Commissioning Plan – Construction Phase

Sample Company

Initial Draft – 05/18/2009
Design Version – 07/01/2009
Construction Version – 06/31/2010
Final Version - MO/DA/YR

Commissioning Plan – Construction Phase
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The CxA will maintain a system of record keeping toward the documentation necessary for final reporting and Re-commissioning plans. The system includes the following division of tasks and documents.

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1 Overview

The *Commissioning plan* is a living document describing the key steps taken throughout the construction, and operation of the newly added facility to attain the desired results. This commissioning plan has been developed in draft form for this specific project during the early construction phase. The plan provides direction site-specific commissioning specifications by the construction team, and provides direction for the commissioning tasks during construction. This plan focuses on providing support for the specifications and provides forms for the application of the commissioning process.

Abbreviations:

The following are common abbreviations used in this document.

A/E-	Architect and design engineers	GC-	General contractor (prime)
CxA-	Commissioning authority	MC-	Mechanical contractor
CM-	Construction Manager	PC-	Construction checklist
Cx-	Commissioning	Subs-	Subcontractors to General
Cx Plan-	Commissioning Plan document	TAB-	Test and balance contractor
EC-	Electrical contractor	TCC	Temperature Controls Contractor
FT-	Functional performance test		

1.1 General Building Information

Project: Mount Nittany Medical Center
Location: State College, PA
Building Type: Hospital
Square Footage: 41,817
Number of Stories: Three floor addition to an existing two story building
Agency:
Tenants: NA

Purpose of Commissioning:

The purpose of the construction phase commissioning plan is to provide quality direction for the commissioning process during construction, particularly providing resolution for issues and providing details not anticipated during design, such as scheduling, participation of various parties involved in this project, actual lines of reporting and approvals, coordination, et cetera.

Commissioning Objectives

Commissioning is a systematic process of ensuring that all building systems perform interactively according to the Design Intent and the Owner's operational needs. The commissioning process is intended to assist with the coordination of traditionally separate functions of system documentation, equipment startup, control system and calibration, performance testing, and training. Commissioning during the construction of this project is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify that applicable equipment and systems are installed in accordance with manufacturer's recommendations and to industry accepted standards.
2. Verify that the systems and equipment receive adequate operational checkout by the installing contractors.

3. Verify and document proper performance of equipment and systems.
4. Ensure that Operation and Maintenance (O&M) documentation is properly compiled and is readable, understandable, and complete.
5. Ensure that Owner's operating personnel are adequately trained.

Commissioned Systems

The following are the commissioned systems in this project. Refer to part 6 of this commissioning plan for additional details. All general references in this document refer only to equipment that is to be commissioned.

Equipment and System	Equipment and System
HVAC System	**Electrical System**
Variable Speed/Frequency Drives	Power Distribution System
	Lighting Control Systems
HVAC Pumps	Lighting Control Programs
Air Handling Units	Engine Generators and UPS Systems
Supply air valves	Transfer Switches
Variable / constant volume boxes - VAV	Switchboard
Fan powered boxes - FPB	Meter Monitoring
Dual duct mixing boxes - DMB	Grounding
Centrifugal Fans	
Exhaust reclaim	
Automatic Temperature Controls – Including an intentional sequence of operation	Fire Alarm and interface items with HVAC (i.e.: smoke evacuation, smoke dampers, stair well pressurization, et cetera)
Fire/Smoke Dampers	
Ductwork	**Other Shell Related Systems**
Testing, Adjusting and Balancing	Building Insulation Installation
	Building Roof Installation Methods
	Doors & Windows Installation Methods
Plumbing system	Water Infiltration / Shell Drainage Plain
Water Heaters	Shell Flashing Details
Medical Gas	**Fire Protection**

