OCRWM CASK SYSTEM DEVELOPMENT PROGRAM

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ABSTRACT

The Department of Energy's (DOE) Office of Civilian Radioactive Waste Management (OCRWM) is in the process of planning, developing, designing, and certifying a series of casks that will be used to transport spent fuel and high-level radioactive waste from the commercial nuclear power plants and other storage facilities to federal waste management facilities. The certification process will involve review of each cask design and issuance of a Certificate of Compliance (CofC) by the Nuclear Regulatory Commission (NRC). The DOE is currently developing one legal-weight truck cask and one 100-ton (91-tonnes) rail/barge cask scheduled to accommodate a 1998 start up of OCRWM spent fuel acceptance. OCRWM is also pursuing specific beneficial cask design features under two other cask contracts. This paper will discuss the development of these casks that are being carried out by General Atomics and Babcock & Wilcox (B&W), specific beneficial cask design features, supporting technical activities, and OCRWM's activity with regard to the storage/transport compatibility issue.

INTRODUCTION

The DOE has been authorized under the Nuclear Waste Policy Act (NWPA) of 1982, and its 1987 amendment, to develop a national program for the disposal of spent nuclear fuel and high-level radioactive waste. The OCRWM was created within DOE to carry out the legislative mandate of the NWPA. One of the responsibilities derived from the NWPA is to provide a means of transporting the waste material from existing storage sites (i.e., reactors and other storage facilities) to Federal Waste Management facilities (FWM) beginning in 1998. Because a repository will not be ready by 1998, OCRWM is planning to accept spent fuel at an interim Monitored Retrievable Storage (MRS) facility starting in 1998. The plan also anticipates development of a fully operational MRS by the year 2000. Subsequent movement of the waste from the MRS to a final disposal site is presently planned to commence around the year 2010. The NWPA, as amended, requires that transport of spent fuel be subject to licensing and regulation of NRC and the Department of Transportation (DOT).

To meet the transportation requirements of the NWPA, as amended, OCRWM has established a transportation program comprised of two phases, as described in the 1986 Transportation Business Plan (1). Phase I includes design and development of a series of casks, development of support facilities and operational planning, economic and system analysis, and institutional interaction. Phase II includes procurement of a fleet of casks, arranging carriage activities, maintaining equipment, inspecting equipment, planning and scheduling operations, training operating personnel, and continued institutional interaction.

The cask system development activities of Phase I have historically been planned to be carried out under four initiatives. The first initiative covers development of spent fuel casks for shipment from reactors, hence, from-reactor casks. The second initiative is development of a from-MRS cask if an MRS is established. The third initiative covers development of specialty casks for non-standard fuel and certain irradiated hardware and components. The fourth initiative is development of a defense high-level waste cask.

Current cask development activities are concentrating on the first initiative, development of from-reactor casks. OCRWM decided to develop new casks under Initiative I for a number of reasons, two of which were payload efficiency and the availability of a sufficient number of casks.

The spent fuel to be shipped under the NWPA is expected to be older and cooler than that used as a design basis for the current generation of spent fuel casks; therefore, resulting in less heat to be dissipated and a reduced need for gamma shielding. This will significantly contribute to increased capacity and achievement of higher payload-to-weight ratio. Furthermore, due to regulatory restrictions on most of the existing certified cask designs, no additional casks could be fabricated according to those certified designs. Consequently, OCRWM decided to develop a new generation of casks to transport spent fuel and high-level waste under Initiative I of the cask procurement program.

Five preliminary cask designs for legal weight truck (LWT) and rail/barge (R/B) modes have been completed under Initiative I. Two of the designs are for LWT casks, and the other three are for R/B casks. Two of the five designs

were selected for full funding through final design. The two designs are a LWT cask by General Atomics (GA) and a R/B cask design by Babcock & Wilcox (B&W). Two designs, a LWT cask design by Westinghouse Electric Corporation (WEC) and a R/B cask Design by Nuclear Assurance Corporation (NAC), were selected for emphasis on their special features. Both WEC and NAC were directed to focus their efforts on developing only the unique features of their designs.

