Coordinating Building Systems for Commissioning

Gerald J. Kettler, PE, CCP
AIR Engineering and Testing, Inc.

Synopsis

Commissioning involves the verification that the facility is designed, constructed, and tested to meet the owner's project requirements. Since facilities are assembled from many sub-systems, the integration of these systems is critical to total functionality. This integration process cannot wait until final testing without creating many delays and added costs. This paper describes an integration and coordination process that is used to assure that the interconnected building systems are installed tested and ultimately perform for total facility functionality.

About the Author

Gerald Kettler is president of AIR Engineering and Testing, Inc. of Dallas, Texas. His firm specializes in commissioning and HVAC test and balance. He has a degree in Mechanical Engineering and an MBA, and is a licensed engineer in 9 states. He is certified in commissioning by the Building Commissioning Association, ACG, and NEBB and is an Accredited LEED Professional. Some of his other certifications include; Construction Specifications, Energy Management and Environmental Management. Presently, Mr. Kettler serves as ASHRAE chair of both the technical committees for commissioning, and test and balance, and as a subcommittee chair for the ASHRAE guideline 0 and 1 on Commissioning.

Coordinating Building Systems for Commissioning

Buildings are designed and constructed by assembling and integrating many subsystems. Each of these subsystems has unique requirements from site preparation to structure. In addition to basic systems such as building shell, mechanical systems, plumbing, and electric systems, there are often specialty systems such as building automation, fire sprinkler and alarm, communication, and information systems. The design of most of the specialty systems is done with performance specifications, that is, the resulting performance of the system is described but the specific equipment and interconnections are not.

The ultimate use and function of the building depends upon the successful interconnection of these many systems. Each one of the specialty systems and usually the basic systems are installed by a separate contractor. Many of the systems are also designed by the subcontractor. Although each contractor understands their equipment, they often do not consider the interconnections with other systems.

The function of commissioning is to assure the successful performance of the building systems and conformance to the owner's project requirements. The ultimate performance depends upon the integration of these systems and the testing and demonstration of the results.

This integration function can be facilitated by the following procedure: at a point and time when the building systems and specialty contractors have been selected and the project management and trades personnel are beginning to install their systems, a series of meetings are conducted to facilitate or, in some cases, force communication between the various trades and systems. The function of these sessions is not to get into the basics of each system but to 1) define the interconnection points, locations, and methodologies between all systems, 2) clarify code and sequences of operation that require interconnection and 3) define system and integration testing.

Each physical system must be located in a space of sufficient size and located to facilitate installation and maintenance. This often requires added shop drawings and coordination drawings. Responsibility for these plans must be assigned and coordinated. This function often involves the design team for clarifications and possible changes in function and location.

The process described here is divided into planning sheets for: fire sprinklers, specialty systems, electrical and emergency power systems, fire alarm systems, mechanical-life safety-refrigerant systems, energy management systems, and integrated testing. Each sheet includes items on installation locations, interconnections, and testing by contractor, local authority and commissioning team.

Fire Sprinklers

The fire sprinklers must share space with the mechanical and electrical systems. The controls and monitoring of the fire systems must connect the fire sprinklers with the alarm system, the elevator systems (if present) and fire department alarms and connections. Fire systems including

a fire pump may also need interface with emergency power systems. The file alarm contractor needs a copy of the approved sprinkler shop drawings to find the locations of flow and tamper switches, and the zone locations. The type of sprinkler flow alarm device will need a power source if it is an electric bell and strobe light. Dry pipe and pre-action systems must be located and power provided as required. In some locations, separate heating is required to prevent potential freezing. Approval and testing by local or other authorities and integrated testing must be coordinated.

Specialty Systems

Specialty systems can include: elevators, escalators, telephone, technology (computers), public address, medical systems, etc. Elevators require one or two dedicated telephone lines that are often forgotten. The elevator codes usually require shaft venting that is not covered in the building or mechanical codes. The elevator code smoke relief vent only requires an opening in the top of the elevator shaft. No damper is required so the opening often becomes a permanent source of hot air in the summer and cold air in the winter. High rise elevators require location panels adjacent to the fire alarm system. Alarm recall systems must be integrated with the alarm system as well as elevator lobby smoke detectors.