Commissioning Team Information

Table 1-1: Team Members' Contact Information

Team Member	Person	Company	Phone, Fax, Email
Commissioning Authority	Brian Toevs	BETA Engineers A 7group Member Company 36 West Main Street Mechanicsburg, PA 17055	P: 717-697-6300 F: 717-697-1699 E: toevs@sevengroup.com
Owner			
Architect			
Mechanical Engineer			
Plumbing Engineer			
Electrical Engineer			
Structural Engineer			
Civil Engineer			
Construction Manager			
General Contractor			
Plumbing Contractor			
Mechanical Contractor			
Sheet Metal Contractor			
Electrical Contractor			
Fire Protection Contractor			
HVAC Controls Contractor			
Testing & Balancing Contractor			

Commissioning Roles and Responsibilities

Team Members

The members of the commissioning team consist of the CxA, CM, assigned members of the GC, A/E teams (particularly the mechanical and electrical engineer), the MC, EC, TAB representative, TCC, and any other installing subcontractors or suppliers of commissioned equipment or assemblies. Additionally, the Owner's key maintenance staff members will be a part of the commissioning team.

General Management Plan

The Owner has engaged the services of BETA Engineers as the Commissioning Authority. In general, the CxA coordinates the commissioning activities and reports to the Owner. The CxA's responsibilities, along with all the contractors' commissioning responsibilities are detailed in the specifications. The specifications will take precedence over the Cx Plan. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

Descriptions of Roles

Following are the General Descriptions of the commissioning roles:

CxA: Coordinates the Cx process, writes tests, oversees and documents performance tests.

CM: Facilitate the Cx process, ensures that subcontractors perform their responsibilities and integrates Cx into the construction process and schedule.

A/E: Performs normal construction observation, approve O&M manuals, et cetera. Answer questions regarding system design and intended operation. Assist in resolving design-related issues.

Subs: Complete checklists, document system checkout, and demonstrate proper performance.

Mfr: The equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform contracted startup.

Commissioning Process

This section details the commissioning process, tasks, and activities.

Initial Commissioning Meeting

After the commissioning planning meeting, an Initial Commissioning Meeting is held with all commissioning team members. The commissioning plan, process, and schedule are presented and discussed. Questions are answered regarding the commissioning plan and specifications. The communications process is discussed and finalized. Also covered are the general list of each party's responsibilities, and who is responsible to develop the startup plan for each piece of equipment and the proposed commissioning schedule. The outcome of the meeting is increased

understanding by all parties of the commissioning process and their respective responsibilities. The CxA keeps notes from the meeting and distributes them to each team member.

Other Meetings

The CxA attends selected planning and job-site meetings in order to remain informed on construction progress and to update members involved in commissioning. The CM provides the CxA with information regarding substitutions, change orders and any Architect's Supplemental Instructions (ASI) that may affect commissioning equipment, systems or the commissioning schedule. The CxA may review construction-meeting minutes, change orders or ASI's for the same purpose. Later during construction, the CxA, as required, will schedule necessary meetings between various commissioning team members.

Field Observation

Field observations will be made by the CxA and are intended to provide the CxA with an understanding of the systems and assemblies, configuration and layout and allow the CxA to verify that construction checklists are being used and to identify issues that may negatively impact any later activities of startup, functional testing, operations or maintenance. The commissioning observations are not detailed inspections for checking of every item on the construction checklists. Issues identified during the field observations are added to the Issues Log and written observations reports are issued as needed.

Miscellaneous Communication Protocols

The following are the protocols on this project:

1. CxA may call the GC and/or appropriate sub contractor directly, with minor questions
    a. For questions or issues where the CxA disagrees with the designer or contractor, the CxA generates a formal RFI through the CM.
    b. CxA questions or issues that may result in change of scope, significant clarification in the sequences of operation or other project documents shall become RFIs through the CM.
    c. The CxA will not direct implementation changes to specified sequences without approval from the A/E.
    d. The CxA will provide a record of all commissioning related issues and significant communications to the Owner, CM, and A/E.

Progress Reporting and Logs

The CxA regularly communicates with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling issues through memos, progress reports, issues logs, etc.

