CONTROL ROOM ENVELOPE RECONSTITUTION

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Abstract

Commonwealth Edison Dresden Station redesigned the Control Room Envelope (CRE) per General Design Criteria (GDC) 19, Standard Review Plan (SRP) 6.4, and the governing Regulatory Guides resulting from the 1979 Three Mile Island (TMI) event. Modifications to the Control Room Envelope (Control Room, Auxiliary Electrical Equipment Room (AEER), Auxiliary Computer Room, and the 'B' Train HVAC Equipment Room) were performed to install a Safety-Related 'B' Train Control Room HVAC System along with other system improvement modifications to the ducting system. In September 1996, Dresden Station experienced the inability to properly maintain the CRE at the required positive pressure to all adjacent areas in accordance with UFSAR/Technical Specifications. Further investigation identified penetrations and air flow balancing deficiencies that resulted in the station entering into an administrative imposed 14 Day Limiting Condition of Operation (LCO) and notification of the USNRC. A special team was quickly put in place to methodically identify, seal, and test the CRE for pressure leaks as well as unfiltered inleakage. With Dresden Station's success path to reconstitute the CRE, it became apparent that specific actions were required to maintain the CRE integrity. Special testing using the tracer gas technique was implemented to validate the dose rate calculations for the Control Room Operator dose assessments in the event of a design basis accident. The lessons learned and the methods used to meet UFSAR/Technical Specification requirements sent a clear message to the industry that quantification of the CRE inleakage and positive pressure to all adjacent areas would not be the exception, but the industry norm.

I. Introduction

The CRE has four modes of operation, Normal, Toxic Gas, Smoke Purge, and Isolation/Pressurization, to meet GDC 19, SRP 6.4, and UFSAR habitability requirements. The CRE was designed to include the Main Control Room, Safety-Related 'B' Train Equipment Room, and the Auxiliary Computer Room. These rooms are supplied air flows through a common duct system with redundant hvac systems, a Non-Safety Related 'A' Train and a Safety-Related 'B' Train. The 'A' Train System operates in three modes of operation, Normal, Smoke Purge, and Toxic Gas. The 'B' Train System operates in two modes of operations, Toxic Gas and Isolation/Pressurization.

In September of 1996, inappropriate air flows were identified at the main entrance to the Control Room. Air flow indications at the main entrance indicated that the Control Room was at a negative pressure to an adjacent Work Execution Center (WEC) area. A Problem Identification Form was initiated for the deficiency. Shift operations was notified and the WEC HVAC System was secured. The Control Room was then verified to be positive to the WEC area. System Engineering was immediately notified which resulted in all other adjacent CRE areas being smoke tested for adequate flow paths. All other adjacent areas were identified to have lower pressures relative to the CRE. This was recognized as only addressing a symptom of a potentially bigger problem. Actions were taken to perform pressure measurements relative to the CRE. Inadequate pressures were identified and an Operability Determination was performed. Dresden notified other ComEd sites. A determination was made that Control Room pressures relative to adjacent areas in both the Normal and Isolation/Pressurization Modes did not meet the UFSAR/Technical Specification requirements and Control Room HVAC System was Inoperable. The station entered a 14 Day Administrative Technical Requirement LCO to restore operable status or within the following 36 hours be in a condition where secondary containment was not required.

The CRE was identified to have > 4000 scfm unfiltered inleakage with the Auxiliary Computer Room temporally isolated from the CRE. During the reconstitution of the CRE, the Auxiliary Computer Room was temporarily removed from the CRE, by temporary alteration, when it was determined that the room was not essential in performing emergency response actions. Massive sealing efforts were initiated and January 11, 1997 Tracer Gas Testing quantified unfiltered inleakage < 263 scfm. Control Room HVAC System final air balancing was then initiated.

With the implementation of Upgraded Technical Specifications, January 15, 1997, the Station entered a 7 Day shutdown LCO action statement because the CRE pressure requirements could not be met.

