AN APPROACH TO INNOVATIVE REMOTE SPENT FILTER HANDLING

Louis J. DeRitis, Martin Brownstein
ATCOR Engineered Systems, Inc.
Avon, Connecticut 06001

Arturo Corral
Bechtel Western Power Corporation
Los Angeles, California

ABSTRACT

Reducing both man-rem exposure and manpower expenditure during normal spent filter handling and maintenance operations is essential to routine nuclear power plant operation. Unfortunately, lack of either attention or operating experience on the part of equipment designers and engineers frequently prevails. This in turn prevents the use of standardized components, integrated systems, and simplified approaches to accomplishing the necessary task of remote spent filter handling in accordance with ALARA principles. ATCOR recently completed a successful acceptance test and supply of a Spent Filter Handling System for The Georgia Power Company, Vogtle Nuclear Power Station.

This paper discusses ATCOR's design plan and implementation for achieving a totally integrated system for efficient, remote handling of spent filters with maximum protection to operating personnel. The paper also includes a description of the approach followed for predelivery performance testing. The resulting impact of this on the final design, which ultimately led to repeatable successful plant operation, is also discussed. All problems encountered, along with their corresponding solutions are discussed in detail. Future designers and operators of these types of equipment and interfaced systems can thus avoid the common pitfalls presented, thereby increasing their expertise and likelihood of successful plant operations.

INTRODUCTION

The design and supply of the Spent Filter Handling System for The Georgia Power Company, Vogtle Nuclear Power Station was a culmination of careful and critical design reviews toward reduced manpower and exposure. This equipment was designed to interface with a wide variety of existing in-plant mechanical filtration and solidification systems. Many unique site conditions surfaced during the evaluation phase which presented significant technical challenges. These existing conditions required innovative design features to be incorporated into the final equipment supplied. A few of the major design considerations and controlling conditions include: a) the multiple filter configurations, b) the location and orientation of filter housings within their respective shielded cubicles, c) narrow travel routes available for equipment transport, d) restrictive in-plant lift capacities for hoisting requisite components. The actual system used required: a filter transfer cask with an integral hoist and controls; remotely operated, self centering, fail-safe grapples; drum shields; mobile drum shield transfer and capping device; filter cubicle working shields; transfer cart and miscellaneous handling tools. All of these were integrated into a unique functional system for remote spent filter handling and transport throughout the Vogtle Plant.

SYSTEM OVERVIEW

The Spent Filter Handling System equipment is designed to provide the safe and timely transfer of the radioactive, spent filters from their respective filter housings to an on-site process or storage area at the Vogtle Nuclear Power Plant for eventual transport to a burial facility.

The mechanical filter assemblies at the Vogtle Plant are located within numerous individually shielded vaults, serviced by an overhead monorail. Top access to each vault is gained by the removal of an existing concrete hatch. A specially designed split working shield is then inserted. The spent filter handling equipment provided mates with this shield and enables the plant operators to remotely open the filter housings, remove the spent filter cartridges and transfer them into a shielded drum which is subsequently capped. The shielded drum is then moved and the filter cartridge encapsulated prior to on-site storage or off-site shipment to a waste disposal facility.

The ATCOR supplied Spent Filter Handling System consists of the following major assemblies.

Filter Transfer Cask
Working Shield 'A', 'B' & 'C'
Drum Shield 'A', 'B', 'C', & 'D'
Transfer Cask Cart
Mobile Filter Transfer/Capping Station
Filter Handling Tools

Figure 1 depicts an overview of a typical Filter Vault, along with the aforementioned components which are used in the handling of spent filters at the Vogtle Nuclear Power Plant.

In a typical operation, the filter cubicle Working Shield replaces the concrete hatch cover during filter handling operations. The Working Shield is provided with a removable, bearing mounted central tool plug. With the tool plug in place, a remotely operated tool is inserted and used to unbolt the filter housing cover. Using a second tool mounted on the Working Shield body, the housing cover is swung to its open position. Conversely the reverse operation is performed when installing the replacement filter.

The central tool plug is then removed and the Transfer Cask, less its base plate, is positioned in place of the plug. The cask mounted Filter Grapple Hook is remotely lowered and engages the spent filter cartridge. Assistance for guiding the Grapple Hook into place may be accomplished using the Hook Tool mounted on the Working Shield.

The filter cartridge is then hoisted into the Transfer Cask. All of the previously discussed operations may be visually monitored using lead glass windows and redundant illumination which is provided integrally with the Working Shield Assembly.

Next, the sliding drip pan is placed into its operational, closed, position, within and under the cask bell, to provide collection of any residual liquid contained within the spent filter cartridge.

