DEEP BED CHARCOAL FILTER RETENTION SCREEN IN-PLACE REPLACEMENT AND REPAIR

William Burns and Rajendra Pande
Commonwealth Edison Company
LaSalle County Station

Raymond Rosten and William Knous
Duke Engineering and Services, Inc.
Naperville, IL

Brian Schumel
Power Cutting, Inc.
Lake Bluff, IL

Abstract

During filter unit testing on the control room filtration unit, it was noted that the deep bed screen was corroded in several areas. This originated an investigation and evaluation by station personnel. The root cause for the corroded areas was attributed to water leakage past the installed deluge system valves (into the filtration unit) creating a localized corrosive environment on the charcoal retention screen. Options to repair or replace the charcoal adsorber were investigated. It was determined that a screen repair and replacement could be performed. Because of the time constraints and complexity of the repair, considerable preplanning was required. A special welding method was developed involving the use of remote cameras and welding devices that would accommodate the small space between the screens. Several screen sections were replaced and post testing was completed satisfactorily. This repair method resulted in significant cost savings and limited the filter unit unavailability time by decreasing the scope of the work and affording a unique repair method.

I. Introduction

The LaSalle County Station is a two unit Boiling Water Reactor (BWR). The main control room is common for both Units 1 and 2. The control room ventilation system utilizes two 100% capacity equipment trains with each emergency makeup train filter unit sized for 4000 cfm. The emergency makeup filter units were manufactured by CVI and utilize a two-inch deep bed design for the charcoal adsorber section. The CVI charcoal adsorber unit is designed with stainless steel charcoal retention screens.

During the early operation of the filter units, the fire protection deluge system was inadvertently operated and wetted the charcoal beds. The isolation valves were then closed to prevent recurrence. In addition, leakage past the isolation valves also provided chronic wetting of the charcoal. As a result the water combined with the charcoal impregnant and produced a mixture corrosive to stainless steel. LaSalle station personnel discovered significant corrosion on the charcoal retention screens during routine visual surveillance activities performed to satisfy NRC Reg. Guide 1.52 [(1)] commitments. An Operability Evaluation performed by the station committed to further evaluation for repair or replacement of the corroded components.

II. Design of the Filter Unit

The LaSalle control room ventilation system emergency makeup filter unit is the safety related supply of air to the control room during accident conditions to meet the control room habitability requirements of General Design Criteria 19 (10CFR50 Appendix A[(2)]). The filter unit is designed to remove gaseous radoinuclides from the influent air. The filter unit is a draw through design with the fan on the outlet and consists of an inlet damper, moisture separator, heater, prefilter, upstream HEPA filter, charcoal adsorber, downstream HEPA filter, fan and outlet damper.

The CVI design of the adsorber utilizes a series of air boxes to distribute flow throughout the unit. It is an all welded stainless steel design. The deep bed adsorber has a top fill hopper with a series of two-inch wide vertical beds and a collection system below the beds for charcoal removal. The air enters an inlet air box horizontally, turns 90° horizontally to flow through the bed, turns again 90° horizontally and exits through an outlet air box. The air box design utilizes 24 gauge perforated sheet as the charcoal retention screen to allow airflow through the charcoal and maintain the charcoal in place. See Figure 1.

