Commissioning as a Quality Assurance Solution

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Synopsis

Many managers, directors, operators, procurement officials, and capital improvements officers have discovered advantages to incorporating third party independent commissioning providers into their overall building stock quality assurance programs. This presentation examines multiple models employed by a variety of institutions that have discovered budgetary and managerial advantages to appropriate outsourcing of quality control functions to independent commissioning services companies in both existing buildings and new construction projects.

Bundling of services such as test and balance or fire protection system verification into comprehensive, retro, or continuous commissioning programs can provide advantages in costs of services, as well as efficient management of projects. Given the present financial environment, particularly in the governmental and educational sectors of our economy, building owner representatives can team with commissioning providers to increase the value and benefit of operations presently attained through higher overhead delivery models.

About the Authors

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Commissioning – Quality Assurance

Many association brochures and company prospectuses have made various attempts at defining "commissioning". Owners frequently seem perplexed by the notion that designers and contractors might not deliver quality services, even though they receive fees that should be commensurate to first class performance. And providers often stumble about attempting to justify and sell the virtues of the commissioning process, often inadvertently impugning the character of entire trades and/or professions erroneously and unnecessarily.

In application commissioning is a quality assurance delivery vehicle. Part of the difficulty in defining commissioning resides in the intuitive nature of the process. Every stake holder in the design and construction processes, from the smallest individual contribution during the programming phase, to the assistant draftsperson detecting a repetitious error, through every hand and mind that fabricates, transports, installs, and verifies the multitude of materials and devices that make a facility, and ending with owners, occupants, and operations and maintenance (O&M) personnel acceptance contributes to the commissioning of a facility. So why then, the owner may ask in the concept stage of a building project, do we need yet another layer of services?

Quality assurance is the answer. If the design and construction model consistently produces on time, within budget, working facilities in accordance with design intent to the satisfaction of occupants and O&M staff by definition (pick your favorite) an adequate commissioning process exists. Despite stories to the contrary, instances occur where quality assurance results from a standard construction delivery model because commissioning roles and responsibilities are provided by the design and construction teams, either formally, or (more likely) informally.

Unfortunately, in practice this case tends to be the exception to the rule. Typically, formal testing protocols, verification against design intent criteria, adequate documentation, and successful O&M training must be secured through the auspices of a commissioning authority, independent or otherwise. Where there is an absence of a commissioning authority, owner support services, such as O&M personnel or facility engineering staff, often provide an interface to ensure occupant satisfaction, particularly in complaint driven instances.

Quality Assurance Gone Wrong

So what do we mean by quality assurance? A classic conversation between an automatic temperature controls contractor and a commissioning agent goes something like this:

ATC: "We won't need to waste our time performing your tests because we've already checked out this system and it's working just fine."
CA: "How do you know it's working just fine?"
ATC: "There are no complaints."
CA: "Well, the building is not occupied."

ATC: "Right."
CA: "What happens when the building becomes occupied and complaints begin?"
ATC: "We'll come out and tweak the system."
CA: "What happens if there are complaints after that?"
ATC: "This system is under warranty and we will make callbacks to address complaints."
CA: "What happens after the warranty expires?"
ATC: "We won't have complaints to deal with. The O&M staff handles it."
CA: "Uh-huh."

Clearly, one's view of quality assurance depends on what side of the warranty your scope of work resides. Many control vendors provide outstanding commissioning services for their installations to avoid the costly callback model. Most major control manufacturers provide standardized point-to-point verification and sequence checkout documentation for their vendors. But what happens if the installer has other projects on similar deadlines and cannot complete the standardized commissioning protocols. Or, if the controls contractor performs the point-to-point verifications and sequence checks, but a mechanical installation issue prevents proper operation or function, who covers the interfaces between trades?

An owner can receive a "callback commissioning" program. A warranty may be in place that allegedly provides quality assurance – provided all problems arise and cause failures within the warranty period, typically one year but which may be longer by specification or for specific parts and equipment. Too often the owner's personnel at the owner's expense assumes by default a commissioning or retro-commissioning function that may be endless, may not provide a long term solution, and may represent a hidden cost that is self-perpetuating. In this environment, an independent third party commissioning agent may provide an avenue to achieve lasting solutions that reduce the complications that O&M departments will have to deal with later.

Innovative strategies to incorporate roles and responsibilities that already exist in the design and construction processes or in maintenance and facilities departments, that are normally implemented through in-house personnel or through design consultants, have been demonstrated to streamline the delivery of quality assurance to new construction and maintenance and operations of existing facilities at significant savings to the building owner. Early and frequent involvement of commissioning agents in the construction, maintenance, and operation of facilities results in clear definitions of roles and responsibilities of all parties, allows for the actual monitoring of performance to occur through the auspices of the commisssioning services provider, and thus frees the owner's personnel to focus on their managerial and administrative functions.