Progress Reports:	The progress reports contain an update of the milestones progress, a list of new and outstanding issues, a description of commissioning progress corresponding to the plan, etc.
Issues Logs:	The CxA keeps a log of all commissioning-related issues.

Initial Submittals and Documentation

Standard Submittals

The CxA reviews normal submittals concurrently with the A/E's review, with comments back to the A/E within the prescribed time period (approximately 4 days). Once there is an approved submittal, the contractor has two weeks to submit information required for Cx, including:

- Required for Functional testing Data (2 weeks after Submittal Approval)

a. Cut Sheets and performance data (regular submittal data)
b. Product description literature (general information)
c. Installation guide
d. Start-up guide and checkout plan
e. Any required test plans / reports (factory tests, start-up, et cetera)

- Required for Systems Manuals (2 weeks after equipment delivery)

a. O&M Booklets
b. Warranty and service contract information
c. Control drawings and points list
d. Control sequences and schedules
e. Certifications (pressure, leaks, gas, government inspections, et cetera)

Installation, Startup, and Initial Systems Checkout

This phase of the work by the contractor requires utilizing enhanced documentation procedures and forms provided or approved by the CxA. A major element in this phase is the completion of construction checklists.

Construction Checklists

Construction checklists (CC) are important to ensure proper equipment and systems installation that is operational and that functional performance testing may proceed without unnecessary delays. Each piece of equipment receives full construction checkout by the Contractor. No sampling strategies are used. In general, the construction testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

Construction checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., oil levels OK, fan belt tension, labels affixed, gages in place, sensor calibration, etc.). However, some construction checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system).

Contractors typically already perform some, if not many, of the construction checklist items the commissioning authority will recommend. However, few contractors document in writing the execution of these checklist items. This project requires that the procedures be documented in writing by the installing technician. The CxA does not witness much of the construction check-listing, except for testing of larger or more critical pieces of equipment and some spot-checking.

Start-up and Initial Systems Checkout Plan

The CxA assists the commissioning team members responsible for startup in developing detailed start-up and initial systems checkout plans for all commissioned equipment. The following procedures will be used for this project for mechanical equipment.

- The CxA obtains manufacturer installation, startup and checkout data, including actual field checkout sheets used by the field technicians from the contractor.
- The CxA adapts and enhances, if necessary, the representative construction checklists (CC) and procedures from generic lists and develops original lists, as necessary
- The GC and Subs copy all pages with important instructional data and procedures from the startup and checkout manuals not covered in manufacturer field checkout sheets and add a signature line in the column by each procedure.
- The copied pages from above, along with the construction checklist provided by the CxA and the manufacturer field checkout sheets become the “Startup and Checkout Plan.”

- The sub should provide any additional necessary detail and documenting format to the CxA for approval, prior to execution for systems that may not have adequate manufacturer startup and checkout procedures.
- The GC submits the startup and checkout plan to the CxA for review and comment.
- The GC then provides the startup and checkout plan to the respective Subs for their use.

Execution of Checklists and Startup

As the GC and Subs are fully responsible for installation of all equipment related to the scope of the project, they are also responsible for the execution of all construction checklists, electrical inspection checklists, and when required all startup and checkout forms. The CxA will spot-check and spot witness checklists during site visits. Additionally, the CxA will employ sampling techniques to verify proper completion of checklist items. If sufficient deficiencies show up in the sampling, then additional samples will be checked. If an inordinate number of deficiencies are found, the contractors may be required to go through and self-verify that all remaining checklist items of the type in question are documented correctly.

The CxA will be given at least five (5)-business days notice prior to any startup activities. It is the responsibility of the Subs and/or Vendors to direct and execute all startup activities. All checklist items are to be completed sequentially in chronological order. For example, all “pre-start” checks on the checklists are to be completed first. The CxA and CM if necessary will observe selected startup procedures of primary equipment, unless there are multiple units, then a sampling strategy will be used. For components of systems, like VAV boxes, the CxA will observe a sampling of the startup procedures.

