Primera

OVERCOMING COMMON CHALLENGES IN HVAC COMMISSIONING

FEATURING REAL-WORLD CASE STUDIES

WRITTEN BY: ERIN LOWERY, PE, PMP, LEED AP BD+C AND MARC JACH, CCP

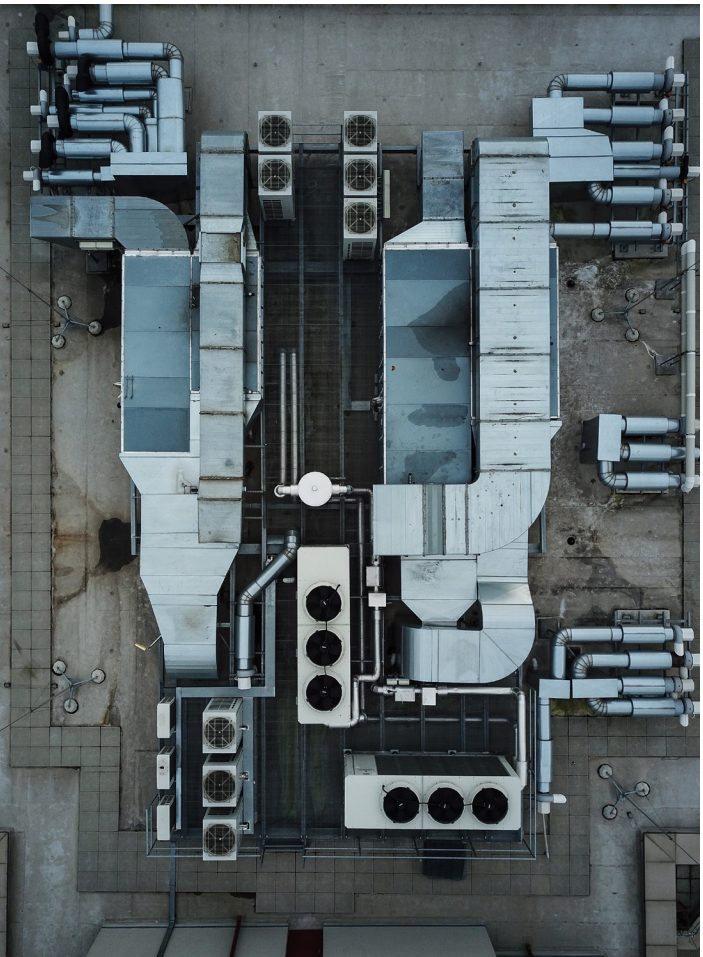


TABLE OF CONTENTS

INTRODUCTION

Before commissioning became a part of the construction process, building owners and operators were at the mercy of contractors telling them everything was finalized and functioning correctly without any independent verification. When issues arose, contractors had typically moved on to new projects, leaving building owners and operators to resolve problems themselves after the handover. This is where the importance of a Commissioning Authority (CxA) comes into play.

The role of a CxA is to serve as an independent, knowledgeable expert resource throughout the design and construction phases of a project to ensure that the owner receives what has been promised, and that the building systems function according to the design intent. The commissioning of HVAC (Heating, Ventilation, and Air Conditioning) systems (as well as other control systems such as electrical, plumbing, etc.) in the Architecture, Engineering, and Construction (AEC) industry is a critical process to ensure that these systems operate effectively, efficiently, and safely.

KEY ASPECTS FOR IMPLEMENTING THE COMMISSIONING PROCESS:

Implementing the commissioning process in building projects is crucial for ensuring optimal performance and efficiency. This section will explore the key aspects that contribute to the successful commissioning of a building, from planning and design to execution and verification.

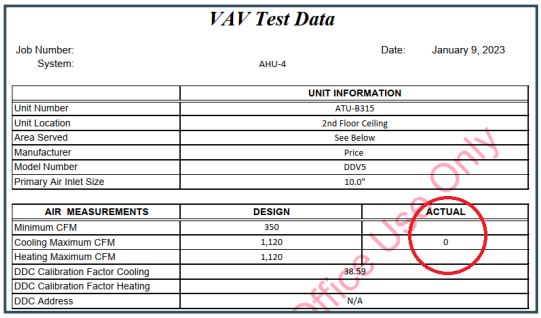
- **EARLY INVOLVEMENT:** Engaging an HVAC commissioning authority or experts at the initial design phase can avoid expensive redesigns or future retrofits. Their insights during design reviews can ensure that systems are properly specified, well-integrated, coordinated with other building systems, and easily maintainable in the future for building operation staff.
- **CLEAR COMMUNICATION:** Effective communication among all stakeholders—owners, architects, engineers, contractors, commissioning authorities, and facility managers—is crucial throughout the commissioning process. Clear communication helps establish project goals, expectations, and responsibilities, minimizing misunderstandings and delays. Early discussions among team members can identify problems early, making solutions easier to implement.
- **COMPREHENSIVE TESTING:** Thorough testing and verification of HVAC systems during commissioning are essential to identify and address any deficiencies or performance issues. This includes functional performance testing, temperature and humidity control verification, and verification of air and water system performance during balancing.
- **DOCUMENTATION AND REPORTING:** Accurate documentation of commissioning activities, test results, and system performance is necessary for tracking progress, troubleshooting issues, and providing a record of compliance with project requirements and standards. These documents are compiled at the end of the project to provide a detailed report of all commissioning process activities and provided to the Owner.
- **TRAINING AND EDUCATION:** Providing comprehensive training to building operators and maintenance staff is critical for ensuring that HVAC systems are operated and maintained properly after commissioning is completed. Well-trained staff can optimize system performance, identify problems early, and implement preventive maintenance measures.