The Transfer Cask is then positioned over the Mobile Filter Transfer/Capping Station. The drip shield coffer is drained and slid to an open position which permits a clear path for discharge of the spent filter into the drum below. Using the Filter Transfer Cask Winch, the filter is lowered into the disposal drum, which is pre-lined with cement and pre-positioned within a Drum Shield. The winch is then raised to its stored position and the Transfer Cask is removed and fastened to its base plate. Next the operator can remotely cap the drum and fasten the Drum Shield cover to its body. The drummed filter is then transported for encapsulation to the filter handling room, as is the Transfer Cask for its interim storage.

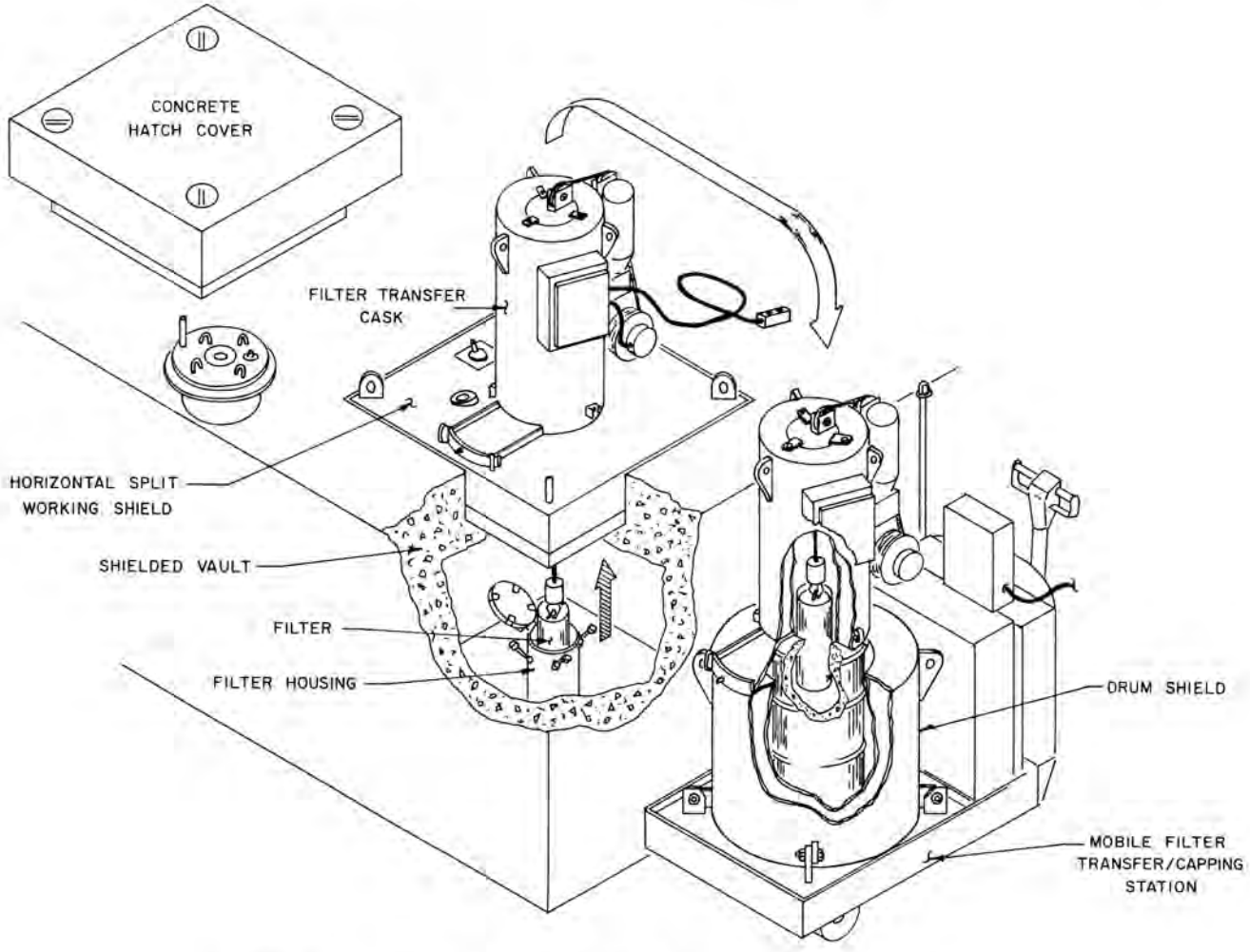

Fig. 1 Spent Filter Handling System Overview

DESIGN PLAN -- THE KEY TO SUCCESS

Although project goals are understood by all concerned at the onset, conditions may exist to deter the optimal equipment design and operational procedures to be easily used.