Vintage 1955 Hospital Hot Water System

Since its original construction, a large hospital had undergone numerous renovations and additions performed by a variety of designers and contractors. O&M personnel spent a significant amount of time troubleshooting frequent hot/cold complaints from occupants of different wings of the hospital. Recently, facility managers contacted a local test and balance

(TAB) contractor to investigate the persistent temperature complaints. The TAB firm, having an associated commissioning capability, recommended a retro-commissioning approach. The retro-commissioning (RCx) team was assembled for preliminary meetings and included a commissioning agent (CxA), TAB personnel, hospital O&M staff and facility management.

The RCx team utilized O&M staff to explain a systematic valve opening and closing procedure that had evolved over the course of years whereby valves were positioned to restrict and force water flows based on complaints and observations. This manual operation of hot water system valves had actually become incorporated into the semi-annual winter-summer turnover procedures, accompanied by subsequent "tweaking" to mitigate the louder, more adamant protests.

The hot water system consisted of 495gpm of primary hot water pumping at 200°F through the boiler loop, and 18 secondary pumps, allegedly in a decoupled configuration circulating a total of 1600 gpm at 180°F through the load loops. Based on an understanding of the manual valve adjustments, the CxA developed a testing protocol implemented by the TAB technicians to measure temperatures, pressures and water flow rates. Combined with analysis of the data and documentation by the RCx team two main problems were identified:

- 3 of the 18 decoupled loops were identified as improperly piped resulting in out of tolerance primary water flows with excess flow on the improperly piped circuits at the expense of other circuits, and in one case reverse flow was demonstrated in a piping network. These imbalances created temperature disparities between hot water distribution loops and adversely impacted the efficiency of the system.

- A 6" hot water return line from the original 1955 construction was discovered piped improperly in violation of the decoupled design intent, thus creating a blending of cooler return water into the 200°F primary boiler loop.

After a meeting of the RCx team to discuss these findings, a renovation project was undertaken through the hospital's standard process, with one exception: the piping corrections renovation project incorporated third party independent commissioning to confirm design intent. As a result, this hospital's hot water system operates more efficiently today, requires far less maintenance attention, has freed O&M personnel to perform PM procedures benefiting other systems, and has greatly reduced space temperature complaints and thereby increased occupant comfort and confidence.

Aircraft Hangar Airflow

A recently constructed aircraft hangar in a northern climate procured by the U.S. government through a design-build model incorporated two large make-up air units with the design intent of recovering space temperature within a fixed elapsed time in hangar bays following a door opening event. The design-build team included independent TAB services and independent commissioning services, both contracted through the builder. During the acceptance phase

specifications required a functional performance test (FPT) team composed of design-build team members, including the TAB and CxA representatives, interfacing with government TAB and commissioning professionals. This combined FPT team operated based on specified procedures, forms, and sequencing requirements.

Review of the TAB report for these units, and subsequent TAB verification, confirmed that the make-up air units (MAU's) were almost 50% below design airflow capacity. Based on static pressure measurements the vendor of the equipment insisted that the units could be re-sheaved to achieve design flow. Using fan law calculations, a new sheave combination and belts was installed. Measurements of the resulting airflow and brake horsepower indicated only a marginal increase in airflow of 5% with a correspondingly slight increase in motor work.

Perplexed, the vendor recommended a second sheave and belt change based on fan law calculations using the new data. Again, the increases in airflow and power consumption were far less than theoretical, and in fact this second modification only increased airflow an additional 1%. Faced with these results the vendor called in a site visit by a manufacturer representative, who determined that despite correct model and serial numbers and fan selections, the wrong unit housings were installed on site.

The manufacturer conducted a field modification of these MAU's by removing the top of the units, fabricating and installing compartment height extensions, and reinstalling the tops. The CxA performed a verification exercise which documented that the manufacturer's personnel did not seal any of this modified cabinetry. After a subsequent manufacturer site visit and retesting, a third sheave and belt combination, and retesting a modest increase in airflows and brake horsepowers was realized, but the MAU's still performed at 30% below design airflow capacity.

Further actions of the CxA in conjunction with the design-build team and their vendor resulted in an extensive investigation by the manufacturer. The manufacturer determined, despite the equipment field modifications, that corrective actions were not complete. This was due to failure to incorporate a discharge transition modification that had been determined by the manufacturer's designers but was not implemented by the manufacturer's field crew. Yet another site visit by the manufacturer's field team resulted in the discharge ductwork modification, a fourth sheave and belt change, and more TAB measurements brought the airflow to within 12% of design versus specified tolerance of minus 10%.

Conference calls including the CxA, the TAB contractor, the design-build team, and the government resolved the remaining discrepancy by allowing a design change to a higher discharge air temperature to achieve design MBH within specified tolerances. Having achieved all the noted alterations and having performed preliminary FPT's by the CxA, the combined FPT team was able to demonstrate design intent compliance on a design ambient day via an actual door opening, recovery time FPT.

