the following prior to Owner's final balancing.

3.5.5.1.1. Operational verification of all component devices and the total system, including automatic controls when applicable. Operational verification includes verification that all motors, fans, dampers, and other operable devices are performing in compliance with Specifications throughout their operable range and that all devices are controlled as described in the specified sequence of operation.

3.5.5.1.2. All tabulated data, motor amperage readings, valve tag verifications, and other data required by Technical Specifications.

3.5.5.2. Where final balancing of a system or particular components of a system are not specifically indicated to be performed by Owner or Owner's consultants, Contractor shall provide final balancing and adjustments for operation within specified tolerances prior to Functional Performance Test of such system.

3.5.6. Coordination and Scheduling.

3.5.6.1. Members of the Commissioning Team, including Owner, may observe Functional Performance Tests of equipment components and systems. Contractor shall provide written notice to Owner at least seven (7) days prior to Functional Performance Tests of equipment components and systems. Contractor shall notify Owner in advance of any changes to the Functional Performance Test schedule. Owner may require Contractor to reschedule Functional Performance Tests to ensure availability of Owner's representative(s).

3.5.6.2. Contractor conducts Functional Performance Tests after system Start-up and Pre-functional Checklists are satisfactorily completed and approved by Owner. Air balancing and water balancing shall be completed before Functional Performance Tests.

3.5.6.3. Contractor conducts Integrated System Tests after Functional Performance Tests are satisfactorily completed and approved by Owner.

3.6. INTEGRATED SYSTEM TESTS

3.6.1. Objective and Scope:

3.6.1.1. The objective of an Integrated System Test is to demonstrate that each system operates jointly and independently of other systems according to the Contract Documents.

3.6.1.2. Contractor shall operate each system, jointly and independently of other systems, through selected modes of operation (fire alarm integration with HVAC, emergency power modes, equipment failures among related systems, etc.) for specified system responses. Contractor is required to demonstrate to Owner's satisfaction each operational sequence.

3.6.2. Development of Integrated System Test Procedures:

3.6.2.1. The purpose of an Integrated System Test is to verify and document compliance with the stated criteria of acceptance. Contractor or Commissioning Consultant, if hired by Owner, shall develop specific script-type test procedures and associated test forms to verify and document proper operation of each piece of equipment and system, jointly and independently of other systems.

3.6.2.2. Contractor shall prepare Integrated System Test Procedure forms as part of the Commissioning Plan. Once approved by Owner, Contractor shall utilize the forms for all testing activities.

3.6.2.3. Integrated System Test Procedure forms must include the following.

3.6.2.3.1. System and equipment or component name(s).

3.6.2.3.2. System and equipment location and identification number as identified in the Equipment Matrix.

3.6.2.3.3. Unique test identification number and reference to unique Functional Performance Test identification numbers for the system and equipment.

3.6.2.3.4. Date and time of test.

3.6.2.3.5. Project name.

3.6.2.3.6. Participating parties.

3.6.2.3.7. Specific sequence of operation or other specified parameters, including performance data being verified.

3.6.2.3.8. Instructions for setting up an Integrated System Test.

3.6.2.3.9. Specific script-type, step-by-step procedures to perform an Integrated System Test, in a clear, sequential and repeatable format that is customized for the system being tested.

3.6.2.3.10. A Pass / Fail checkbox (or data entry box as appropriate) for clearly indicating whether or not proper performance of each part of an Integrated System Test was achieved and space for actual readings.

3.6.2.3.11. Section for comments.

3.6.2.3.12. Signatures and date block for participants and Owner approvals.

3.6.3. Contractor shall operate, or cause to be operated, each system, device, or equipment item, both intermittently and continuously, for a duration period as indicated in the Specification Section(s) for each item and/or in accordance with the manufacturer's written recommendations, the Contract Documents and the Commissioning Plan.

3.6.4. Coordination and Scheduling.

3.6.4.1. Members of the Commissioning Team, including Owner may observe Integrated System Tests of equipment components and systems. Contractor shall provide written notice to Owner at least fourteen (14) days prior to Integrated System Tests of equipment components and systems. Contractor shall notify Owner in advance of any changes to the Integrated System Test schedule. Owner may require Contractor to reschedule Integrated System Tests to ensure availability of Owner's representative(s).

3.6.4.2. Contractor conducts Integrated System Tests after Functional Performance Tests are satisfactorily completed and approved by Owner.

3.7. DOCUMENTATION AND NON-CONFORMANCE

3.7.1. Documentation:

3.7.1.1. Contractor shall witness and document the results of all Functional Performance Tests and Integrated Systems Tests using specific procedural forms developed for that purpose or approved electronic database program. Prior to testing, Contractor shall submit these forms to the Owner for review and approval. Contractor will include the completed, filled-out forms in the Commissioning and Close-out Manual.