- **CONTINUOUS MONITORING AND OPTIMIZATION:** Implementing systems for ongoing monitoring and optimization of HVAC performance can help in maintaining energy efficiency, occupant comfort, and indoor air quality over the life of the building. This may involve the use of building automation systems (BAS) and data analytics tools to identify trends, anomalies, and opportunities for improvement.
- **ADAPTATION TO CHANGING NEEDS:** Understand that building usage patterns and occupant requirements can change over time. HVAC systems should be designed and commissioned with flexibility and adaptability in mind to handle future changes or expansions smoothly, avoiding major disruptions or costly modifications.
- **LESSONS LEARNED DOCUMENTATION:** After completing the commissioning process, it's valuable to conduct a "lessons learned" review to identify successes, challenges, and areas for improvement. These insights can benefit future projects and help enhance HVAC commissioning practices.

By incorporating these items into the HVAC commissioning process, AEC professionals can help ensure the successful delivery of buildings with high-performing, energy-efficient, and comfortable HVAC systems.

COMMON CHALLENGES DURING THE HVAC COMMISSIONING PROCESS

In this section, we will delve into specific examples of HVAC issues uncovered during the commissioning process, supported by short case studies. These real-world scenarios highlight common challenges and the solutions implemented to ensure system efficiency and reliability.



VAV Test Data

Job Number:
System: AHU-4
Date: January 9, 2023

	UNIT INFORMATION
Unit Number	ATU-B315
Unit Location	2nd Floor Ceiling
Area Served	See Below
Manufacturer	Price
Model Number	DDV5
Primary Air Inlet Size	10.0"

AIR MEASUREMENTS	DESIGN	ACTUAL
Minimum CFM	350	
Cooling Maximum CFM	1,120	0
Heating Maximum CFM	1,120	
DDC Calibration Factor Cooling		38.59
DDC Calibration Factor Heating		
DDC Address		N/A

Office Use Only

HVAC ISSUE - INADEQUATE AIR BALANCING: During the commissioning process of a newly constructed office building, it was discovered that several areas within the building experienced uneven temperatures and airflow. Despite the HVAC system being properly designed and installed according to specifications, occupants in certain zones reported discomfort due to inconsistent conditions.

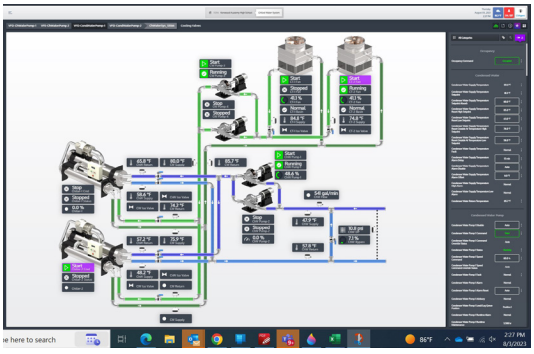
Upon further investigation, the commissioning team found that the airflow distribution was not balanced correctly throughout the building. Some areas received insufficient airflow, leading to poor ventilation and temperature stratification, while other areas experienced excessive airflow, resulting in discomfort and wasted energy.

BOILER ISSUES - CHEMICAL TREATMENT: During the commissioning of a building around 20 to 25 years old, many VAV reheat valves didn't close, resulting in overheating of the spaces. Despite flushing the hot water system, significant contaminants persisted in the piping since only city water was used, and no sidestream filter was installed on the system either. The commissioning team recommended a chemical treatment plan and installing a sidestream filter, which resolved the problem.