With documented evidence that the CRE 'B' Train was balanced and the Control Room Envelope could be maintained at design basis pressures $\geq$ 1/8 inches water gauge (w.g.), relative to all adjacent areas, the Plant Operations Review Committee determined that the CRE Safety-Related 'B' Train was Operable on January 21, 1997. The CRE was being maintained at a positive 0.42 inches w.g., relative to the most restrictive adjacent area.

The Auxiliary Computer Room has since been permanently removed from the CRE by modification and UFSAR change and a new hvac system has been installed to maintain temperature and pressure parameters for the room and AEER.

The CRE Non-Safety Related 'A' Train was not declared Operable until August 21, 1997. The 'A' Train operability was impacted by availability of fire damper replacements. Dampers were installed and final air balancing was completed on August 20, 1997.

Some of the principal actions, techniques, and methodologies used to address the Dresden Station Control Room pressure event were:

- A special team, Control Room HVAC Project Team, was developed to address actions required to resolve Control Room pressure deficiencies.
- Special Procedures were developed to identify and quantify leak paths, prove results of sealing efforts, and ensure Control Room pressures were properly obtained.
- Tracer Gas Testing methodologies were implemented to identify and quantify leak paths.
- Auxiliary Computer Room removed from CRE.
- Sealing techniques and methodologies.
- Operator dose evaluation for GDC 19 based on SRP 6.5.5.
- Air flow balancing of CRE and adjacent area hvac systems.
- Technical Surveillance Procedures developed and implemented to ensure CRE is maintained to meet UFSAR/Technical Specification requirements.

II. Control Room HVAC Project Team

A special Control Room HVAC Project Team was developed to control and resolve CRE deficiencies. This team was comprised of personnel from each department that had the potential of contributing to the resolution of the deficiencies. Personnel were selected by their demonstrated expertise and program/procedure knowledge of Dresden Station and Commonwealth Edison Company policies and procedures. These elements would contribute to the team's ability in providing rapid and efficient resolutions to issues as they were identified. The team was comprised of the following personnel:

- Project Manager – Project Management Department
- Control Room HVAC System Engineer – System Engineering Department
- Design Engineering – HVAC Design Engineer
- Structural Design Engineering
- Architect and Engineering – Sargent and Lundy Engineer
- Operations – Unit Supervisor
- Maintenance Supervisor – with authority over all maintenance departments, Mechanical Maintenance, Electrical Maintenance, Instrument Maintenance, Laborers and contractor personnel.
- Scheduling
- Work Analyst

- Procurement/Warehousing
- Alternate Parts Replacement Engineer
- Corporate HVAC Oversight Engineer

When the station entered the 14 Day Technical Requirement LCO and the team was developed it was understood that the team would perform on a twenty-four hour/day basis until the CRE reconstitution was complete. The team was scheduled for 12 hour shifts, seven days a week, with a 1 hour turnover at the beginning and the end of each shift. A Project Control Center was established and maintained twenty four hours a day to meet any unforeseen emergent condition or schedule impact.

The Project Manager maintained control of all CRE reconstitution activities. This position was also the central point of contact for the project and assumed all reporting actions for station management. This position was also tasked to ensure project schedules were maintained. Station Management prioritized the Control Room HVAC Project as Priority One on a daily basis, second only to new operability concerns if identified.

The Control Room HVAC System Engineer was the Assistant Project Manager and was responsible for the evaluation of daily sealing and testing activities to ensure design basis was being maintained.

The HVAC Design Engineer assisted in development/approval of sealing details for HVAC system components and consulted with the System Engineer on Control Room HVAC System and adjacent area hvac systems.

Structural Design Engineering personnel developed/approved design details for structural sealing efforts on ceilings, walls, floors, and associated elements.

Architect and Engineering personnel, Sargent and Lundy Engineers, assisted in the development/approval of structural, electrical and mechanical penetrations, bullet proof wall covering, architectural application (i.e. kitchen cabinets, bathroom vanities, shower stalls, locker assemblies, etc.) sealing details.

Operations personnel, Unit Supervisors, maintained control in operation of equipment for testing, authorization of testing procedures, and sealing work packages. Being part of the team ensured operations knowledge of scheduled activities through out the project. Their input assured a path of success and less impacts to work and testing efforts.