To document the checklist items, the technician actually performing the work will initial and date each line item or paragraph of all procedures in the startup and initial systems checkout plan. Additionally the field technician will initial all line items in the construction checklists and manufacturer’s field check off sheets, as they are completed. Only individuals having direct knowledge of the line item being completed shall check and initial the forms.

The Subs and vendors submit a signed copy of the completed start-up and construction tests and checklists through the CM to the CxA. Further details are found in the Specifications Section 01810. The CxA may review construction checklists in progress, as necessary. More than one trade may be required to complete information on the same checklist. The CM will provide the forms in a central location for use by the subs.

Sampling Strategy for CxA Observation of Equipment Checkout and Startup

Observation of construction checklist execution will be at the discretion of the CxA. The CxA, at their own discretion, will witness selected portions of the startup work. The CxA observations will generally consist of witnessing the first portion of the startup including discussion with the technician about the procedural issues.

Phased Commissioning

Because of project size, this project will require startup and initial checkout in phases.

Controls Checkout Plan

The controls contractor develops and submits a written systematic plan to the CxA, which describes the process, they intend to follow in checking out the control system and the forms on

which they will document the process. The controls contractor will also meet with the TAB contractor prior to the start of TAB and review the TAB plan to determine the capabilities of the control system for use in TAB. The controls contractor will provide the TAB with any necessary unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.). The controls contractor shall also provide a technician qualified to operate the controls to assist the TAB contractor in performing TAB. TAB work will not begin until the control system has received a point-to-point checkout and equipment can run in normal mode, appropriately controlled by the Automatic Temperature Control System.

TAB

The TAB contractor submits the outline of the TAB plan and approach through the CM, to the CxA and the controls contractor eight weeks prior to starting the TAB. Include in the approach, an explanation of the intended use of the building control system. The CxA reviews the plan and approach for understanding and coordination issues and may comment, but does not "approve." The controls contractor reviews the feasibility of using the building control system for assistance in the TAB work. The TAB submits weekly written reports of discrepancies, contract interpretation requests and lists of completed tests through the CM to the CxA. This will facilitate quicker resolution of problems and will result in a more complete TAB before functional testing begins. A checklist form for reviewing the TAB plan is provided as one of the construction checklists.

Submitting Completed Documentation

Within five (5) days of completing any checklist forms for any given system, and prior to functional testing, the CM submits the completed forms to the CxA for review. At the CxA's request, forms shall be provided to the CxA for review, or use prior to completion. With all submissions, any outstanding or incomplete line items shall be clearly documented and a date provided for expected completion. Upon CxA's review of completed forms, the CM will be notified of any areas or issues deemed incomplete or inadequate. The GC and appropriate Subs are responsible for resolving all outstanding issues.

Development of Functional Testing and Verification Procedures

Overview

Functional testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all of the control system's sequences of operation and components are verified to be responding as the sequences state. Test procedures are initially written by the CxA and are then reviewed by the Subs and Vendors for enhancements as appropriate. All testing procedures shall be written in accordance with the specifications and the commissioning related formal written work products and submittals. Generally, the CxA writes step-by-step functional test procedures and documentation formats for all commissioned systems and equipment, except for regulated tests including fire suppression, fire alarm, elevator, and NETA electrical tests where detailed testing and documentation requirements already exist. The commissioning team will also seek to utilize contractor's previously prepared checklists for more common items including ductwork installation logs, piping tests and possibly contractors' initial equipment checkout forms. Functional testing will include manual functional testing, automatic temperature control system trending and testing and may include some stand-alone data-logger monitoring. For some systems, the CxA directs and documents the actual testing, which is normally performed by the installing contractor of vendor. For other systems, the contractor will

conduct and document testing with limited involvement of the CxA. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor.

Scope of Testing

The specification "Testing Requirements" Section 01810 provides specific functional testing scope for each piece of commissioned equipment. A detailed description of the functional and construction testing procedures and process is found in the Specifications, 01810 Part 3. The testing requirements included in the bid documents will be updated to include job specific information. They will be developed for this project for each piece of commissioned equipment.