TRUCK CASK DESIGN

GA is developing two dedicated LWT cask designs, one for shipment of Pressurized Water Reactor (PWR) spent fuel and the other for Boiling Water Reactor (BWR) spent fuel. The GA-4 is being designed to carry 4 PWR spent fuel assemblies and GA-9 is being designed to carry 9 BWR spent fuel assemblies. Both designs, as shown in Fig. 1 and Fig. 2, are very similar, but differ only to accommodate different fuel geometries and their somewhat different radiation spectra.

The main external difference is that the GA-9 packaging is about 26 centimeters longer than the GA-4 packaging. The GA-4's overall dimensions are 2.28 meters in diameter by 5.93 meters long. The GA-9 has the same overall diameter as the GA-4, but its overall length is 6.19 meters. When loaded with maximum design weight fuel, the GA-4 and GA-9 packages each weigh approximately 24.5 tonnes. Both casks have square rather than the more common circular cross sections, and both are XM-19 stainless steel structures with depleted uranium for gamma shielding. Both casks have external solid neutron shield made of a 1%-borated polypropylene. The fuel support structure for both casks is removable and is constructed of stainless steel. The impact limiters, closure bolts, closure O-rings, leakage test ports, gas sample penetrations, and drain penetrations for the two casks are identical. Both the GA-4 and the GA-9 cask designs have the capability of achieving leaktight containment. Burnup credit is used for GA-4 (PWR cask) but not for the GA-9 (BWR cask) (2).

As a part of the design package, GA is developing a special semitrailer that will satisfy the 4-tonnes weight limit for the semitrailer. GA has selected a single drop configuration semitrailer for its low center of gravity that will provide greater stability. The GA-4 and GA-9 casks will each have their own dedicated single drop semitrailer due