3.7.2. Non-Conformance:

3.7.2.1. Contractor shall record results of Functional Performance Tests and Integrated System Tests. Commissioning Consultant and / or Contractor shall report all Deficiencies and non-conformance issues to Owner in accordance with the procedures outlined in the Commissioning Plan.

3.7.2.2. At the sole discretion of Owner, Owner may permit Contractor to make corrections of minor Deficiencies observed during a Functional Performance Test or during an Integrated System Test. However, the Contractor must document the Deficiency and resolution on the appropriate report form.

3.7.2.3. Contractor shall make every effort to expedite testing and minimize unnecessary delays, while not compromising the integrity of a Functional Performance Test or an Integrated Systems Test.

3.7.2.4. Contractor and Owner will attempt to resolve Deficiencies in the following manner.

3.7.2.4.1. When there is no dispute about a Deficiency and Contractor accepts responsibility for correction.

3.7.2.4.1.1. Commissioning Consultant or Contractor documents the Deficiency and the corrective actions, and then proceeds to another test or sequence. A Deficiency report is submitted to Owner. Contractor corrects the Deficiency, completes the statement of correction form certifying that the equipment or system is ready for retesting, and sends the certification to Owner and / or Commissioning Consultant.

3.7.2.4.1.2. Contractor reschedules test with Owner.

3.7.2.4.2. When there is a dispute about whether or not the test indicates a Deficiency or the Contractor's responsibility for correction of the apparent Deficiency.

3.7.2.4.2.1. Commissioning Consultant or Contractor documents the apparent Deficiency. A Deficiency report is submitted to Owner, including the apparent Deficiency.

3.7.2.4.2.2. Contractor facilitates resolution of the Deficiency and provides recommendations to the Owner. Contractor and Owner may bring other parties into the discussions as needed. Final technical interpretive authority is with the Architect/Engineer. Final acceptance authority is with the Owner.

3.7.2.4.2.3. Contractor documents the resolution process.

3.7.2.4.2.4. If Owner agrees with Contractor's interpretation and proposed resolution, Contractor forwards response to Owner. Contractor reschedules test with Owner. Contractor must repeat this process until satisfactory performance and Owner's approval is obtained.

3.8. DEMONSTRATION AND OWNER TRAINING

3.8.1. Commissioning Consultant in coordination with Owner shall develop the Training Program to outline the project specific requirements for Owner Training after reviewing the different systems to be installed and commissioned. The purpose of this Program is to specifically communicate the required content and training durations required by the Owner based upon the type of equipment and the Owner's past experience. The Training Program should be a guideline for the Contractor to develop the Training Plan. Owner must approve the Training Program and any deviations from the Contract Document requirements prior to the Contractor developing the Training Plan.

3.8.2. Contractor shall coordinate, schedule and complete the training related to all equipment specified in the Contract Documents. Contractor may utilize the installing subcontractor and/or manufacturers' representative or others approved in advance by Owner for specific portions of equipment or systems training. Contractor shall conduct multiple training sessions as required to adequately train Owner's staff.

3.8.3. Contractor shall conduct classroom-style training session followed by on-site demonstrations of system operation. Refer to Technical Specification Sections and Contract Documents for training requirements. When equipment or a system requires both demonstration and training, Contractor may combine the demonstration and training provided that the Contractor obtains the Owner's approval at least ten (10) days prior to the demonstration and training.

3.8.4. Contractor shall furnish to the Owner a professional quality video and audio recording of the training. Owner may select portions of the training to be recorded.

3.8.5. Contractor shall submit a written training plan, referred to as the Training Plan, to the Owner and Architect/Engineer for review and approval. Training Plan shall cover the following elements.

3.8.5.1. Equipment included in training.

3.8.5.2. Intended audience.

3.8.5.3. Location of training.

3.8.5.4. Objectives.

3.8.5.5. Subjects covered.

3.8.5.6. Duration of training on each subject.

3.8.5.7. Instructor for each subject.

3.8.5.8. Methods (classroom lecture, video, Site walk-through, actual operational demonstrations, written handouts, etc.).

3.8.5.9. Instructors and qualifications.

3.8.6. Contractor shall use Operating and Maintenance Manuals and the Equipment Matrix as a basis for instructing Owner's staff regarding system operation. Contractor shall review contents of Operating and Maintenance Manuals and review equipment data and performance verification to Owner as part of Owner training. This instruction and data review should be held in a classroom environment.

3.8.7. Contractor shall demonstrate in the field: start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of the system(s) and each component device.

3.8.8. Contractor shall demonstrate system performance at each stage of sequence of operation. Contractor shall promptly correct any deficiencies noted during the demonstration and document on a Deficiency report.

3.8.9. Contractor shall cooperate with Owner and Owner's Test, Adjust, and Balance Firm for verification testing and final adjustments and balancing as may be indicated in the Contract Documents or as directed by Owner.