Development Process

Before writing test procedures the CxA obtains all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, control sequences and set points. The CxA develops specific test procedures to verify proper operation of each piece of equipment and system, using the testing requirements in the Specifications, Sections 01810. The CxA obtains clarification, as needed, from contractors and the A/E regarding sequences and operation to develop these tests. Prior to execution, the CxA provides a copy of the primary equipment tests to the installing Sub (via the GC) who reviews the tests for feasibility, safety, and warranty and equipment protection. Blank copies of the procedures are input into the O&M manuals for later use by operations staff.

Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers. The CxA follows the Specifications when given and uses judgment where needed to determine which method is most appropriate. According to the Specifications, not all pieces of identical equipment receive in-depth testing. The CxA reviews owner-contracted, factory or required owner acceptance tests and determines what further testing may be required to comply with the Specifications. Redundancy is minimized.

Trend Logs and Monitoring

The test team will use the building automation system or data loggers monitor system points. All monitoring will occur after systems are in normal operation and manual functional testing and other adjusting of setpoints and schedules are complete. Normally this occurs a few weeks after substantial completion. The CxA provides a list of monitoring points to the controls contractor, for trending setup. The duration is typically 1 to 2 weeks. The data is provided to the CxA in a prescribed format, for use in graphing data. The CxA analyzes the data looking to verify proper operation and identify any operational problems. A report of findings will be submitted. The points to be monitored are generally identified in the testing requirements of the specifications; however the list may be modified based on information gathered during manual testing. Often additional monitoring will be required in order to verify that problem areas have been corrected. During off-season testing, additional trending will be required and analyzed. Often the facility staff will be capable of setting up theses monitoring sessions without help from the controls contractor, assuming that training has already taken place.

Where points are not monitored by the automatic temperature control system, the CxA may use portable data loggers to gather the needed data. The data loggers are the property of the CxA, used only to collect the required data. Upon collection of the data the CxA will remove the data-loggers.

Testing Plan Overview

Following a majority of system start-ups, a functional testing plan is developed. This overview will provide the contractors with a better idea of where functional testing lies in the schedule, what issues are preventing the start of testing, which contractors are needed for each test and how much time might be expected from them.

Execution of Functional Testing Procedures

Overview and Process

The CxA schedules functional tests through the GC and affected Subs. For any given system, construction checklists are completed, with the necessary signatures, prior to performing functional testing. This is an assurance for the CxA that the system is ready for functional testing. The CxA will over-see, witness, and documents, the functional testing of all commissioned equipment and systems according to the Specifications and the Cx Plan. Subcontractors shall execute the functional tests. The control system is tested before it is used to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connections between systems.

Issues, Deficiencies, and Retesting

The CxA and/or the GC when applicable, documents the results of the test on the forms. Corrections of minor deficiencies identified are made during the tests at the discretion of the CxA. The CxA records the results of the test on the procedure or test form. Deficiencies and unresolved issues are noted and reported to the Owner and CM. Items will be added to the unresolved issues log and will be discussed at the next job conference of commissioning meeting. If an issue is more critical and requires more immediate action, then a memo on the specific item will be issued. Should design issues arise then RFI's will be generated and sent to the A/E. Ultimately such issue resolution may result in the generation of a change order. As issues are addressed verbal or written responses from the GC or the A/E will be recorded thus recording their disposition and planned actions? As issues are resolved or the required change is completed, the GC notifies the CxA so that the issue can be moved from the running issues log to the resolved issues log and testing can resume.

Facility Staff Participation

The Owner's facilities operating staff are encouraged to attend and participate in the testing process. The CxA will notify the Owner and CM, who will then notify the facility staff when the commissioning events will occur.

Sampling

Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. The Specifications specify the sampling strategies that are used on this project, with a summary listed in, *Functional Testing Scope Outline*, if used.