Criteria Evaluation and Verification

A design plan is therefore initiated to flag potential obstacles which could reduce the margin of success anticipated at the onset. The first step of the plan requires the system designer to evaluate and verify information regarding existing project criteria and plant specific layout conditions. To successfully complete this step requires the cooperation of cognizant plant personnel who are willing to do the leg work needed to answer questions and verify conditions as originally presented within the specification and drawing data package given to the spent filter handling system supplier.

During this evaluation period, an oversight was recognized by the project engineer. Review of the specification and designer requested detail drawings, indicated that one of the filter assemblies that the plant expected to be handled was oversized. In fact, it would not fit within the physical design parameters specified for the transfer cask. Having the purchaser aware of the situation early into the project permitted the required design changes to be incorporated with minimal cost impact.

To facilitate proper location of filter housing tools within the working shields required information not available on the drawings originally given to the designer. To determine the housing covers direction of motion when opened, site personnel had to visually check each assembly. Details such as these can usually extend the project schedule if not acted upon expeditiously as they might otherwise require rework of large assemblies which affect both cost and schedule.

Design Review

Having created a sufficient design basis, a preliminary design is generated for the purchaser's review and followed by a purchaser/supplier integrated design review meeting. The design review is an excellent method, not only to freeze the equipment design, but to also use the input of the intended operators experience regarding the systems handling procedure's operability.

Additional areas of review taking place at this point include; the project status, purchase order and specification clarifications, along with any purchaser initiated subjects. Areas of concern surfaced and were resolved during the first design review. As additional detail information, requested during the design evaluation phase was made available, it became apparent that multiple types of filter lift bails existed. The resolution presented to and recognized by the purchaser required that the design of a second, failsafe filter grapple assembly be provided. Without it, the system would not have been 100 percent functional for the myriad of filters required to be lifted remotely.

Quality Assurance

Close Quality Assurance surveillance during the fabrication phase is a major part of the plan. Mis-direction by the fabricator and discovery of deviations are avoided as final inspection draws near by this use of frequent in-process inspections. In conjunction with Quality Assurance, the design engineer performs operational tests of the equipment as soon as possible for further verification of the design fit, form and function. The preceding ensures that final testing will be accomplished without a redesign effort after the fact.

Integrated Operation Test

The final step within the design plan is the performance of the integrated systems operation test at the fabrication facility. This test, as closely as practical, duplicates site physical conditions using the approved operating procedure written for the plants equipment.

A dry run is first performed by the designer for "de-bugging" and is monitored by his organization's quality assurance representative for compliance to the customer's specification and the operating procedure. With the fine tuning successfully completed, the procedure is then repeated and witnessed by the Purchaser's representative for acceptance. As a result of this test, the purchaser was able to note the time required for various operations relative to exposure and determine which of the procedure's steps may require the most attention when remote alignment of equipment is taking place. As a result, additional alignment stripes were added. The procedure was annotated to include information gathered during the tests, such as fields of vision through the lead glass windows, maximum areas covered by the remote handling tools and suggested operations requiring use of guide reins attached to the equipment being remotely aligned.

The performance of the operational test at the fabricator's facility made on-the-spot, minor modifications possible. The purchaser, having witnessed the modifications and the successfully completed test, was able to accept the system and negate physical changes after receipt of the equipment on site which are usually quite costly.

An additional benefit of the test was the creation of a video tape capable of being used by the plant as a training aid.

EQUIPMENT DESCRIPTIONS

The following is a brief description of the Filter Handling equipment supplied for the Vogtle Nuclear Power Plant.

Filter Transfer Cask Assembly

The Transfer Cask provides a safe and efficient method for remote retrieval of radioactive spent filter cartridges from their housing, filter transfer, filter disposal in the process area, and personnel shielding as required during these operations to satisfy ALARA considerations.

The cask is a stainless steel right circular cylinder bell configuration with a fully removable base plate and a permanent top with an access port. A typical cross section consists of 5-5/8 inches of lead (Pb), housed within a 3/8 thick inner and outer stainless steel shell.

A side mounted, electric motor driven winch assembly provides the means for raising and lowering the filter cartridge. In the event of a power failure, a manual handcrank may be used to operate the winch. Attached to the stainless steel winch cable is a remotely operated filter Grapple Hook. Two (2) interchangeable Grapples are provided depending on what type of filter bail will be handled. The Grapple Hook is a scissor device which is opened/closed by a solenoid driven shaft and incorporates failsafe features such as spring loading so that the Grapple Hook always returns to the Filter Engaged position. This feature along with the operator's requirement to use a covered pushbutton to open the hook virtually eliminates the possibility of dropping a spent filter during handling. The winch cable and electrical supply, pass through the top access port from their respective supply reels to the Grapple Hook. Both the winch and Grapple Hook are operated by a single pendant to control hoist and hook operation.