3.8.10. As a minimum, Contractor shall perform training on all systems including, but not limited to, the following (as applicable to the Project):

3.8.10.1. Heating, Ventilating, and Air Conditioning Airside and Waterside Systems.

3.8.10.2. Building Automation System.

3.8.10.3. Life Safety Systems (including Fire Alarm, Stairwell Pressurization, Fire Protection, and Smoke Containment, Control, and Response System).

3.8.10.4. Elevators/Escalators.

3.8.10.5. Refrigeration Systems.

3.8.10.6. Lighting Control Systems.

3.8.10.7. Communications Systems (including Network, Data, Nurse Call)

3.8.10.8. Emergency Power and Uninterruptible Power Supply (UPS) Systems.

3.8.10.9. Domestic and Process Water Systems.

3.8.10.10. Medical Gas and Vacuum Systems.

3.8.10.11. Laboratory Gas and Vacuum Systems.

3.8.10.12. Any other major system not identified above.

3.9. DEFERRED TESTS

3.9.1. Deferred Tests:

3.9.1.1. Contractor shall complete Deferred Tests as part of this Contract during the warranty period. Contractor shall schedule this activity with Owner and / or Commissioning

Consultant. Contractor shall perform tests and document and correct deficiencies. Owner may observe the tests and review and approve test documentation and Deficiency corrections.

3.9.1.2. Contractor shall incorporate final updates to the Commissioning and Close-out Manual.

3.9.1.3. If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, performance of such test may be delayed to later in the warranty period, upon approval of the Owner. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as Deferred Tests.

3.10. COMMISSIONING DOCUMENTATION

3.10.1. Contractor shall compile and organize all Commissioning documentation into a Commissioning and Close-out Manual and deliver to the Owner as specified in Section 01 77 00 – Project Close-out Procedures.

3.10.2. The Commissioning and Close-out Manual submitted to Owner shall contain all documentation related to the Commissioning process, including, but not limited to:

3.10.2.1. The Commissioning Plan.

3.10.2.2. Project Commissioning schedules with Commissioning milestone activities.

3.10.2.3. Completed Equipment Matrix.

3.10.2.4. Request for Start-Up/Functional Performance Test Forms with all attachments.

3.10.2.5. Completed Prefunctional Checklists with all required attachments,

3.10.2.6. Functional Performance Test Procedures and results.

3.10.2.7. Integrated System Test Procedures and results.

3.10.2.8. Training Program.

3.10.2.9. Training Plan and all supporting documentation.

3.10.2.10. Deficiency reports and solution results.

3.10.2.11. Recommendations on continuous Commissioning, best practices, and preventive maintenance.

3.10.2.12. Refer to Section 01 77 00 – Project Close-out Procedures for additional Close-out documentation to be included in the Commissioning and Close-out Manual.

END OF SECTION 01 91 00

Attachment No. 1 – Equipment Matrix

Download an Electronic Version of the Equipment Matrix template at the following Internet Address:
http://www2.mdanderson.org/depts/cpm/standards/supp.html#templates

Project Name
Equipment Matrix

Integrated System / System / Component / Unit / Unit.1 / Unit.2 / Unit.3	Equipment Manufacturer	Equipment Model Number	Equipment Serial Number	Emergency Power	Manufacturer / Vendor Representative	Manufacturer / Vendor Contact Information	Manufacturer PO Number	Estimated Replacement Cost	Start-Up Date(s)	Prefunctional Checklist Approved	Functional Performance Test Approved	Integrated Systems Test Approved	Substantial Completion Date	Warranty Start Date	Warranty Duration (Years)	Short Description (from MDACC)	Mainsaver Work Group (from MDACC)	Mainsaver Group Code (from MDACC)	Estimated Service Life (from MDACC)
I - MECHANICAL																			
S - CWS- Chilled Water System																			
C - Pump																			
U -																			
U.1 -																			
S - AHU- Air Handling Units																			
C - VFD																			
U -																			
C - Air Terminal Units																			
U -																			
S - FCU- Fan Coil Units																			
C -																			
S - CRAC- Computer Room Air Condition Units																			
C -																			
S - Fans																			
C -																			
U -																			
I - PLUMBING																			
S - Domestic Water System																			
C -																			
U																			
U.1 -																			
S - Diesel Fuel System																			
U																			
U.1 -																			
S - Subsurface Drainage System																			
C -																			
S - Elevator Sump System																			
C -																			
S - Sewage System																			
C -																			
S - Med Gas																			
C -																			
S - Lab Piping System																			
C - Lab Waste																			
U																			
U.1 -																			
C - Liquid Nitrogen																			
U																			
U.1 -																			
C - Lab Vacuum																			
U																			
U.1 -																			

Example