The Maintenance Supervisor was responsible for assignment of personnel to perform repairs to equipment and sealing activities in accordance with work packages developed by work analysts and schedules defined by operations and project management. The supervisor had shift responsibilities for Electrical Maintenance, Instrument Maintenance, Laborers and contractor personnel. The position also had the responsibility to maintain adequate manpower to meet scheduled activities for the shift. Callout lists were maintained to coverage.

Work Analysts were responsible for the development of work packages in a timely manner to facilitate rapid and efficient closure of identified deficiencies. As a norm, work packages resolving deficiencies were worked the same shift the deficiency was identified. This rapid and efficient response required all other team members in the development of the work package. Details had to be developed and approved. Work package development had to be correct and detailed to enable work to proceed without interpretation.

Scheduling personnel were responsible for developing a daily schedule resulting from the morning meeting at 0600 hours. The scheduled work activities were the result of the Project Manager or Assistant Project Manager's evaluation of reported work completion, test results, parts availability/receipt, manpower availability, and operations support. The Control Room HVAC Project was established as top priority unless other plant operability concerns were identified.

Procurement/Warehousing personnel were responsible for the location of required parts/materials or the qualification and procurement of materials/components. These personnel were also responsible for expediting delivery and schedule input for work packages development and work authorization.

Alternate Parts Replacement Engineering personnel were responsible for qualification of procured parts on an as needed basis. Personnel were required to expedite parts procurement, manufacturing if required, delivery, and tracking.

The Corporate HVAC Oversight Engineer provided assistance in regulatory guidance, standardization of identified deficiency resolution, transmittal of lessons learned through out ComEd, and promulgation of industry norms. The engineer assisted in the development of a ComEd Control Room HVAC WIN Team that met on a continuing basis from March 1997 through September 1997. Dresden lessons learned, industry norms, and standardization were main topics of review. Additional assistance was provided in obtaining the use of the Tracer Gas Testing methodology and expediting materials/equipment.

III. Special Procedures

From the start of the project, special procedures were required to test CRE parameters. These procedures were developed and implemented to identify and quantify unfiltered inleakage, define CRE pressures relative to all adjacent areas, monitor daily sealing efforts in respect to CRE pressures, and perform final air balancing of Control Room and adjacent area hvac systems. With the Control Room unfiltered inleakage > 4000 scfm, the previous Control Room HVAC System air flow balance was invalidated. Thus, a special procedure was developed for the Control Room HVAC System to ensure design air flows were met. In addition to the CRE air flow balance, special procedures for each adjacent hvac system was developed. Proper air flow balancing is required of each adjacent area to ensure design pressures and air flows would be maintained for each area.

IV. Dresden Technical Surveillance Procedures

Dresden Station Technical Surveillance Procedures were developed and implemented to ensure the Control Room HVAC System and CRE meet UFSAR/Technical Specification requirements. Examples of these procedures are:

- Control Room HVAC System Pressure Boundary Surveillance, this procedure was developed as an eighteen month Technical Surveillance because it will continue to be used to ensure CRE seals are maintained and do not experience degradation prior to lose of required CRE pressure. It was developed to identify as-found CRE pressures relative to adjacent areas and was used extensively to quantify sealing effects on CRE pressures as sealing was performed. This procedure was performed once a shift and results were plotted to give the team and Station Management knowledge on the progress of sealing activities. This procedure will enable the detection of degraded seals between specific adjacent areas, degraded flows or pressures of adjacent area hvac systems, or the need for required flow balancing between Control Room and 'B' Train Equipment Room. This procedure can also provide a basis for Post Maintenance/Modification Testing (PMT) when new penetrations are installed or old penetrations are compromised.
- Control Room Negative Pressure Duct Surveillance Procedure was developed to ensure CRE seals, negative pressure ductwork/equipment outside the CRE, and bubble tight dampers are maintained to mitigate an increase in unfiltered inleakage into the CRE.
- Control Room Emergency Zone HVAC System Surveillance Procedure was developed to ensure that the Safety-Related 'B' Train Control Room HVAC System is maintained to meet UFSAR/Technical Requirements. This procedure includes the verification that outside air makeup is maintained $\leq$ 2000 scfm.