Telephone and technology systems often have continuous cooling requirements that are not covered by building HVAC systems that are turned off after normal operating hours. Remote monitoring systems must be accommodated and well as special fire protection, power quality and emergency power for some systems. Testing and commissioning of each system must be coordinated.

Electrical and Emergency Power

The electrical and lighting systems are essential for building operation. Space must be available for installation and maintenance. Emergency power must be coordinated and provided for all emergency systems. Elevators, fire pumps, and emergency lighting are usually connected to emergency generators if required by codes. Other systems also have unique requirements. For example if the building has smoke dampers and a smoke control system, emergency power is required for damper operation as well as the smoke exhaust or control fans and the entire mechanical control system. Transfer switches, annunciator panels and controls must be coordinated with power and alarm systems.

Fire Alarm

Fire alarm panels must be approved and located according to local fire department requirements. Alarm and signal devices are required for resident safety and emergency responder notification. Dedicated telephone lines are usually required as well as a contract with a monitoring company in many localities. Connection to the fire sprinkler systems and the mechanical systems are essential to proper building operation. The location and connection of the air handler smoke detectors present problems of which contractor will provide and connect the devices and what

type of alarm function is required. Emergency power and/or battery backup are usually required. Local inspection of these systems is usually very detailed and must be coordinated with the other building systems.

Mechanical- Life Safety – Refrigerant Systems

Mechanical systems are often installed in locations or limited spaces that make maintenance very difficult. This coordination requires interface with the design team preferably early in the design phase. The sequence of operation particularly for emergency and smoke control operations must be checked and all required controls installed. The timing of alarms, damper operation and equipment control can be problematic and should be resolved in this coordination stage. For example, if fast acting smoke dampers are activated before the fans have been turned off and ramped down, the ductwork may be in danger of overpressure and damage.

Refrigerant exhaust systems must be on emergency power, if available. These systems must meet the code requirements and also ASHRAE Standard 15 where required. This requires refrigerant sensors, exhaust fans and control panels as well as shut off switches and available emergency breathing equipment.

Testing of these systems are essential and often quite time consuming.

Energy Management Systems

The functioning of the energy management system is essential to building function and comfort. The location of the sensor and control devices must be coordinated and verified for all systems. If the controls are used for emergency and smoke control systems, it is essential that the control system be on emergency power. This is often forgotten. The design and final sequences of operation must be coordinated and verified. Changes to the preliminary sequences are frequent and must be approved by the design team. Sensors must be calibrated and graphics checked for accuracy.

Systems Commissioning

The function of commissioning is to verify that operation conforms to the owner's project requirements. The sub-systems are first checked independently, and then the entire system is functionally checked. After the individual systems are verified the integrated functions are verified.

Each system should have a testing plan developed by the designers, contractors, and the commissioning authority. The plan, as well as the records and results, become a part of the facility commissioning report.

The following forms can be used to provide the described coordination.

Figure A

SEQ.	ITEM	LOCATION	REQUIREMENTS	NOTES # STATUS
1.	**SPRINKLERS**			SCHEDULES
1.1	Installation – mains, risers, spkrs - valves, pumps - shop drawings			
1.2	Signal Devices – flow, zones - tamper switches - annunciator pnl - alarm bell			
1.3	Interconnections- power - emergency power - fire alarm			
1.4	Testing – Contractor – pressure - flow - pumps			
1.5	Testing – City – pressure - pumps - flow			
1.6	Building systems testing			
1.7	Special systems – dry pipe - compressors - antifreeze			
1.8	Building Systems Testing			

