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Subject Blue Alert- HVAC Upgrade Design

**Title: Blue Alert- Design/Build of HVAC Upgrade Results in Poor Installation**

Identifier 1999-ID-INEEL-442 Date 12-01-99

**Lesson Learned Statement-** Facilities personnel need to assure that the subcontractor is correctly following procedures and guidelines. Any testing of equipment for verification of operation needs to be witnessed by facilities personnel to ensure accuracy and reliability. Before any upgrade project is started, where upgrade specifications are based on a comparison with an existing system, a baseline must be established. (Upgrade specifications with specific performance criteria would be preferable). This baseline should include any pertinent information regarding the system and how it is functioning so that a comparison can be performed upon completion of the upgrade. This will aid in determining if the upgrade was successful or if further action need to be taken. A design/build contract for a retrofit necessitates a very detailed Technical Functional Requirements Document. In addition, the responsibility for proper operation of the completed system must be clearly delineated in the contract documents and should include penalties for performance issues. As a minimum, an engineer should be involved in the development of the subcontract documents and the subsequent system start-up.

**Discussion of Activities-** In the fall of 1998, a design/build contract was issued to upgrade the motors and fans in the Willow Creek Building. The design/build concept was selected as a way to cut the costs of the upgrade since Engineering and Drafting would not have to be involved. Facilities Engineering developed a document that listed what was desired of the upgrade. It included specific instructions as to how the system was to perform after the modifications were complete and what paperwork, drawings, submittals, and information were required for documentation upon completion. The original fan designs were included to aid the contractor in setting up the system and testing it to determine if it functioned correctly. When the upgraded system was supposedly completed, it did not function as well as the old system. Some fans would not produce enough airflow, others would go into an overload condition and shut off, and most of the return air fans would not adjust their speed when the supply airflows changed. Complaints were being received from all over the building and the facilities engineer couldn't get the systems to balance. A Mechanical Engineer was asked to evaluate the system and determine what was causing the problems. He found numerous problems, ranging from dampers not working to VFD (Variable Frequency Drives) that were not connected correctly. Procedural problems were also discovered along with the lack of documentation requested in the original Design Criteria developed by Facilities Engineering. A TAB (Test and Balance) had been requested, but what was received was an incomplete version of a TAB.

**Analysis-** The Design Criteria document stated that the system needed to perform as well as or better than it did before the upgrade; but a baseline performance test of the system was not performed before work began and no records were discovered that proved how the system performed previously. This made it difficult to determine how the upgraded system was actually

performing in comparison to how it had been functioning. No records had been made as to the computer settings to determine if anything had been changed during the upgrade. This made the computer control system harder to troubleshoot. It was discovered that the Facility Engineer was not present when the functional and operational tests were performed and couldn't verify if they had actually been done. Test procedures had not been clearly defined and listed to ensure that all components worked as desired. Additional problems were also discovered. Some of the dampers were not functioning, causing excessive restrictions in the system. The settings in the computer were not standardized so each fan would act completely different all the other fans. Some units had been mis-wired causing the computer to indicate that one fan was on when it was actually controlling a different fan. The pitch settings on the fans have not been verified due to the effort required to reach the adjusters.

**Recommended Actions-** This event illustrates some of the risks of subcontracted design/build projects, and the necessity to have a company representative review and double-check all modifications made to a system. The Willow Creek Building fan upgrade project demonstrated how a subcontracted design/build project can actually cost more money than having a complete design performed by the in-house engineering staff. Facilities personnel need to assure that subcontractors are correctly following procedures and guidelines. Any testing of equipment/systems for verification of operation needs to be witnessed by facilities personnel to ensure accuracy and reliability. In general, technical performance criteria should be established rather than criteria based on a comparison with existing systems. Where comparison criteria cannot be avoided, before any upgrade project is started, a baseline must be established. This baseline should include any pertinent information regarding the system and how it is functioning so that a comparison can be performed upon completion of the upgrade. This will aid in determining if the upgrade was successful or if further action needs to be taken. A design/build contract for a retrofit necessitates a very detailed Technical Functional Requirements Document. In addition, the responsibility for proper operation must be clearly delineated in the contract documents with penalties for performance issues. As a minimum, an in-house engineer should be involved in the development of the subcontract documents and subsequent start-up.

Priority Descriptor BLUE

Functional Category(s) (DOE) Configuration Management, Construction, Design, Maintenance, Operations, Quality, Safety, Management

Functional Category(s) (User-Defined) Configuration Management, Construction, Design, Maintenance, Operations, Quality, Safety, Management

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References N/A