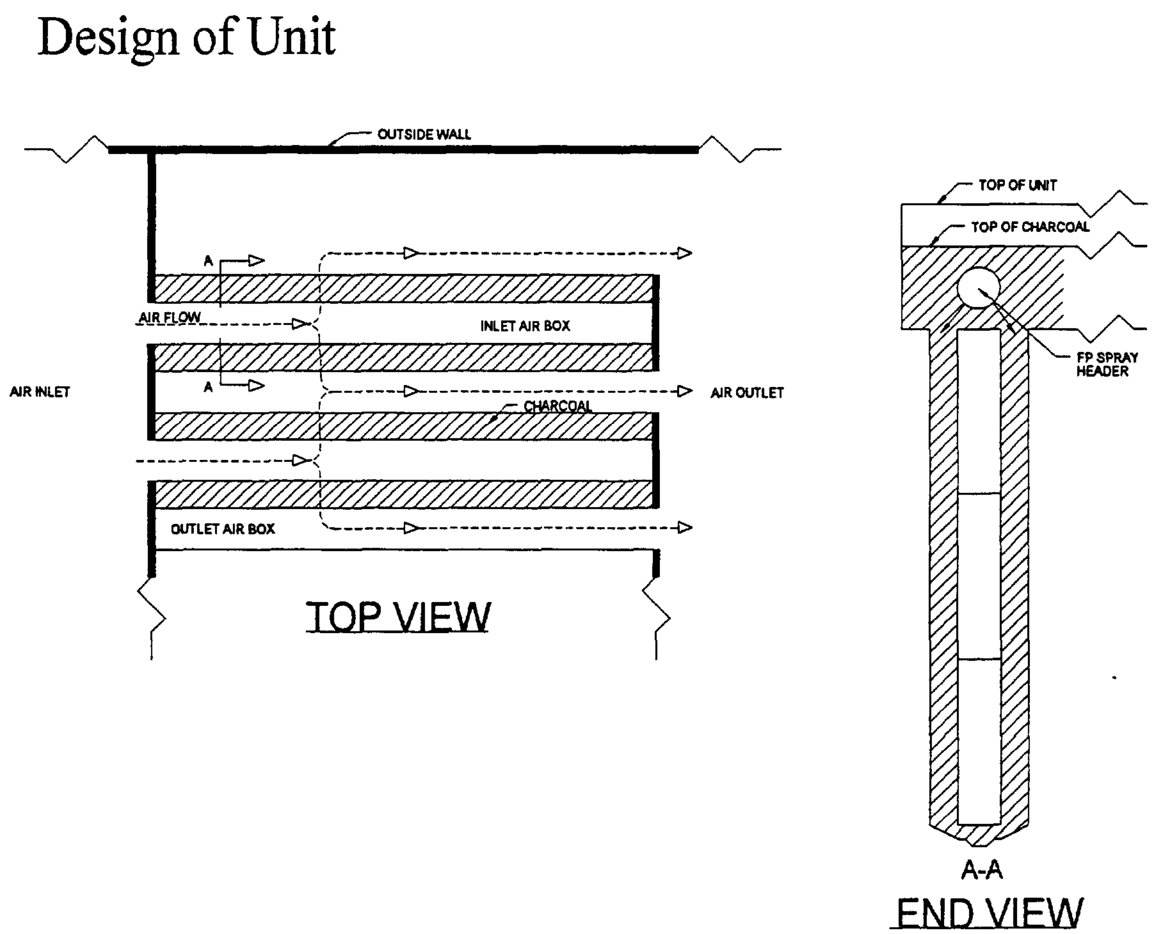

Figure 1 – Design of Charcoal Adsorber

III. Problem Statement and Issues

The screens in the control room filtration charcoal adsorber unit had areas with significant corrosion. The integrity of the screens had been evaluated and found to be acceptable but degraded. To restore the material condition of the filter unit, screen repair or replacement would be necessary.

Corrosion of charcoal retention screens was initially discovered in the standby gas treatment system charcoal adsorber. This adsorber is an eight inch wide bed which was repaired, with significant difficulty, by conventional methods. Later when the corrosion was discovered on the control room filtration units, it was determined that the conventional repair methods could not be performed.

The issues to overcome in the implementation of this project are as follows:

- Working area restrictions – Since the deep beds are only two inches wide and the inlet and outlet accesses are approximately three inches wide, workspace was extremely confined.
- External interferences with conduits/cables.

- LCO window – The repairs to the filter unit must be completed within 7 calendar days. This includes removal of charcoal, screen repair, replacement of charcoal, and post-maintenance testing.
- The retention screens are welded on the charcoal side.

IV. Options Evaluated

There were a number of options considered during the development of the project. The following is a summary of the major options evaluated:

1. Clean and Inspect – The Clean and Inspect option was considered if the station determined that the corrosion levels of the charcoal retention screens was limited to a minor surface corrosion. This could be determined with a simple cleaning of the corrosion layer and a measurement of the perforated plate at the damaged section. This data would then be utilized to determine the structural integrity of the perforated sheet under the most severe conditions (seismic loading). This option was not pursued as a complete solution because of the risk associated with a negative inspection was high with no contingency for actions available. Therefore, this option was implemented only in areas that were not significantly affected by the corrosion.

2. Repair – The Repair option was considered in a variety of forms. For example, repairs of small damaged areas (2"x2" or less) were considered to be feasible by attaching a sheet metal patch over the hole with sheet metal screws and spot welds. Since these repairs required access to the damaged area with hand tools, this type of repair was only designed to be installed in the accessible areas of the screens (i.e. the areas closest to the inlet or outlet air boxes).

   Another repair option evaluated was to replace of an individual screen section. The air boxes are designed with support channels on the air side that divide the screens into three distinct sections. The screens are spot welded to the channels at uniform intervals. Therefore, the individual screen sections can be cut out and replaced independent of the other screen sections. This requires the use of special tools to access the far end of the screens for the cutting, grinding, welding, and inspection to remove the existing screens and install the replacement screens. The replacement of the screen sections was the main repair option chosen.