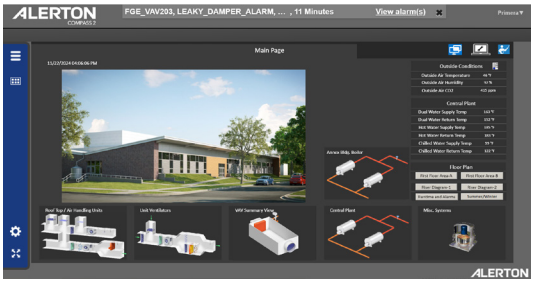
BOILER ISSUES - BOILER CONTROLS AND FIRING RATE CONTROL: During the testing of two newly installed steam boilers in an older building, it was quickly observed that the boilers were cycling on and off. In checking the controls, the temperature control contractor believed that they were controlling the firing rate, but the boilers were cycling on at full fire then cycling off. After consulting with the manufacturer, it was discovered that a steam pressure setpoint could instead be sent to the boiler controller to enable modulation of the firing rate to maintain the steam pressure setpoint. Once reconfigured, the boilers fired up and modulated properly to maintain the steam pressure setpoint.

CHILLER ISSUES - PUMPING: Commissioning chilled water systems involves navigating various challenges. It's crucial to work closely with the balancer and the controls contractor to ensure proper flow is maintained at each point in the system. The differential pressure setpoint for the system needs to be determined by the balancer and the controls contractor is responsible for taking that setpoint and making sure that the pump speed is controlled correctly and not over- or undershooting the setpoint. Quite often it takes considerable coordination to get the system to operate correctly and efficiently.

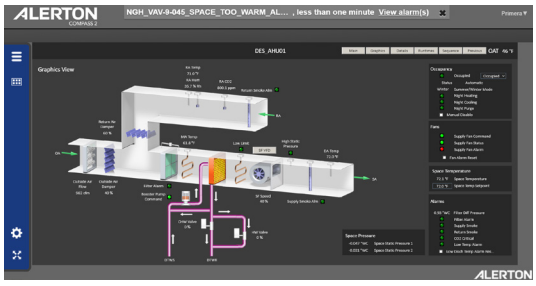
CHILLER ISSUES - CHILLER CONTROLS: Chiller plant sequences of operation frequently require the controls contractor to control the stages/lead/lag of multiple chillers. When the chillers are new and identical, the chiller manufacturer almost always has provisions to allow the chillers to talk to each other and have the chillers themselves do the lead/lag and staging, resulting in more efficient control. When these situations come up, it is recommended that the manufacturer control strategy be utilized.



BUILDING CONTROLS ISSUES: Testing often reveals controls and programming problems. Being able to see outputs being controlled is crucial to the whole process. Tuning of control loops to prevent hunting of controlled devices yet being able to meet setpoints is usually done beforehand, but issues are frequently found. An invaluable tool to check loop tuning is to be able to look at trending to see the output modulation and compare it to the resulting conditions.



AIR HANDLING UNITS: Functional testing of multiple air handling units in one building renovation proved to be complex as there were groups of units that were supposed to operate similarly per the design drawings and sequences of operation. Investigation into building codes revealed that the sequence of operations was copied from the original documents from when the building was built, and current building codes did not allow the lower ventilation rates. Commissioning worked with the controls contractor to ensure that proper updated ventilation rates were being provided.



CASE STUDIES

HVAC AIR SYSTEM CASE STUDY: COMMISSIONING OF XYZ OFFICE BUILDING

The XYZ Office Building is a 10-story commercial office building located in a downtown area. The building was designed to achieve LEED Gold certification, emphasizing energy efficiency and occupant comfort. During the commissioning process, several HVAC issues were identified and addressed:

AIR BALANCING: The commissioning team conducted airflow measurements and discovered significant disparities in airflow distribution across different floors and zones. By adjusting damper settings, fan speeds, and duct configurations, the HVAC system was rebalanced to ensure more uniform airflow and temperature distribution throughout the building.

CONTROLS OPTIMIZATION: The building's HVAC controls were initially programmed with default settings that did not fully align with the building's occupancy patterns and usage schedules. Through commissioning, the control sequences were fine-tuned to optimize energy efficiency while maintaining occupant comfort. This involved adjusting setback temperatures, ventilation rates, and equipment operating schedules to better match actual building occupancy and demand.

TEMPERATURE CONTROL: Occupant complaints about temperature variations prompted a closer examination of the HVAC system's temperature control capabilities. The commissioning team identified issues with sensor calibration, thermostat placement, and control algorithms that were causing temperature fluctuations in certain areas. By recalibrating sensors, relocating thermostats, and refining control strategies, the HVAC system was able to maintain more consistent temperatures throughout the building.

Through the commissioning process, the XYZ Office Building was able to address these HVAC issues and achieve its sustainability and comfort goals. By identifying and resolving these issues early on, the building owner was able to avoid occupant complaints, improve energy efficiency, and enhance the overall performance of the HVAC system.

