TMI-2 SPENT FUEL SHIPPING

G. J. Quinn and H. M. Burton
EG&G Idaho, Inc.
Idaho National Engineering Laboratory
Idaho Falls, Idaho 83415

ABSTRACT

TMI-2 failed fuel will be shipped to the Idaho National Engineering Laboratory for use in the DOE Core Examination Program. The fuel debris will be loaded into three types of canisters during defueling and dry loaded into a spent fuel shipping cask. The cask design accommodates seven canisters per cask and has two separate containment vessels with "leaktight" seals. Shipments are expected to begin in early 1986.

INTRODUCTION

Significant progress is being made at Three Mile Island Unit 2 (TMI-2) to ship the spent fuel damaged during the 1979 accident. The fuel debris is scheduled for shipment to the Idaho National Engineering Laboratory (INEL) for use in a DOE Core Examination Research and Development Program beginning in March 1986. The fuel debris will not be characterized exactly until it is examined in detail at INEL. Therefore, the shipping cask is being designed using conservative assumptions of failed fuel properties.

To accomplish fuel shipment, several organizations have been working in concert. General Public Utilities Nuclear Corporation (GPU Nuclear) will be providing the vessels (called canisters), for the damaged fuel, loading them with core debris, preparing them for shipment, and loading them into shipping casks supplied by EG&G Idaho, Inc. EG&G Idaho will transport the casks to INEL, unload the casks, and store the canisters for characterization. Westinghouse Electric Corporation is responsible for designing and fabricating the defueling vacuum system and tooling. That equipment will be used by GPU Nuclear to load the core debris into the three types of canisters. This paper briefly discusses each component in the defueling, transporting, and storing cycle for TMI-2 fuel debris.

DISCUSSION

Babcock & Wilcox (B&W), under contract to GPU Nuclear, designed the three types of canisters for TMI-2 core debris. The first type is called the fuel canister and will have a removable lid for remote manual loading of up to full cross-section, partial-length fuel assemblies. The second type is called the knockout canister and will be loaded by the vacuum defueling system. As pieces of fuel debris are vacuumed out of the core, the slurry will flow through the knockout canisters and larger pieces will settle out of the flow stream. The third type is called the filter canister and will process the effluent water from the knockout canisters and filter the small particles from the flow of the vacuum system.

Filled canisters will be moved from the Reactor Building to the spent fuel pool of the Fuel Handling Building for storage and preparation for shipment. To ensure a safe shipment, controls have been established to control the combustible mixture of gas which could accumulate in canisters. Radiolytic decomposition of water left in the fuel debris has the potential of generating hydrogen and oxygen. To ensure that gas generation does not accumulate during shipment, each canister will be dewatered before loading into the rail cask. In addition, the catalytic recombiner system installed in each canister will be monitored, and the canisters will be leak-checked and inerted.

The TMI-2 canisters will be loaded into the spent fuel shipping casks using a transfer cask system. The dry loading concept using the transfer cask system reduces the time required for loading the shipping cask by eliminating decontamination that would be performed for casks loaded underwater.

Nuclear Packaging, Inc. (NuPac) will supply the two rail shipping casks which can each accommodate seven canisters. Each of those casks will have a separate inner containment vessel placed within the outer vessel. The shipping package will have two levels of containment in addition to the containment capability provided by the canister itself. The "leaktight" seals on each cask containment vessel will have a leakrate of 10^{-7} atm-cc/s as specified in ANSI N14.5. That low leakrate is necessary, because characteristics of the fuel debris in the canisters are not well known. The "leaktight" seals are a conservative design measure to account for the fact that there are not well known isotopic and particle size distributions for the fuel debris. Determining such distributions will be a part of the Core Examination Research and Development Program, but the first consideration is the ability to ship the debris for examinations. "Leaktight" seals provide state-of-the-art sealing for reusable shipping containers and permit materials to be shipped that have extremely low calculated allowable leakage rates. Testing seals of the cask will be performed in low radiation fields to verify that the seals are assembled correctly. Shield plugs are provided inside the inner containment vessel above the fuel canisters and reduce dose rates during seal testing. Those plugs and internal energy absorbers above and below each fuel canister reduced the allowable length of the canisters to 150 inches.

The internal energy absorbers, together with the external energy absorbers at each end of the cask, will ensure that impact loads to the canisters are well below the design criteria. The canisters are designed to maintain structural integrity for criticality control up to 40g axial and 100g lateral loadings during hypothetical drop accident conditions

(30-ft drop). The Transportation Technology Center of Sandia National Laboratory will perform a drop test on a scale model cask to verify load predictions and provide the public with a readily understandable demonstration of the safety of the shipping cask.

In addition to withstanding accidental drops, the cask is designed to limit temperature increases to the canisters and contents in case of a fire. The cask will have a wire wrapped thermal shield of thin stainless steel encasing the cask body. The design will ensure that, if the cask is subjected to a fire accident condition, the design pressures for the containment vessels will not be exceeded.

After the two loaded rail casks are bolted to railcars, they will be shipped to INEL. At INEL, the cask and transport skid will be removed from the railcar, placed on a truck transporter, and transported to a research facility, the Hot Shop of Test Area North. At the Hot Shop, the cask will be uprighted and each canister remotely unloaded. The canister will be removed and placed in a storage rack, which, when full, will be moved to an underwater storage location in the Water Pit of the Hot Shop (storage pool). The canisters will be vented passively to remove radiolytic gases generated by the decomposition of water. As canisters are selected for examination, they will be removed from the Water Pit and transferred to the TAN Hot Cell.

Although the original TMI-2 core contained 177 fuel assemblies, each canister may contain up to the weight of approximately one original fuel assembly. That means there will be more than 177 canisters. Indeed, the shipping plan is based on 238 canisters, because the canisters are shorter than the length of the fuel assemblies and may not be able to hold the volume of an original assembly. The two rail casks will be transported on one train to and from Idaho. A round trip may take up to 2 months, including loading and unloading time. For 17 round trips, almost three years will be required to complete the shipping campaign.