3. Replacement – The replacement option consists of two separate options. The first was a like-for-like replacement of the deep bed unit by CVI and the second was to replace the deep bed filter with trays. The first option to install another deep bed unit was rejected because it would require a great deal of modification work to remove interferences, it was expensive, and the problems associated with the deep bed units would remain (e.g. labor intensive loading/unloading of charcoal). The replacement of the deep bed unit with trays was not considered as a possibility for the seven day LCO and would have required a Technical Specification change to allow a longer filter unit outage. The replacement of the deep bed units with trays is no longer being considered as an option due to expense and difficulty of performing the replacement.

V. Plan of the Unit Repairs

After consideration of the alternatives, the following plan was developed to repair the units.

- The damaged screen sections were initially identified by photographs/inspection. This was utilized to establish the extent of expected repairs.

- The charcoal would be removed from the unit to allow for screen access.

- The damaged screen sections would be completely replaced.

- Other small repairs would be installed as required.

- New charcoal would be installed.

- Post maintenance testing would be performed.

The screen replacement was fully planned including the use of a mock-up charcoal adsorber assembly. The project team developed a new screen sectional design. The design was based on installation of the screen sections on the air side of the air box assemblies such that the screen would fit between the channels separating each section (see Figure 3). To install the screen sections, the existing screens were cut out. This operation required special tooling due to the restricted access to the full depth of the air boxes. Various tool assemblies were developed (see Figure 2) that could be manipulated from either the inlet or outlet air box. The mock-up unit was instrumental in the development of the required tooling and other preparations prior to the repair activities on site.

Since the whole repair activity was to be completed in a seven day window from removing the unit from service until the completion of the post-maintenance testing, each activity was closely scrutinized and added to the overall equipment outage schedule. With all of the other factors considered the actual repair time allotted was three and a half days. With this window defined, the teams practiced on the mock-up until all repairs could be completed within the three and a half-day schedule.

VI. Development of Tooling Assemblies

To address all phases of the repair process, four long handle tools were designed and manufactured. The tooling consisted of:

- Cutting torch
- Grinding / cleaning tool
- Video inspection camera
- Spot welding and clamping tool

The first design of the cutting tool was a small plasma-cutting torch. During mock up testing it was identified that the plasma cutting process left a jagged and non-uniform cut requiring grinding and dressing the cut areas. It was apparent that the process needed to be refined to reduce the screen removal time. During testing it was determined that the existing screens could be cut using a modified manual Tungsten Inert Gas (TIG) torch. Torch amperage settings were adjusted to minimize thermal distortion. This ensured that the screen cut would be smooth and straight.

The grinding tools consisted of an air-operated right angle grinder and straight head rotary grinders. The grinding tools served three purposes, 1) to clean the corrosion off the screens; 2) to clean up any burrs on the screens after the cutting process; and 3) to grind off any unacceptable spot welds during the installation process.

The video inspection camera consisted of a small right angle video camera mounted on a pole connected to a VCR/monitor. The camera was used to visually inspect the condition of the existing screens along with the charcoal adsorber frame area once the damaged screen was removed. It was also used to perform a visual inspection of the new spot welds.

The spot welding tools also clamped the replacement screen while welding the replacement screen to the charcoal adsorber frame. Two separate tools were developed to allow for vertical and horizontal welds. The weld head consisted of a modified TIG torch and gas cup encased in a machined aluminum housing. This aluminum housing also contained an air cylinder that acted as the screen clamping mechanism during replacement.

The weld head functioned as follows; after the damaged screens were removed and the replacement area cleaned and inspected, a new screen was placed in its proper location. The weld head would then be positioned into its proper location. Once proper replacement screen position was verified, the operator would energize the clamping mechanism, which in turn would apply pressure to clamp the new screen against the existing charcoal adsorber frame. Once the operator verified the proper fit-up, the spot weld would be installed using an automatic welding program. The welding program was computer controlled and addressed upslope - downslope time, welding amps, arc time, arc length along with pre-flow and post flow gas coverage.