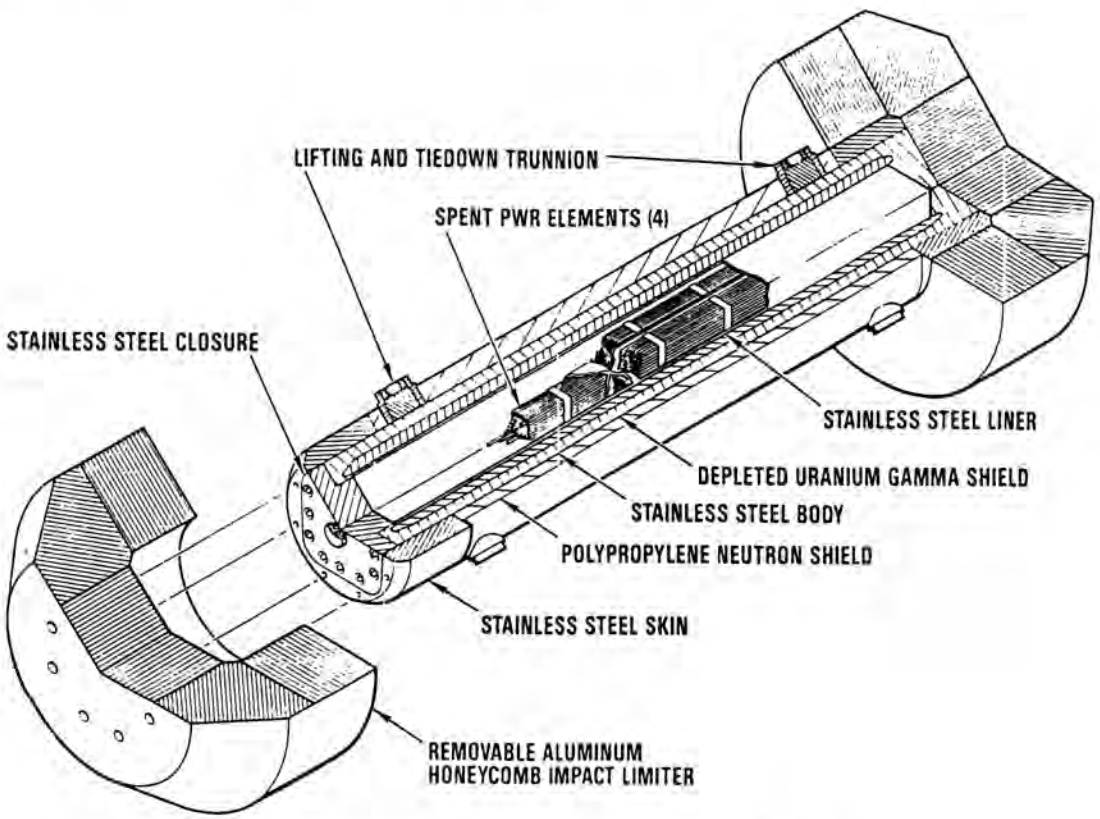

Fig. 1. GA-4 Legal Weight Truck Shipping Cask.

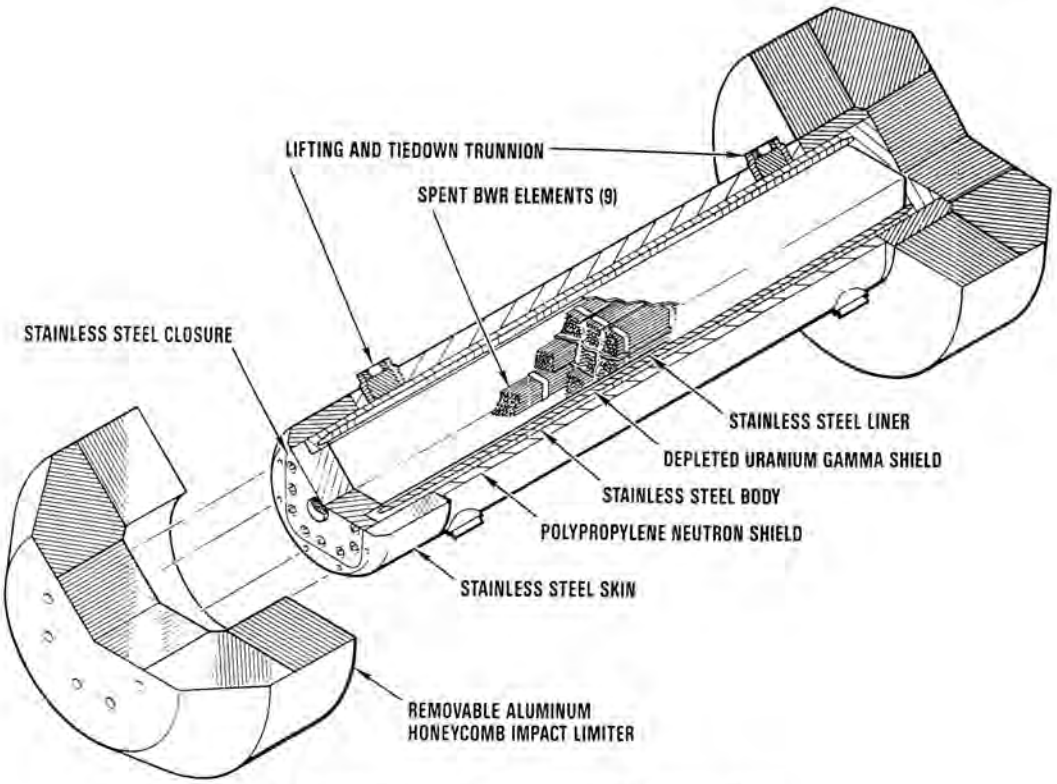

Fig. 2. GA-9 Legal Weight Truck Shipping Cask.

to difference in cask trunnion spacing and weight limitations.