V. Tracer Gas Testing

Tracer Gas Testing was used to initially quantify as-found inleakage to the CRE. Tracer Gas Testing was performed with the Auxiliary Computer Room isolated from the CRE. Three tests were performed to quantify inleakage with each associated room of the CRE in different modes of operation. In October 1996, Tracer Gas Testing identified that unfiltered inleakage to the CRE was > 4000 scfm. This test was performed after adjacent areas were verified to be properly aligned. Massive sealing efforts were initiated to reconstitute the CRE.

Tracer Gas Testing was again performed in November 1996 to quantify bubble tight isolation damper inleakage. Three dampers exceeded design criteria and seals were replaced.

After extensive sealing efforts, Tracer Gas Testing was performed and on January 11, 1997, the unfiltered inleakage was quantified at , <263 scfm for both Control Room HVAC System 'A' and 'B' Trains. This quantification was made after adjacent area hvac systems were verified to be properly aligned, meeting design air flows, and pressures.

VI. Auxiliary Computer Room

During the reconstitution of CRE, the Auxiliary Computer Room was temporarily removed from the CRE, by temporary alteration, when it was determined that the room was not essential in performing emergency response actions. The Auxiliary Computer Room has since been permanently removed from the CRE by modification and UFSAR change. A new AEER HVAC System has been designed and installed to maintain temperature and pressure parameters for the room and AEER.

VII. Sealing Techniques and Methodologies

Extensive sealing efforts were required to drop the unfiltered inleakage into the CRE below 263 scfm. Sealing efforts were implemented to seal continuously 24 hours a day, 7 days a week. As leak paths were identified, Design, Structural, and S&L A/E Engineers developed and approved sealing details in accordance with Corporate and Dresden Procedures. These elements of the Control Room HVAC Project Team provided vast amounts of knowledge and experience. Knowledge of codes, standards, and guidelines and industry materials enable the team to fulfill their required tasks.

During the sealing efforts, new material applications were addressed. These new applications consisted of how the materials were mixed and applied. The vintage of Dresden Station has seen numerous plant modifications, areas of the plant going back as far as 1969 and other areas with newer construction as late as 1988. This type of plant configuration restricts the use of common application techniques and requires the development of innovative mixing and application procedures. Details were developed for applications using Elastomers in CRE panels, conduit penetrations through walls, ceilings and floors. However, material applications in operating facilities require greater hazard consideration and care. Examples include:

- Details for conduit penetrations through fire walls. These penetrations required damns to be built out of fire rated Thermofiber with an RTV Silicone Elastomer pour around Control Room Panel and power cables. With the Station on line, extreme care had to be exercised in packing Thermofiber and pouring the Elastomer. These elements necessitated testing by the vendor and Architect/Engineers to determine specific setting times for the elastomer in different applications. Different ratios of the catalyst resulted in a wide range of penetration and setting of the elastomer. Testing results were incorporated into tables for catalyst and base material combinations for different applications (i.e. overhead injection penetrations, wall damned injections or pours, and floor pours in conduits and penetrations.
- Details for the sealing door frame voids between wall and frames were developed.
- Detailed instructions were developed for the application of coatings to seal porous cinder block walls of the Control Room Envelope. Block walls were found unsealed on one or sometimes two sides of the block. Thus providing numerous leak paths.
- Bullet proofing for the Control was installed over cinder block walls without sealing. Details were developed for the application of sealant on the plating.
- Details were developed for support beam structure voids in the CRE.

In total there were over one hundred details and instruction guides developed and implemented to resolve the CRE leak paths. These detail and instructions have been incorporated into multiple binders where they can be easily referenced for repairs or use in other applications. These details and instructions have been provided or made available to other ComEd Stations.