O&M Manuals, Warranties, and As-Builts

Standard O&M Manuals

The CxA reviews the O&M manuals, documentation and redline as-builts for systems that were commissioned to verify compliance with the Specifications. The CxA recommends approval and acceptance of these sections of the O&M manuals to the CM. The CxA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. Refer to Specifications 01810.

Commissioning Record

The CxA will compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders and deliver it to the GC, to be included with the O&M manuals. The correspondence, meeting minutes and progress reports, miscellaneous notes, etc. kept in the commissioning Record Book during construction will not be retained into this record and the O&M manuals. The format of the manual follows:

Training and Orientation of Owner Personnel

Training and Orientation

Owner training and orientation on equipment and systems provided by the Contractor will be accomplished in three general steps using three forms.

Overall Plan.

After reviewing the specifications, and after interviewing facility staff, if necessary, the Owner and Commissioning Authority (CxA) fill out a table listing all the equipment for which training or orientation will be provided, on, *Project Training Plan—General Scope and Responsible Parties*. This form lists, among other things, the type and number of trainees, rigor of training desired by the Owner, the primary responsible subcontractor, the trainer's company and columns for tracking training agendas. The Commissioning authority provides this form to the Contractor for reference.

Specific Training Agendas.

For each piece of equipment or system for which training is provided, the Owner and CxA fill out Section 1 of the *Training and Orientation Agenda*. This section includes some of the information from, regarding the scope of training and the intended audience, for reference by the trainer in developing the training agenda. The CxA develops a plan for including in the training session contractors / trainers from different disciplines, when appropriate, by listing their company names in Section 2 of the form. In particular, the controls contractor will provide brief training on controls in the same session with the mechanical training for equipment controlled by the building automation system.

This form is then submitted to the Contractor who has the trainer fill out the rest of Sections 2 and 3 of the form, describing the subjects covered, duration of each subject and the methods that will be used in the training, along with the name and qualifications of the trainer(s). The trainer returns this form to the Contractor, who submits it to the Owner and CxA. The Owner and CxA review the agenda; make comments; approve the form subject to the comments; and submit back to the Contractor. The Contractor provides the approved agenda to the trainer to use during the training. The trainer provides a copy of the agenda to each trainee.

Training Record.

For each piece of equipment, prior to training, the Contractor provides each trainer, *Training and Orientation Record*. On this form, the trainer documents each training session (duration and general subjects covered). The trainer signs for the session and obtains the signature of each trainee. The trainer also checks off subjects covered on the Agenda. When the training is complete, the Contractor provides a copy of the *Training and Orientation Record,* and the trainer's Agenda, to the Owner and CxA. The Owner and CxA review and make final approval by signing it. The CxA may witness any of the training sessions. Refer to Specifications 01810 for further details.

Special Training and Orientation

The following checked orientation and trainings will be completed by the CxA and A/E according to the specifications:

Re-commissioning: The commissioning authority will provide instruction on the use of blank functional test forms for periodic re-commissioning of equipment and systems, per the specification.
Architect: The architect will provide a general overview of the facility, its use, special features, tenant and public considerations, etc.
Mechanical Design Engineer: The mechanical designer will provide an overview of the major systems and equipment in the facility, including for each system: the design intent, why the system was chosen, an overview of its operation, and interactions with other systems, any special areas to be aware of, issues regarding future expansion and remodeling, etc.
Electrical Design Engineer: The electrical designer will provide an overview of the major electrical systems and equipment in the facility, particularly the lighting control systems, fire alarm, security and emergency power, focusing on the design intent, why the system was chosen, an overview of its operation, and interactions with other systems, any special areas to be aware of, issues regarding future expansion and remodeling, etc.

The following table summarizes the current training requirements listed in the specification.