RAIL/BARGE CASK DESIGN

B&W is developing the BR-100, a common use R/B cask (i.e., one cask with interchangeable baskets for PWR or BWR fuel assemblies). The cask design capacity is 21 PWR or 52 BWR assemblies. The cask design has a circular cross section and a stainless steel structure with a lead gamma shield, as shown in Fig. 3. Shielding for neutron is provided by an internal neutron/thermal shield made of borated concrete. The BR-100 with impact limiters has an overall length of 6.39 meters, a diameter of 3.20 meters, and weighs about 92.4 tonnes for the heaviest payload. The cask design uses a fully recessed closure head. Burnup credit is used for the PWR configuration, but not for the BWR configuration. In addition, boral is used in the stainless steel basket for criticality control. The basket also includes a layer of copper for better heat transfer purpose. The cask is a leaktight design. The impact limiters are made of low and high density balsa and are encased in Kevlar with a thin outer shell of steel (2).

B&W is designing a railcar based on American Association of Railroads (AAR) specifications and the Federal Railroad Administration (FRA) requirements. The railcar has an overall length of 14.47 meters, a width of 3.2 meters, and an overall height of 4.34 meters. The estimated weight of the railcar is 20.4 tonnes, and the Gross Vehicle Weight (GVW) of the railcar/skid/cask package will be close to the 263,000 lb. (119.30 tonnes) limit when loaded with the heaviest design payload.

BENEFICIAL DESIGN FEATURES

As mentioned above, WEC's and NAC's activities are concentrated on the development of some specific design features identified by DOE. They are both performing these activities under reduced funding, and each contractor has a feature that could prove very beneficial to the OCRWM program.

WEC's activities are directed toward demonstration of the acceptability of their proposed titanium material for transport casks. The benefit in using titanium alloys for cask construction is the substantial weight savings due to titanium's high strength-to-weight ratio. The particular titanium alloy proposed by WEC for use in cask fabrication has not been approved as a structural material in the United States. Therefore, WEC's task is to demonstrate the acceptability of titanium to NRC. The first step in this process is to gain approval of the titanium alloy as an American Society of Mechanical Engineers (ASME) code material. The ASME Main Committee has approved, by letter ballot, the titanium grade 9 code case submitted by WEC. The next