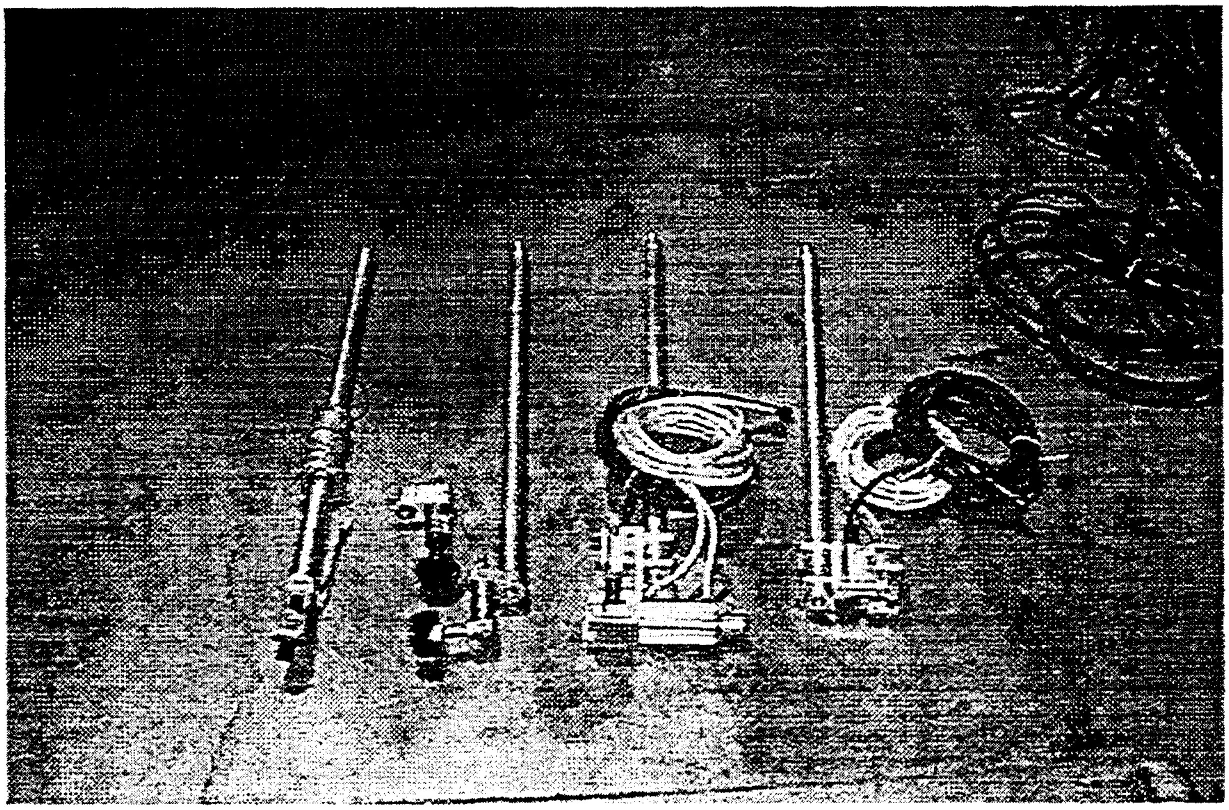

Figure 2 – Long-Handled Tooling Assemblies

VII. Execution of the Planned Activities

- Pre-Repair – All of the equipment necessary to perform the repair activities were pre-staged to the mezzanine level where the charcoal filter assembly was located. This included running all the power cords for the welding machines, providing the service air hoses, and assembling all of the necessary tooling in the immediate area. Also the charcoal removal equipment was staged and checked out to minimize the time required to remove charcoal. In addition, the out of service was prepared in advance to minimize the time required to take the unit out of service. After the unit was tagged out of service, the individual screen sections were inspected to verify the areas requiring repair. Next, the charcoal was removed from the unit and the screen areas were cleaned of corrosion.

- Repair – Two crews for each of two shifts were assembled to make the repairs. One crew would work on the inlet side and the other on the outlet side of the charcoal filter assembly. The screen sections were cut out utilizing the TIG cutter. The replacement screens were then installed and subsequently inspected. A total of 21 of 96 screen sections (48 screen sections per filter train) were replaced.

- Post-Repair – Following the inspections of the replacement screens, the charcoal was refilled in the unit. Final cleaning of the interior of the charcoal filter assembly was performed. Finally, the post-maintenance filter testing was performed which included flow, filter differential pressure, and in-place filter testing to verify proper operation of the unit. Subsequent air flow distribution testing has also been satisfactorily completed.

Figure 3 – Screen Repairs

VIII. Conclusion

The repair of corroded charcoal retention screens in a deep bed filter unit can be accomplished successfully in place within the allotted Technical Specification LCO with extensive preplanning including the use of a mock-up and the selection of a project team. The project team key members included engineering, maintenance, operations, the original equipment manufacturer, and a specialized welding contractor.

IX. References

1. Regulatory Guide 1.52 Rev. 2 "Design, Testing and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

2. Code of Federal Regulations 10CFR50 Appendix A General Design Criteria 19 "Control Room."