VIII. Operator Dose Evaluation Based on GDC 19 and SRP 6.5.5

Following CRE repairs and testing, the Control Room HVAC System was declared Operable, but degraded. Although the UFSAR Control Room pressurization requirements of a positive 1/8 inch w.g. was not met, the Control Room was at a positive pressure relative to all adjacent areas, and the measured in-leakage was within analytical bounds. The operability analysis used to bound Operator dose with GDC 19 requirements was based on the use of SRP Section 6.5.5 methodology (Suppression Pool Fission Product Scrubbing Effect). Operator Thyroid dose was calculated to be less than 30 Rem.

IX. Air Flow Balancing of CRE and Adjacent Area HVAC Systems

The Control Room HVAC System was assumed to be balanced previously. However, the quantification of unfiltered inleakage > 4000 scfm invalidated air flows previously identified and a contract was initiated to procure the services of an American Air Balance Council (AABC) certified Test and Air Balance Engineer. The certified AABC Test and Air Balance Engineer was required to meet Sargent and Lundy Specifications T-3343 and K-4080. When unfiltered inleakage was quantified at < 263 scfm final air flow balancing was required to ensure CRE design air flows and pressure were obtainable. Final air flow balancing was performed after verification that adjacent area hvac systems were aligned properly and meeting design air flows and pressures. Final air flow adjustments were made in the Safety-Related 'B' Isolation/Pressurization Mode. This was done to ensure that air flows were maintained to meet Operator dose calculations in accordance with GDC 19 and SRP 6.4. Final air flow measurements were not completed on the non-Safety Related 'A' Train System until damper replacements were installed August 20, 1997. With completion of the final air balance of both trains of the Control Room HVAC System and the completion of documentation that the system meet design flow criteria, the Control Room HVAC System declared to be fully Operable.

Air flow balancing should not be completed prior to identification that adjacent area hvac systems are properly aligned, meeting design air flows, and design pressures. These elements have the potential of influencing final air flow balance of the CRE.

Verifications were made prior to final air balance that adjacent area hvac systems were properly aligned, maintaining design air flows and design pressures.

X. Conclusions

It should be noted that the Dresden Control Room HVAC Project was completed by satisfactorily meeting the original design basis of the UFSAR/Technical Specifications. The Dresden Control Room HVAC Project Team was one of the key factors for the rapid and efficient completion of the CRE Project. Without a concentrated effort by all departments and the proper prioritization of the project by Station Management, the project would not have had the success that was obtained in such a short period of time. The team provided a focused and methodical effort to resolve CRE deficiencies. The concentrated efforts of the project team, the understanding and practice of team concepts, and the prioritization given by Dresden Station Management assisted in the development of a clear and defined path of resolution. This project has fostered emphasized practice of team concepts in performing major projects and tasks through out ComEd.

Development of special procedures to complete required tasks provided documentation to evaluate and record as-found and as-left configurations and parameters to support acceptance of the CRE design basis.

The development of Technical Surveillance Procedures is essential in maintaining achieved design. Proceduralized instructions and documented acceptance of configurations and quantitative values provide assurance that design basis or as-left accepted conditions were achieved. These procedures assist in providing documented history of the performance and maintenance of the equipment and components of the system.

Tracer Gas Testing was instrumental in definition and quantification of unfiltered leak paths. The significance of these data is that they represent documented measured inleakage rates and can be used for Control Room Habitability assumptions in lieu of engineering assumptions. Assumed values of inleakage could not be validated during the Dresden CRE reconstitution.

Extensive sealing efforts were performed during the CRE project. These sealing efforts were the result of a joint effort between the team, Dresden Station personnel, additional ComEd personnel from other stations, and external contractors and vendors. With completion of the Dresden CRE Reconstitution Project, additional techniques and methodologies for sealing were established and are currently being used by other industry stations.

Proper air flow balancing is essential to obtaining CRE and adjacent area hvac system design bases and should not be completed prior to identification that adjacent area HVAC Systems are properly aligned, meeting design air flows, and design pressures. These elements have the potential of influencing final air flow balance of the CRE.

Lessons learned from the Dresden Station Control Room Envelop Reconstitution have and will be shared throughout the nuclear industry. Special procedures, technical surveillance's, sealing details and techniques, and air flow balancing techniques and procedures have been bound in manuals for quick reference or use and can be shared with interested persons/companies as needed.

XI. References

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