BOILER AND CHILLER CASE STUDY: COMMISSIONING OF ABC SCHOOL

The ABC School underwent a comprehensive HVAC commissioning process as part of its facility upgrade and expansion project. Here are some specific issues related to boilers and chillers discovered during commissioning:

BOILER ISSUE: During functional testing, it was found that one of the boilers exhibited irregular cycling behavior, frequently turning on and off in short intervals. This cycling indicated a control system malfunction, which was likely causing excessive wear on boiler components and reducing overall system efficiency. The commissioning team diagnosed the problem as a faulty control sensor and it was replaced, resulting in smoother boiler operation and improved energy performance.

CHILLER ISSUE: One of the chillers in the facility was found to be operating at suboptimal efficiency levels, despite being relatively new. Investigation revealed that the chiller's condenser coils were heavily fouled with dirt and debris, impairing heat transfer and reducing cooling capacity. The commissioning team recommended a thorough cleaning and maintenance program for all chillers, including regular coil cleaning schedules, to prevent similar issues in the future and optimize chiller performance.

By addressing these boiler and chiller issues during the commissioning process, the ABC School was able to achieve reliable and efficient operation of its HVAC systems, ensuring a comfortable working environment for its teachers and students while minimizing energy costs and environmental impact.

TOP 10 LIST OF COMMISSIONING FINDINGS:

Through the commissioning process, various issues can be identified that, if left unaddressed, could compromise system performance, energy efficiency, and occupant comfort. The following is a comprehensive list of the top 10 commissioning findings, highlighting common problems and their potential impacts on building operations.

1. **CONTROL SYSTEM ISSUES:** Inaccurate sensor calibration leading to discrepancies in temperature, humidity, or pressure measurements, affecting system control and performance. Integration issues between various components of the BAS, such as sensors, actuators, controllers, and the central building automation system (BAS), resulting in communication errors and system malfunctions.
2. **CONTROL SEQUENCE ERRORS:** Incorrect or misconfigured control sequences causing equipment to operate sub-optimally or inefficiently, impacting occupant comfort and energy consumption.
3. **OCCUPANCY AND SCHEDULING ERRORS:** Inaccurate occupancy detection or scheduling settings causing HVAC equipment to operate unnecessarily during unoccupied periods or fail to provide adequate comfort during occupied hours.
4. **FAULTY ACTUATORS AND VALVES:** Malfunctioning actuators, valves, or dampers within the HVAC system, resulting in improper airflow regulation, temperature control issues, or pressure imbalances.
5. **ENERGY MANAGEMENT STRATEGIES:** Suboptimal implementation of energy management strategies, such as demand response, night setback, or load shedding, resulting in missed energy-saving opportunities or unintended consequences on system performance.
6. **USER INTERFACE ISSUES:** Poorly designed or confusing user interfaces for building operators or occupants, hindering efficient system control, monitoring, and troubleshooting.
7. **INSTALLATION DEFICIENCIES:** Either altogether improper installation is noticed, or installation that would hinder or prevent future maintenance or replacement of components.
8. **INCONSISTENT DESIGN PARAMETERS:** Design values copied from one area to another without checking any changes in area conditions result in mismatched equipment sizing leading to over/under cooling or heating.
9. **INADEQUATE AIRFLOW/WATER FLOW:** Balancing attempts to set everything at design rates, but physical limitations of piping or ductwork may prevent those rates from being achieved.
10. **EQUIPMENT OPERATIONAL DIFFERENCES FROM DESIGN:** Differences either in equipment capacity or conditions severely different than design can affect the efficiency and energy consumption. Not using time schedules by running equipment 24/7 also affects energy consumption.

Addressing these commissioning findings is essential for ensuring the reliable operation, energy efficiency, and occupant comfort of building HVAC and environmental control systems. Ultimately, a well-commissioned system not only meets design expectations but also adapts to the dynamic needs of the building and its users, providing a reliable and sustainable environment.

ABOUT THE AUTHORS

ERIN LOWERY, PE, PMP, LEED AP BD+C is a certified project manager with nearly 25 years of facilities project experience. Erin's experience includes project management and mechanical design for transit, healthcare, higher education, K-12, museums, residential, aviation, parks and recreation, and municipal projects. She specializes in the management of renovation and new construction projects, from design through commissioning. As a LEED accredited professional, Erin thoroughly understands the requirements for green building design and construction.

MARC JACH, CCP is a resident commissioning expert at Primera Engineers. His expertise is the result of more than 35 years of experience in the design, commissioning, and project management of commercial HVAC systems. His experience includes project management, programming, and commissioning with distributors of Carrier Air Conditioning, Honeywell, Johnson Controls, and Tridium. Marc specializes in direct digital controls building automation systems.