A manual sliding drip pan located at the lower most point of the cask body is retracted to allow the filter cartridge to enter the cask. With the filter in place, the drip pan is returned to its operational position such that it will collect residual liquid discharged by the filter during transfer. A valve mounted on the drip pan is used to drain liquids prior to disposal of the filter. A mechanical stop prevents the drip pan from being accidentally removed from the cask.

Working Shields with Central Tool Plugs

The purpose of the working shields is to provide personnel shielding during filter removal operations using minimal operating time. The Working Shield is designed to be placed over the appropriate filter cubicle access hatch when the concrete hatch cover is removed. The shield is constructed of carbon steel with stainless steel jacketing. The shield assemblies provided each consist of a 9 inch and a 3 inch nominally thick section to provide the total shielding thickness required. This enables the assembly to be moved in sections compatible with the rated capacity of the area hoist.

A removable central plug, mounted on an axial bearing, is provided with ports for remote wrench tool insertion. These wrench tools are used to release the filter housing cover bolts while viewing the operation through a lead glass window located within the plug. The plug may be rotated allowing the tools to be located above all bolts at varied bolt circle diameters.

Prior to opening the filter housing, the central plug is removed and replaced with the Transfer Cask bell, in preparation for filter cartridge removal.

The Working Shields are further provided with universal tool ports for the remotely operated Hook Tool, lead glass viewing windows, redundant cubicle illumination and lifting lugs for vertical and horizontal handling. Due to filter housing arrangements, one working shield is provided with additional equipment to be used when opening the housing covers. The additional items consist of a Gapple device, cable mounted from a manual winch and used in conjunction with the Hook Tool.

Drum Shield Assemblies

The function of the Drum Shield is to provide personnel shielding in addition to that provided within the plant's pre-lined (cement) 55 gallon drum, during transfer of spent filters from the filter Transfer Cask.

The Drum Shield is a right circular cylinder with a fully removable top section including approximately 6 inches of the shield cylinder. With the top removed, a portion of the 55 gallon drum is exposed. This allows clearance for the remote operated drum capper, included within the scope of the Mobile Filter Transfer/Capping Station (MFT/CS). The shield's cross section includes 4 1/8" of lead (Pb) sandwiched between 3/8" stainless steel plates. This cross section provides the required total of 6" lead equivalent taking the cement lined drum into account. The shield is provided with top section and body lift lugs. Lift lugs are provided for handling the cover, body or assembled unit. Tie down lugs are provided for stability during transfer on the MFT/CS.

Transfer Cask Cart Assembly

The Transfer Cart Assembly provides mobility to the filter Transfer Cask, tools and Working Shields throughout the pre-designated areas of the plant. The cart is a rechargeable battery powered, motorized, 8,000 pound nominal capacity vehicle. An inch high lip provides containment of any liquids spilled on the cart platform and may be evacuated by a drain at the rear of the vehicle. Travel speed is equal to the operator's walking speed and is controlled by a butterfly switch located on the steering handle.

Mobile Filter Transfer/Capping Station (MFTCS)

The MFT/CS is used in conjunction with the Drum Shield. The assembly is made up of the following major items: A heavy duty motorized cart, pendant controlled remote operated drum capper and capper support structure. Guides are provided on the cart's platform to center and hold down the Drum Shield. A one inch high lip provides containment of spilled liquids as with the Transfer Cart. The drum capper is an air operated device controlled by a hand held pendant. The capper is mounted on a removable structure permitting it to be moved to a position which allows transfer of the spent filter from the cask to the shielded drum or for placement of the Drum Shield top section. The capper is then returned to its functional position and locked in preparation for the capping procedure or final transport.

Hook Tool

This tool is intended to be inserted through the universal tool port to assist in orientation and engaging the Transfer Cask Grapple Hook with the filter cartridge lifting handle. It may also be used to pick up many miscellaneous items within the filter compartment. The Hook is also used for swinging the filter housing cover to the open/closed position. The tool may be retracted such that its end is within the shield plug body. If required, the universal tool port may be removed and the tool completely extracted.

Filter Housing Socket Tools

The filter housing wrenches are modified sockets with extension rods. They are used to tighten/loosen filter housing bolts. The tools and their extension rods are integral. A safeguard is provided to prevent inadvertently dropping the tool into the filter compartment.

SUMMARY & CONCLUSIONS

By working in close association with Georgia Power and Bechtel personnel, and understanding their plant specific needs, ATCOR designed and supplied the components necessary for a totally integrated spent filter handling system. The equipment provided has met its design and operational goals. Extensive reductions in both man-rem exposure and manpower expenditure during filter handling operations have been successfully accomplished in a cost effective manner.