Executive Summary

Sample Company

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Sample Company has constructed a 80,000 sf. addition to the east wing of its existing facility located in Mechanicsburg, Pennsylvania.

The project was to increase available health care to the Mechanicsburg area and help with over crowding of the facility.

The project included a three story addition with a penthouse to the top of an existing two story building as well as some upgrades to the chiller plant. The upgrade of the existing 12K high voltage feed to the facility evolved into a double ended feed through a new double ended distribution switchgear to further aid in averting a loss of power to the facility as well as the addition of 2 new 1-megawatt diesel generator sets.

The addition houses critical care and bariatric patient rooms as well as positive and negative isolation rooms. The addition is a steel framed block /brick curtin wall constructed building with rigid wall and roof insulation and a flat roof with a seamless rubber membrane.

The HVAC system consists of commercial custom air handlers, two (2) single deck and one (1) dual deck heating/cooling with VAV boxes for local distribution of air, exhaust air heat recovery systems, chilled water, hot water, revisions to the existing cooling towers, one [1] existing and the replacement of two [2] aging chillers, chilled, hot and condenser water pumps. The addition stairs towers are heated by cabinet unit heaters. The building is controlled by an automatic temperature control system with multiple occupancy programs.

The projects primary objective was to create a state-of-the-art health facility to meet the current standards with improvements to the environment while enhancing the quality of life of the occupants.

The services BETA Engineers provided for these systems were the following: Review Design Intent/Basis of Design.

- *Incorporate commissioning requirements into the construction documents.*
- *Create a commissioning plan.*
- *Review approved submittals for equipment within the scope of commissioning*
- *Perform on site tasks:*
    - *Prepare Construction Checklist for the contractors to document the installation of each piece of equipment.*
    - *Prepare written, project-specific test procedures for functional testing of all commissioned components and systems.*
    - *Perform site observations and notify the Construction Team of any observed issues.*
- *A Training Matrix was developed to aid the contractors and owner to identify required training.*
- *Assimilate pertinent information for the owner from the equipment Operations and Maintenance Manuals into the re-commissioning manual.*
- *Identify and create training agendas for the instructors to follow when providing training for the owner.*
- *Prepare a Final Commissioning Report.*
- *Perform an 8- 10 month warranty review.*

- *Create and deliver a Systems Manual.*

The Project Team included Mr. John Smith, Environmental & Safety Coordinator, and Mr. Mike Miller, project liaison, Mr. George Ritter, Director of Engineering, and acting as the Owners Representatives. Messrs. Smith, Miller and Ritter have experience with construction from previous projects and have been integrally involved with this project. It has been the owners' belief that there is no better way to ensure the best quality for a project than to have the owner directly involved.

At the beginning of the commissioning process, BETA Engineers reviewed the Design Intent/Basis of Design documents. This documentation was used as a base for which all system design and installation were compared and reviewed as design and construction progressed. This was a design-bid-build project with an at-risk construction manager.

As the Design Phase progressed, BETA Engineers reviewed the project specifications. Commissioning requirements were inserted by Beta Engineers in the project documentation into divisions 1 General, 15 Mechanical & 16 Electrical Requirements. This was to help ensure the commissioning requirements were properly specified in the contract documents.

As a part of the Design Phase, two distinct reviews were performed. These design reviews were performed during the Design Development Phase (approximately 30%) and Construction Documents Phase (approximately 90%). Design reviews were performed by BETA Engineers. One primary focus of the design reviews was to discuss the building shell components. The goal in this part of the design review was to minimize the impact of weak shell components or details on HVAC operation. Another focus was to help eliminate potential areas for water infiltration by discussing and, where necessary, improving details. See the report after this summary. Design reviews also focused on coordination among mechanical, electrical, plumbing and architectural trades. Also, the design reviews focused attention on equipment locations and equipment accessibility and maintainability. The issues that arose during these reviews were discussed with the Design Team and owner and mostly reconciled as construction continued. The design document updates came as addendum items to the project construction documentation.

In the Project Design Stage, BETA Engineers identified 19 items that were reported to the Design Team and addressed. BETA Engineers also made a number of Field Observation Reports to the Team and all those items were discussed and resolved.

In the submittal phase of the construction, BETA Engineers made few remarks on shop drawings as far as items to be addressed pertaining to commissioning and needing to be brought to the Teams' attention for resolution.

Early in construction, a Submittal Log was requested from the Architect to determine which submittals would need to be reviewed from the commissioning perspective. The submittal reviews were performed by BETA Engineers. Tracking forms were developed for those shop drawings, equipment and functional testing of the items identified to be commissioned. These forms would allow a documented means of following the progress of the equipment receipt, installation and startup for the project. The submittals were reviewed with minimal comments or issues from the commissioning perspective.