Based on this experience several conclusions can be reached:

- Independent TAB and CxA presence on the design-build team saved the government considerable expense with regard to resolution and retesting required to drive a solution to the deficiency.
- TAB and CxA presence on the design-build team saved the builder considerable expense in testing, producing useful data, and resolving conflicts with the vendor and the manufacturer.
- TAB and CxA involvement reduced the resolution time, allowing the owner to receive beneficial occupancy without waiting for resolution of an extended dispute.
- A clearly specified commissioning process assigning roles and responsibilities to design-build and government parties, combined with specified design intent criteria and testing protocols assisted all parties to determine appropriate mitigation actions.

Humidity Issues in School Buildings

Recent summer conditions in school buildings caused a school administrator to contact an independent commissioning authority (CxA) employed by the school system on unrelated projects. The CxA met with maintenance personnel at one of the buildings and performed a site observation and interview process involving the school's maintenance supervisor and selected school staff members. Upon receipt of a report of these activities from the CxA the school administrator directed his O&M personnel to coordinate actions to restore reasonable occupied conditions to the school in question. Patching of obvious infiltration points in the building envelope, repair of malfunctioning dampers, modifications of the control sequence, operation of multiple portable dehumidifier systems and circulation fans, cleaning, and disinfecting were immediately implemented to provide comfortable conditions.

The school system invited the CxA, a mechanical design firm, an architectural design firm, and key school maintenance and operation personnel to a preliminary meeting for the purpose of forming a retro commissioning team to assess and recommend solutions for perceived humidity problems. An RCx team was formed under the commissioning authority of the architect based on photographic and empirical evidence collected by the CxA and presented during the initial meeting that indicated architectural features such as roof and building membrane as prime candidates for extensive investigation. Under direction of the architect, the RCx team devised a plan to utilize the assets of each firm without duplicating services, and established communication and coordination channels, allowing efficient and meaningful evaluation and testing of existing systems. By including school personnel on the RCx team, efforts were arranged around the school's winter occupied schedule, thus reducing site visit expenses.

Based on the single school's RCx model, an additional four facilities were included in the RCx project. The results included a summer project streamlined for correcting specific aspects of each school's condition and operation that can be implemented over the following summer

break, thus improving the environmental quality of these buildings in the course of a single year from initiating the RCx assessment process to completion of the subsequent corrective projects.

Fire Alarm Verification

A large physical plant capital construction official recently contracted an independent CxA to participate at a fixed cost in the design phase of a renovation-addition project of a high profile facility. CxA involvement in the design team meetings resulted in incorporation of the owner's O&M personnel in discussions of systems acceptance experiences. While the fact that HVAC systems present a continuing challenge to the owner's personnel upon and after acceptance was confirmed as anticipated, design discussions revealed that particular difficulties repeatedly arise during the acceptance of fire alarm systems.

The design team resolved to incorporate additional fire alarm commissioning into the project administered through the commissioning provider firm. This resulted in acquiring an out of state fire alarm commissioning firm to review design and submittal information, to develop a fire alarm commissioning plan, to attend key meetings involving the fire alarm system, and to provide technical support to the overall commissioning effort. The local firm's technicians managed by the fire alarm specialist performed significant portions of the verification, thus reducing commissioning costs to the owner. Employing an out of the area fire alarm specialist with no conflicts of interest ensures a greater degree of objectivity.

O&M personnel were initially indifferent to the notion of having a third party involved in the fire alarm commissioning they had assumed by default for many years. Experiencing unsatisfactory turnover from vendors over the years the O&M department had developed a distrust of the commissioning process they assumed the fire alarm vendor had been performing. The O&M staff therefore verified and tested the fire alarm systems themselves after each installation, attempting to uncover issues before the warranty period ended and the fire alarm vendor started charging hourly rates for site visits.

Incorporating a third party independent commissioning agent resulted in clear lines of communication between the owner, contractors, designers, authorities having jurisdiction (AHJ), and the commissioning team. Documentation protocols, clear specification of commissioning roles and responsibilities, and formal functional performance testing and training resulted in efficient transfer of the project from construction to occupancy. Design review and input from the fire alarm commissioning specialist, combined with proper coordination, resulted in fewer discoveries requiring corrective action by the AHJ during the acceptance phase. It should be noted that functional performance testing was conducted by the fire alarm contractor and attended by the owner and the CxA. This resulted in documentation and added quality assurance without increasing costs due to duplicative services.

Conclusions

The examples presented herein demonstrate some creative applications of third party independent commissioning to new and retro commissioning projects. While third party independent direct for owner services may be a preferred model for many new construction jobs, creative solutions for resolving building issues by applying the commissioning provider services in different configurations can reach beneficial results for reduced overall costs. This is particularly so in situations where the owner's personnel have assumed costly responsibilities in order to reduce or address frequent owner complaints. Expenses incurred by the owner through such unplanned O&M activities reduce effectiveness of preventative maintenance (PM) and other O&M roles.

Early involvement of a third party commissioning provider can reduce O&M costs substantially while providing a greater degree of quality assurance. This concept applies to new construction, renovation and addition projects, and retrocommissioning programs. By meeting and organizing an effective commissioning team that utilizes the skills and assets of all project parties, commissioning costs can be managed to deliver the most cost effective permutations by avoiding duplicative services and utilizing the expertise available.