Figure B

SEQ.	ITEM	LOCATION	REQUIREMENTS	NOTES# STATUS
2.	**SYSTEM** (Elevators, telephone, technology, medical, etc.- 1 page for each)			SCHEDULES
2.1	- Installation Requirements - adequate space - access, maintenance - adjacency			
2.2	-Emergency System? - connections			
2.3	Status / Control panel(s)			
2.4	Interconnection – power - emergency Power			

	- fire alarm/zones - telephone - sprinklers. - etc.			
2.5	Special requirements			
2.6	Special reqmt's – cooling - shaft ventilation - lighting			
2.7	Testing- Contractor - State			
2.8	Building Systems Testing			

Figure C

SEQ.	ITEM	LOCATION	REQUIREMENTS	NOTES # STATUS
3.	**ELECTRICAL AND EMERGENCY POWER**			SCHEDULES
3.1	Electrical Service – Utility - main service boards - distribution panels - lighting and control panels			
3.2	Installation – Generator -Xfer Switch -remote control pnl.			
3.3	Interconnections – elevators - fire pump - smoke control fans or system - dampers - energy mgmt sys. - lighting - process equipment			
3.4	Testing – Contractor – generator - transfer switch - under load bank			
3.5	Testing – City – generator - transfer switch			

Figure D

SEQ.	ITEM	LOCATION	REQUIREMENTS	NOTES # STATUS

4. ELECTRICAL – FIRE ALARM SCHEDULES

4.1	Installation – Main panel - annunciator panel - devices - risers			
4.2	Interconnection – sprinklers, have shop drawings? - energy Mgmt Sys - air Handlers - telephone - monitor company			
4.3	Testing – Contractor - functional - remote monitoring			
4.4	Testing - City			
4.5	Building Systems Testing			

Figure E

SEQ. ITEM LOCATION REQUIREMENTS NOTES# STATUS

5. MECHANICAL,

Including LIFE SAFETY AND REFRIGERANT SYSTEMS SCHEDULES

5.1	Installation – Chases and Ducts - fans - dampers, maintenance access - AHUs and Zones - pressurization			
5.2	Interconnection – Energy mgmt sys. - emergency power - fire alarm - smoke dampers			
5.3	Refrigerant Exhaust Systems- -ASHRAE 15 reqmts - activation devices - alarm devices - breathing gear			
5.4	Smoke Control Systems- Sequence - controls testing - flow/volume testing - smoke/performance test			
5.5	Testing – Contractor – fans			

	- dampers - w/Energy mgmt			
5.6	Testing - City			
5.7	Building Systems Testing			

Figure F

SEQ.	ITEM	LOCATION	REQUIREMENTS	NOTES # STATUS
6	**ENERGY MANAGEMENT SYSTEMS**			SCHEDULES
6.1	Installation – Main control Panels - computer(s) - valves - dampers - sensors, - controllers			
6.2	Interconnection – Mechanical sys. - fire alarm - emer. Power - telephone - LAN/WAN			
6.3	Testing – EMS Contractor - point to point. - calibrations - functional - graphics			
6.4	Building Systems Testing			

Figure G

SEQ.	ITEM	SEQUENCE DEFINED	PRIMARY CONTROL/NOTES

#			RESPONSIBILITY	
SCHEDULES				
7.	**SEQUENCE OF OPERATIONS FOR SYSTEMS COMMISSIONING**			
7.1	Smoke Detector and F/A Activation - systems affected			
7.2	Sprinklers – flow/activation/signals			
7.3	Manual Alarm – General or trouble AHU Smoke - General or trouble			
7.4	Air Handler Shut Down - smoke detector - EMS System			
7.5	A/C zone terminal control			
7.6	Pressurization –Stairwell - floor/floor			
7.7	Smoke Exhaust – Activation and Seq. - auto reset Special Inspector's Report reqd?			
7.8	Emergency Power – gen. auto start - maintain Emer, systems - reset to auto			
7.9	Elevators – Emergency return - monitor/control panel - communications - operate on generator			
7.10	Refrigerant Exh. – Pressure - exhaust.			
7.11	Energy Management System - functional test - sequence of operation - graphics			