Construction checklists were developed from the mechanical, electrical and plumbing drawings for the contractor to complete. These checklists aid the owner in verifying that the specified equipment

was submitted, approved and installed according to the specifications and the manufacturers' recommendations. These checklists were created for most of the items listed in the mechanical equipment schedules with the exception of any static or non-moving equipment. The plumbing checklists were created for only mechanical related equipment; such as water heaters and pumps. The electrical checklists were created for major equipment like transformers and switchgear.

These checklists were intended to supplement the contractors' startup documentation and to insure that the commissioning requirements were provided to all parties associated with the project. When the checklists are combined with the manufacturers' startup data, they form an organized means by which the contractor can collect equipment information to be turned over to the owner at the end of the project. This documentation also provided a vehicle to demonstrate the contractors' readiness for functional testing. By using a tracking form for these construction checklists, we intended for the contractor to monitor their completion and that the completion of construction would coincide with the completion of the checklists. This is a good idea in theory and in actuality as construction drew on, the paperwork, with some gentle prodding, did follow with the construction.

During construction, BETA Engineers' field personnel performed routine site visits to observe quality and construction progress. BETA Engineers personnel attended job conference meetings or reviewed the meeting minutes to keep abreast of the construction progress and to check if the contractors were filling out the checklists. This organization of the installation documentation is becoming a more typical process for construction projects, but these contractors were familiar with the process and did make a reasonable attempt to keep up with the paperwork.

A Training Matrix was developed and distributed in the Construction Phase to allow the owner to review and determine their needs and requirements. From this matrix, training agendas were developed.

The building HVAC system functional tests were developed from the engineers' sequences of operation and addenda as well as the approved equipment submittals. Functional testing is normally scheduled to happen at the end of construction, after TAB has been completed and their report approved, and all outstanding punch-list items are resolved to the satisfaction of the design professional.

The functional testing phase was directed on site by BETA Engineers with involvement from the Air Balancing, the Controls Company, the contractors, and Sample Buildings maintenance personnel were invited to witness the testing. Functional testing had minor complications due, to ATC and mechanical problems; some minor troubleshooting of some of the system occurred because of some programming and some boxes had to be passed over that were not completed. The incomplete checkout caused issues that had to be corrected either while we were doing another step or at the time of the test. During the functional tests we generated an Issues Log, even if the technician had made the necessary adjustments at the time of the test.

Preliminary Functional testing was scheduled as the three new Air Handling Units in the penthouse were able to be put on line for temporary use, supply side only, to allow the removal of other existing units not in this contract, the Testing, Adjusting and Balancing (TAB) Strategies & Procedures Plan was submitted and approved. The preliminary balancing of the water and air systems had taken place. The ATC contractor seemed to be in relatively good shape with his controls. Not all of the building programming and point-to-point system check-out were completed prior to the balancing, and / or subsequently the functional testing. The complete functional testing of the units was deferred for a later time in the construction.

During the Functional Testing Phase, BETA Engineers logged approximately 52 issues. Some of these issues were preliminary issues, due to the units AHU-11A & 82 being used for temporary service and using outside air and no return air with the associated dampers being locked in position, and were resolved by replacing switches or re-syncing valves. A preliminary test of the isolation rooms VAV & Exhaust box operation was checked, but the room pressurization could not be completely checked out because the exhaust system had not been final balanced and the Exhaust Box air flow had to be adjusted. The Isolation rooms were rechecked after the exhaust system was completed and balanced. Some VAV boxes on the second floor were not completely connected to ductwork and could not be checked the first time we performed testing and we went back at a later time to verify their operation.

The chiller plant equipment was checked on an individual equipment basis with the system to be tested at a later date as deferred testing so as to not cause a hardship on the facility if a chiller happens to go off line.

The building domestic hot water system had a problem with the water temperature at the sinks on the upper floor in the addition associated with the new hot water recirculation loop; this was cleared up by opening the return valve that had been left closed.

With the size of the commercial equipment installed for this project, the training was accomplished on site by the contractors and or factory personnel explaining the operation of the various systems to the maintenance personnel and most of the sessions were video taped for the owner's future use.

Deferred commissioning to be completed in the fall of 2010 and includes the exhaust air Energy Recovery system, Air Handler economizer cycle, Air Handler humidifier operation, automatic chiller sequence, secondary chilled water pump sequence, chiller plant emergency operation and chiller plant ventilation.

An effort is being made to develop and provide the owner/maintenance staff with a Systems Manual to include pertinent O&M Manual information as well as warranty information, which when combined can be used to develop a maintenance schedule. A warranty walkthrough will be performed jointly by Sample Company Facility personnel and BETA Engineers.

The members of the Commissioning Team along with the Project Team have worked to resolve issues and provide an excellent Facility for the Sample Company staff and clientele. The benefits of the commissioning process include the elimination of all the problems found during the commissioning of the systems. This allows for the systems to operate as designed, thus minimizing problems to random acts (rather than incompleteness or incorrectness), improving system control and increasing maintenance staff knowledge of how their systems should operate as designed.

Respectfully submitted,

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