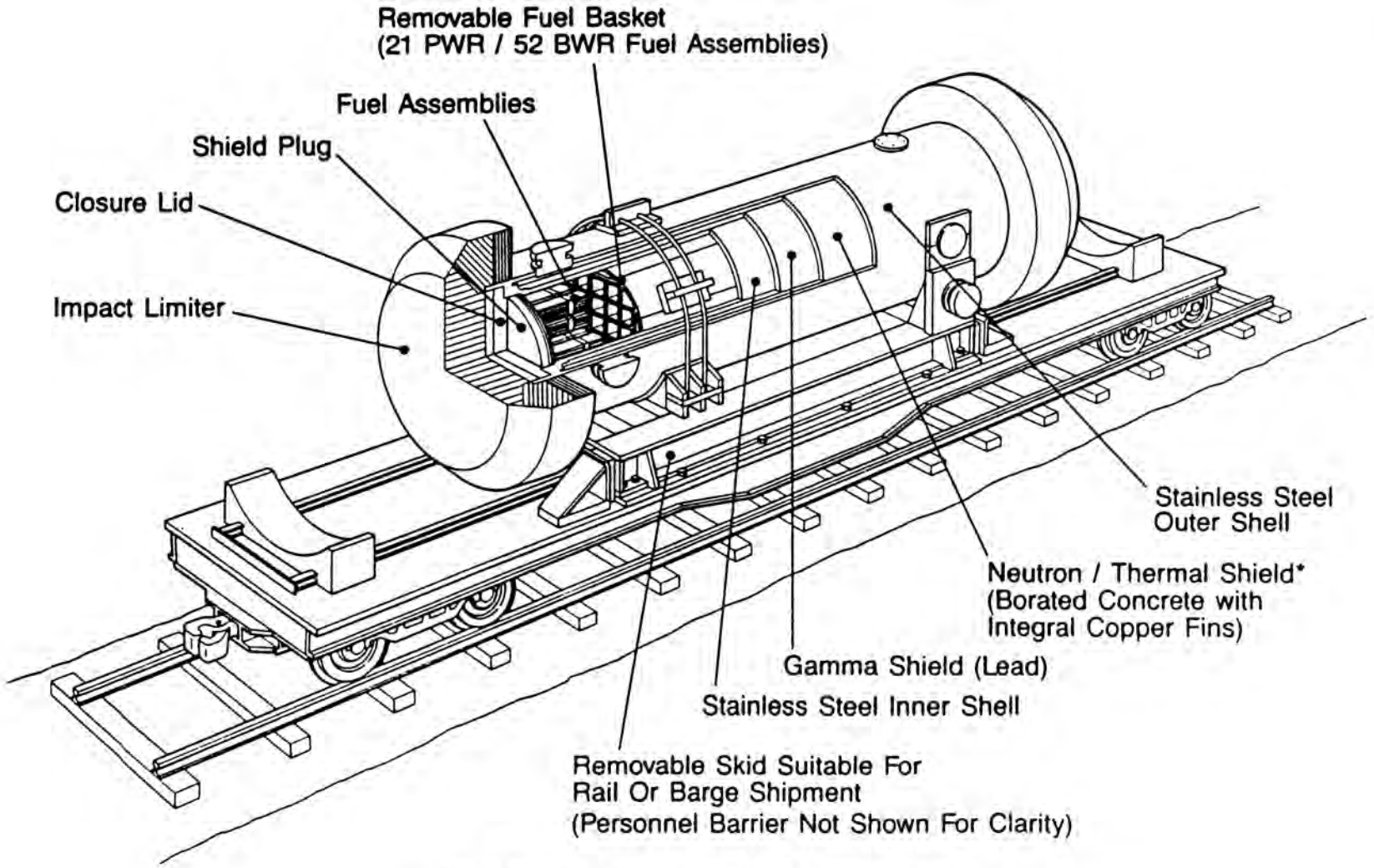

Fig. 3. Babcock & Wilcox Br-100 Ton Rail/Barge Cask.

step in the approval process is a letter ballot from the ASME Supervisory Board of Nuclear Codes and Standards.

The wedge-loc closure system proposed by NAC for their cask would significantly reduce cask turnaround time. This innovative feature is the subject of NAC's development efforts. NAC's wedge-loc closure is a hydraulically actuated device that offers an alternative to the popular bolted-closure systems for a more efficient method to open or close a cask. While the process of opening or closing a 100-ton R/B cask is estimated to take about two hours, the opening or closing process for the wedge-loc closure is estimated by NAC to take 10 to 15 minutes. The result would be reduced worker exposure and reduced operation costs. NAC is presently in the process of preparing for fabrication of a prototype model. The prototype wedge-loc closure will be used for non-destructive testings and demonstration of its operability.

OTHER TECHNICAL ACTIVITIES IN SUPPORT OF CASK SYSTEM DEVELOPMENT

In order to assist the cask designers in the cask certification process, OCRWM, through the DOE Idaho Operations Office, is supervising work by Sandia National Laboratories (SNL) related to technical issues resolution; development of systems, components, and concepts; applied technology; and testings. The technical issues which have been identified as having major impact on the cask development program and are under investigation are burnup credit, source term evaluation, and cask contamination or "weeping."

Burnup credit is a means of taking into account the depletion of the fissile material and generation of poisonous fission products in a spent fuel assembly for the purposes of criticality analysis in designing shipping casks. The implementation of burnup credit in a cask design results in an increase in cask capacity. This will result in decreased risk to the public through a reduction in the number of spent fuel shipments that are required. OCRWM is looking into approaches for implementing burnup credit for transportation of spent fuel and has had several meetings with the NRC regarding this subject. SNL is heading up a task group which also includes participants from Oak Ridge National Laboratory (ORNL) and Pacific Northwest Laboratory (PNL). The task group is conducting numerous studies to increase the information on spent fuel characteristics, criticality safety analysis methods, and methods for the physical measurement of spent fuel burnup. At the same time they are conducting verification activities through destructive assay of spent fuel assemblies.