Specification Section	***System***	***Duration***
15510.1.14.A	*Sprinkler – General*	*One 8 hr day*
15114.1.18.A.3	*Hydronic Pumps*	*4 – 16 Hrs.*
15116.1.29.A	*Fuel Oil Piping Systems and Equipment*	*2 Hrs.*
15117.1.17.A.2	*Modular Indoor Air-Handling Units*	*2 Hrs.*
15118.1.12.A.3	*Rooftop Air Handling Units*	*4 Hrs.*
15119.1.10.A.3	*Split System Air-Conditioning Units*	*1 Hrs.*
15120.1.11.A.3	*Humidifiers*	*0.5 – 1 Hr.*
15124.1.9.A.3	*Radiant Heating Panels*	*0.5 Hrs.*
15128.1.19.B	*Fans*	*0.5 Hrs.*
15129.1.18.A	*Air Curtains*	
15130.1.13.3	*Air Terminals*	*1 Hr.*
15133.3.16.A.1	*HVAC Instrumentation & Control*	*4 – 16 hrs.*
16108.1.22.A	*Switchboards*	*Factory-authorized service representative*
16110.1.30.A.4	*Packaged Engine Generators*	*Factory-authorized service representative / 1 – 2 Hrs.*
16111.1.21.A	*Paralleling Switchgear*	*Factory-authorized service representative 1 HR.*
16112	*Transfer Switches*	*Factory-authorized service representative*

		0.5 – 1 Hr.
16114.1.26.A	*Static Uninterruptible Power Supply*	*Factory-authorized service representative 1 Hr.*
16116.1.18.E	*Emergency Power Supply System (EPSS) Test System*	*2 days / 2 trip(s)*

Warranty Period

During the warranty period, seasonal testing and other deferred testing required is completed according to the Specifications. The CxA coordinates this activity. Tests are executed and deficiencies corrected by the appropriate Subs, witnessed by facilities staff and the CxA. Any final adjustments to the O&M manuals and as-builts due to the testing are made. Refer to specification section 15995 for seasonal testing details for this project. In addition the CxA will return to the project approximately 10 months into the 12-month warranty period. During this visit(s) the CxA will review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. The CxA will also interview facility staff and identify problems or concerns they have operating the building as originally intended. The CxA will make suggestions for improvements and for recording these changes in the O&M manuals. The CxA will identify areas that may come under warranty or under the original construction contract. The CxA will also assist facility staff in developing reports and documents and requests for services to remedy outstanding problems.

Commissioning Formal Written Work Products

The written work products from all parties are described in Table 6-1. The table describes each product, who is responsible for producing it, the general due date, the parties who receive it and who approves it, etc

Product	Created By
Commissioning Plan	CxA
Commissioning Meeting Minutes	CxA
Commissioning Schedule	CM and CxA with other contractors
Equipment documentation submittals	Contractors
Sequence Clarifications	Contractors and A/E as needed
Construction Checklists	CxA (Preliminary in Spec. Revised based on Approved Submittals)
Startup and initial checkout plan	Contractors and CxA (Compilation of existing documents)
Startup and initial checkout forms filled out	Contractors
Final TAB report	TAB
Issues log (deficiencies)	CxA with responses provided by contractors
Commissioning Progress Record	CxA
Deficiency reports	CxA
Functional tests forms	CxA
Filled out functional tests	CxA
O&M Manuals	Contractors with review by CxA
Commissioning record book & CD's	CxA

Product	Created By
Overall training plan	CxA, CM, and Contractors
Specific training agendas	Contractors
Final Commissioning Report	CxA
Misc. approvals	CxA

1.2 Summary Report

A final summary report by the CxA will be provided to the CM or PM. The report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:

1) Equipment meeting the equipment specifications.

2) Equipment installation.

3) Functional performance and efficiency.

4) Equipment documentation and design intent.

5) Operator training.

All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

Appendices shall contain acquired sequence documentation, logs, meeting minutes, progress reports, deficiency lists, site visit reports, findings, unresolved issues, communications, etc. Construction checklists, functional tests (along with blanks for the operators), monitoring data, and analysis will be provided in a separate labeled binder.

The commissioning plan, the construction checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals, as described in the specification Section 01810.

