

## **U.S. Spent Fuel Shipment Experience by Rail**

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### **ABSTRACT**

As planning for the large scale shipment of spent nuclear fuel to Yucca Mountain proceeds to address these challenges, actual shipments of spent fuel in other venues continues to provide proof that domestic rail spent fuel shipments can proceed safely and effectively. This paper presents some examples of recently completed spent fuel shipments, and the shipment of large low-level radioactive waste shipments offering lessons learned that may be beneficial to the planning process for large scale spent fuel shipments in the US.

### **SUCCESSFUL SHIPPING CAMPAIGNS**

This paper presents an example of a large radioactive component shipping campaign as well as examples of spent fuel shipments performed commercially by rail. Shipping campaigns discussed include:

**Rail shipment of the Fermi 2 Main Steam Reheaters, shipped in 4 halves, each weighing 126,000 kg (278,000 pounds).** The shipments provide examples of successful rail shipments of components of the approximate size and weight of a commercial spent fuel shipping cask or the yet-to-be-designed transport and disposal cask (TAD).

**Rail shipment of spent nuclear fuel from the Foreign Research Reactor Spent Nuclear Fuel Return program.** Over the past two years, rail shipments of several casks of spent fuel have been successfully completed as part of this Department of Energy Program. Rail shipments of spent fuel have been completed from the Port of Charleston to the Savannah River Site. The shipments provide examples of cask shipments of spent fuel, albeit in smaller casks than will be required for commercial power plant fuel.

## **FERMI 2 MAIN STEAM REHEATERS**

MHF-Logistical solutions (MHF-LS) was contracted to disposition two radioactive Main Steam Reheaters (MSRs), eight bellows, eight reducers, and associated miscellaneous metals removed during Fermi 2's refueling outage with the least impact on site operations. The MSRs were removed during the two-month refueling outage at the plant that ended May 29, 2006. Each MSR originally measured 32.9 m in length (108 feet). Prior to transport, the MSRs were cut in half at the Fermi 2 site and then loaded on four rail cars for the cross-country journey.

Key features of the project included:

- Packaging, transportation and logistics for removal of radioactive/nuclear materials.
- Rail movement of over-dimensional nuclear reactor components during a nuclear power plant refueling outage.
- Turnkey logistics services associated with cross-country movement of 545,000 kg (1.2 million pounds) of materials
- Real-time tracking of MSRs during the 2,740 km (1,700 mile) movement of the components
- Design and installation of a complete packaging and blocking and bracing system to ensure safe and compliant transport of MSRs.

MHF-LS's original scope of work for this project was to move the two MSRs intact, (each measuring over 31 m length x 4.14 m wide [102' in length and 13'7" wide]). Because the MSRs were covered in insulation and cladding, and due to schedule and cost constraints, our customer was not able to remove these materials to reduce the width of the pieces. MHF-LS proposed a solution that involved segmenting each MSR into two pieces, thus, creating four smaller, more manageable pieces for the movement. By reducing the overall length of the components by half, we were able to increase the clearance envelope with the railroad and ship the pieces with the insulation intact. MHF-LS, in conjunction with our customer, was able to develop a plan that encompassed designing, fabricating, and providing four heavy duty flat railcars and steel blocking to secure the four MSR halves onto the railcars for shipment to the disposal location. This work-around was accomplished on a short time frame to keep the project on track with both schedule and budget.

MHF-LS transported the irradiated MSRs from the Plant located in Newport, Michigan to the EnergySolutions facility in Clive, UT,--a distance of more than 1,700 miles (2,740 km) --without incident. The total activity levels for the MSRs ranged from 1.263E+03 MBq to 1.689+03MBq. With a combined weight of more than 545,000 kg (1.2 million pounds), the units were transported by MHF-LS via a flat deck rail car. MHF-LS

developed a turnkey program to package, transport and disposition the MSRs and associated material. The program included pre-planning activities and submittals; mobilization of personnel and equipment; transportation; and final disposition in Clive, UT.



Figure 1: Fermi Main Steam Reheater halves on railcars

The smooth progress of the project was facilitated by designing and pre-installing blocking and bracing before the railcars were shipped to the Fermi 2 site. This helped minimize the impact to the outage schedule, assuring that the MSRs could be loaded directly onto flat deck railcars as soon as the components were available. MHF Logistical Solutions designed and constructed specialized flexible packaging for the shipments of the MSR halves as Surface Contaminated Objects (SCOs). Miscellaneous materials related to the MSR replacement were packaged in Top Loading Cargo Containers with B&B to package and secure the materials.

In addition to the onsite package preparation work, MHF-LS prepared packaging and transportation plans that met stringent security and safety standards for the shipments. MHF-LS was also responsible for completing railroad clearances prior to the rail movement to ensure that the MSRs would move throughout the designated route without delays caused by pinch points.