The source term evaluation activity is being conducted to better identify the dispersibility and quantity of radioactive material that could be available for release from a spent fuel cask under normal and hypothetical accident of transport. This quantity is a key element in determining the sensitivity of the leak test required before each shipment. The NRC has established regulatory limits on the total quantity of radioactive material that can be released under both normal and accident conditions. In the past, little effort has been placed on determining the actual activity which would be available given the fuel characteristics that limit the potential for radioactive material release. This activity will develop a standardized methodology for determining this total available activity that accounts for the characteristics of the spent fuel (eg. chemical, physical, and particle properties of the individual radionuclides) that affect the potential for radioactive release. The source term evaluation will also apply this methodology to the fission and activation products associated with the material deposited on the spent fuel assembly (e.g., crud).

"Weeping" is a term used to describe the problem encountered when a cask begins spent fuel transport with acceptable levels of removable surface contamination only to arrive at its destination with levels above regulatory limits. OCRWM is presently investigating the causes of weeping. Methods to prevent and correct for weeping effects are under development at SNL.

OCRWM has embarked on a number of activities in support of cask system design, development, and operation. These activities include exploring the use of advanced robotic systems to perform cask handling operations at radioactive waste handling facilities. The results of this investigation would provide guidance to the cask designers regarding the impact of robotic handling on cask design. Other activities include further development of the materials which have been proposed by the cask designers for their cask designs. The development activities include characterization of materials such as depleted uranium, ferritic steel, and borated materials. Investigation of cask closure seals behavior over temperature ranges expected under normal and accident conditions of transport is also among the activities for supporting the cask system development efforts. This activity includes: evaluation of different elastomeric, metal, and composite seals; investigation of new seal geometries; preparation of design guidance for selecting seal configuration; and developing tests to verify manufacturer's seal performance data.

OCRWM'S EFFORT IN STORAGE/TRANSPORTATION COMPATIBILITY

Presently, OCRWM is planning to use the from-reactor casks solely for transporting the waste from storage sites to the MRS facility. The casks would be loaded at reactors with the spent fuels that are presently stored in the pools, and they would be transported to the MRS. After the casks

arrive at the MRS, the spent fuel would be unloaded and placed into an storage system.

With the increased deployment of at-reactor dry storage systems by utilities, OCRWM is developing its cask systems with storage/transportation compatibility in mind. One of the at-reactor storage systems that may have the potential to be also used for transporting the waste and are being deployed or will be deployed by a substantial number of utilities are Multiple Element Sealed Canister (MESC) system (3).

MESC system includes a canister that is loaded with spent fuel assemblies, drained and vacuum dried, backfilled with an inert gas, sealed, and placed in an outside-pool concrete storage module. An example is the NUHOMS system that is designed, fabricated, and licensed for storage by Pacific Nuclear Fuel Services (PNFS). OCRWM is participating in a cooperative program that would qualify the NUHOMS dry shielded spent fuel storage canister (DSC) for off-site transportation in accordance with the requirements of 10 CFR 71. The certification of NUHOMS' DSC for transport under the requirements of 10 CFR 71 would facilitate the direct transfer of the DSC's from the storage system directly into a transportation cask for off-site shipment, thus eliminating the need for returning the canister that contains the spent nuclear fuel to the plant's spent fuel pool. This minimization of spent fuel rehandling would benefit both the utilities and OCRWM's waste management system. The project involves performing the necessary engineering analysis, design, and licensing tasks for the NUHOMS DSC, which is presently licensed for storage applications under 10 CFR 72, and to *submit* a topical report licensing document to NRC for approval. A topical report for qualification of the NUHOMS's DSC, based on a conceptual design of a transport cask, is being prepared and is planned to be submitted to NRC in April of 1991 by PNFS.

CONCLUSION

GA and B&W are in the final design phase and are expected to submit the safety analysis reports (SARPs) for their designs to NRC in the beginning of 1992. The CofC for the designs are expected to be issued by NRC within two years after the submission of the SARPs. In addition, OCRWM is supporting the efforts in making the at-reactor dry storage systems compatible with the transportation system to the extent possible. OCRWM is confident that will have efficient, reliable, and certified casks by 1998 for carrying out the mission required by the NWPA.

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