Schedule

General Issues

The following sequential priorities are followed:

1. Equipment is not “temporarily” started (for heating or cooling), until pre-start checklist items and the entire manufacturer’s pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.
2. Functional testing is not begun until construction and start-up and TAB is completed, for a given system (this does not preclude a phased approach).
3. The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional testing completed.

4. TAB is not performed until the controls system has been sufficiently functionally tested and approved by the CxA for TAB work. TAB is not performed until the envelope is completely enclosed and ceiling complete, unless the returns are is ducted.

Project Schedule Commissioning Milestones

✓	Actual Date	Milestone	Schedule timing
✓		Initial Commissioning meeting and final plan	Within the first 60 – 90 days after building construction begins.
✓		Provide submittals to CxA for review. Submittals should be delivered to CxA at the same time as being delivered to design team for initial review. CxA does the review concurrently with designers and will feed any comments to designer to be incorporated into their comments. CxA needs all MEP submittals, and all submittals related to LEED related credits.	At the first submittal and throughout the submittal process.
✓		System Verification Checklists (SVC)/tests (write & distribute)	Distributed after approved submittals and before equipment is delivered.
✓		Wall systems mock ups and/or initial construction	After mockup is complete or if none at beginning of 1st wall construction
✓		Window system initial installation	Start with 1st window
✓		Beginning of installation of Roofing system	Start with 1st roof work
✓ ✓		On site review of As-Builts at 30%, 60%, 90%, 100% of construction Main duct runs when complete, Main piping runs when complete, Et Cetera.	As listed
✓ ✓ ✓		30%, 50%, & 90% shell completion: Connections between roof & wall Window flashing / caulking Vapor barrier/air barrier installation	As listed
✓		80% completion of mechanical rooms / equipment, duct, & piping	As listed
✓		60% completion of duct and piping installation Straight duct runs to VAV boxes, P/T plugs installed / accessible, Flow meter installation clearances, Balancing valves / flow control valves accessible. Reasonable access to equipment for maintenance	As listed
✓		Develop Functional Tests	Based on approved submittals. We need full set of approved MEP submittals.
✓		Review / witness duct testing	Based on Contractors Schedule
✓		Above ceiling punch walk through before installation of ceiling tiles (this should be performed by Architect & Owner) Fire proofing, Access to fire dampers cut in and installed, Hanger distances.	Not Commissioning but good for scheduling
✓		Meeting with TAB contractor, walkthrough, review of preliminary submittal requirements listed in specifications.	Around 60% construction, before installation is complete.
		Control system Point-to-Point checkout: Verification of communication between points Verification of sensor calibration	Based on Contractors Schedule
		Obtain ATC software for balancing purposes	As early as possible
		Review ATC graphics package to be sure the programming will be complete before completion of construction.	As early as possible
✓		Site visitations during TAB functions, to perform TAB verification requirements.	Based on Contractors Schedule
✓		Develop Preliminary Training Agendas for contractors to complete. Review training requirements with owner.	During last 3 months of construction.
✓		Receive SVCs back from contractor and review prior to functional	Before Functional Testing begins.

✓	**Actual Date**	**Milestone**	**Schedule timing**
		testing. These could come back as systems are complete instead of all at once.	
		Receive confirmation that engineers punch-list items have been completed	Before Functional Testing begins.
		Receive approved TAB report from engineer.	Before Functional Testing begins.
✓		Functional performance tests: Review FTs in detail with contractors prior to execution, Observe and record results of functional tests as contractors execute the tests.	After Startup. After A/E Punch-list is complete. After approved balancing report. After complete ATC graphics.
		Issues Resolution and redo functional testing.	As needed
✓		Training Verification Receive final training agendas from contractors. Witness training.	Around Functional Testing at the schedule of owner
		Review and comment on O&M Manuals. Extract information required for the development of Re-commissioning manual.	Begin just after submittal approval.
		Final Cx Report	After Functional Testing
		Seasonal testing	As needed