As an additional security and tracking measure, MHF-LS installed global positioning system (GPS) units on the rail cars transporting the MSR halves enabling us to perform real-time tracking of the conveyances while in transit. Instrumentation packages

containing a satellite antenna, GPS receiver, and long-life battery were secured to rail cars. These instrument packages were programmed to independently send location reports twice daily and could be queried for location as required.

While obviously not a spent fuel shipment, the MSR shipment experience does relate to spent fuel shipping in that the size and weight of the MSRs was roughly equivalent to that of a spent fuel cask. The MSR shipping experience can be added to a significant body of experience shipping large radioactive components safely by rail.

## **FOREIGN RESEARCH REACTOR SPENT FUEL SHIPMENTS**

In 2005, MHF-LS was contracted by NAC International to provide rail equipment and transportation to facilitate the movement of spent nuclear fuel from the Charleston Naval Weapons Complex in Charleston, SC to the Savannah River Storage Site in Dunbarton, SC. This work was in support of the DOE's Foreign Research Reactor Spent Nuclear Fuel Program. Because of the sensitive nature of the material, a "special train" was employed for this project. For this special train service, a locomotive was used to pull only the railcars being used for this move. In addition, MHF-LS ensured that clearances were made all along the route to allow the train to proceed unimpeded to its destination at the Savannah River Site.

The spent nuclear fuel was packaged into intermodal containers [19.1 cubic meters capacity (25 cubic-yards)] by personnel at the Naval Weapons Station. MHF-LS provided four privately owned, 161 tonne capacity (177-ton) flatcars to accommodate the spent fuel packages, and mobilized the rail cars to Charleston in early June of 2005. In order to assure timely and uninterrupted rail movement, MHF-LS coordinated pre-shipment railcar inspections with the CSX railroad as well as representatives of the Federal Railroad Administration. This averted problems encountered with previous shipments when onsite inspection (within the secured boundaries of the shipyard) revealed maintenance problems with railcars forcing their rejection and subsequent offsite repair or replacement. MHF-LS provided a Q-cleared Supervisor for the project who conducted the rail car inspection.

Following the inspection, the railcars were staged at the Naval Complex where two of the cars were loaded with a total of 7 containers (3 on one, 4 on another). As a security measure, the loaded rail cars were "buffered" on either end by two empty cars. A caboose was also added to the train, manned by armed security personnel for the duration of the trip.

Once the rail cars were loaded with the spent nuclear fuel, the MHF-LS Project Supervisor inspected the cars and checked all shipping documents. Upon final inspection of the loaded cars, the Project Supervisor forwarded the bills of lading to the MHF-LS Director of Operations, who then provided rail forwarding instructions to the CSX railroad. To maintain security procedures, the Project Supervisor limited his internal company communications on this project to only one other MHF-LS employee.

The cars were pulled from Charleston on June 8, 2005, and arrived as scheduled at the Savannah River Site, approximately 12 hours later without incident. The containers were unloaded and the railcars were cleared and released back to MHF-LS.

In April of 2006, MHF-LS was awarded a second contract, to provide transportation and logistics services for an additional movement of spent nuclear fuel. As with the first project, the materials were transported from the Charleston Naval Weapons Complex in Charleston, SC to the Savannah River Storage Site in Dunbarton, SC. The materials arrived at the destination on time and without incident. MHF-LS executed the project in the same manner as that employed on the initial successful spent nuclear fuel movement completed in June 2005.



Figure 2: NAC Intermodal spent fuel containers loaded on MHF-LS railcars

This project was completed successfully, even though the sensitive nature of the project cargo presented certain challenges that required careful planning as well as efficient on-the-spot supervision. Because of the level of security required for a spent fuel move, MHF-LS limited our internal communications and administration of these project to two employees—our Project Supervisor (an Executive Vice President of the firm, holding a Q Clearance) and our Director of Operations. All aspects of the project, from the planning phase, to mobilization, to the actual on-site and administrative tasks, were handled by

these two individuals. This additional level of project security dictated that MHF-LS bypass normal operational and administrative procedures. Intensive QC procedures were employed to ensure that all aspects of the project were properly executed, despite the highly restricted level of MHF-LS staff involvement.

An additional challenge that MHF-LS encountered on the projects was the need to correct minor errors on the shipping paperwork, which were noted by the MHF-LS Project Supervisor and Director of Operations. With 30 years of combined knowledge of shipping documentation, the MHF-LS project personnel quickly noted and corrected these errors (listing of an incorrect carrier and an incorrect 24-hour emergency response number and contact). The errors were addressed with our customer and were quickly corrected.

## **CONCLUSION**

The large scale spent fuel shipping campaigns for disposal of spent fuel at Yucca Mountain undoubtedly presents a variety of technical and social challenges. However, there is commercial experience with shipments of similar characteristics (size, weight, radioactivity) to suggest that the challenges can be overcome, and that existing transportation infrastructure and procedures are adaptable to ship spent fuel safely and effectively to Yucca Mountain.