Development of On-site Spent Fuel Transfer System Designs

R. W. Lambert
Electric Power Research Institute, Palo Alto, California, USA

C. W. Pennington and G. V. Guerra
Transnuclear, Inc., Hawthorne, New York, USA

INTRODUCTION

Since the passage of the Nuclear Waste Policy Act (NWPA), nuclear utilities have recognized that spent fuel storage was to be a growing concern that would have major operational and economic impact on their nuclear plants. R&D was initiated some ten years ago to develop safe, economical and licensable dry storage technologies that would meet the growing on-site storage requirements.

As development work progressed, it became clear that utilities favored storage that could be added in modular fashion in order to avoid large up-front capital costs. On the other hand, it also became clear that in order to reduce unit costs and minimize the plant operational impact, the modules should be relatively large. Based on the limiting size of cranes and plant facilities, the optimum module size was found to be packages that held about 21 to 24 PWR fuel assemblies. This resulted in shielded packages, either concrete or metal, that ranged from 100 to 150 tons in weight. In the case of concrete, it also required a large diameter package that challenged many plants' handling systems.

The result was that many utilities with smaller cranes or other plant restrictions could not take advantage of the larger module storage designs. Given this incentive, EPRI began to explore the possibility of using the concept of a small-cask-to-large-cask transfer as a way to allow all utilities to make use of the larger storage modules and their favorable economics.

It was soon apparent that such a transfer technology could have other NWPA applications. For instance, it may be possible to ship a greater proportion of fuel in more efficient large rail casks by using a small-cask transfer system at the restricted plants. Also in the scenario of early receipt at a Monitored Retrievable Storage (MRS), before all the facilities are fully in place, it looked promising to make a small-cask transfer from a transport cask into a large storage system using similar transfer technology.

EARLY WORK

EPRI took the early technical lead by initiating two small-cask-to-large-cask projects. The first was a "considerations" study to develop the criteria that would be needed in order to make a transfer system both acceptable for routine utility use and also have a high probability of being licensable by the NRC. This study was performed in 1989 by S. Levy Inc., with R. H. Jones as a subcontractor. This work documented some 38 safety, operational, and licensing considerations that need to be addressed in designing a transfer system.

The second EPRI activity was to complete preliminary designs for a transfer system. Both Transnuclear (TN) and Babcock & Wilcox were involved in this work. The key objective of the projects was to determine the technical, economical and operational practicality of the concept. This phase of work was completed in 1991 and reported at the 1991 International HLW Management Conference in Las Vegas, Nevada. Transnuclear was selected as the contractor to pursue additional EPRI transfer system work.

CURRENT ACTIVITIES

Based on the promising results of the EPRI preliminary design studies, the decision was made by EPRI to move to the next phase of the work by attempting to develop cooperative programs with DOE and possible host utilities, whereby a detail design and a full-scale hardware demonstration could be accomplished. DOE interest in the technology stems from its potential use at an MRS or in facilitating transportation of spent fuel.

Through a series of events in 1991, a program involving DOE, Sacramento Municipal Utility District (SMUD), and EPRI was structured in which a dry transfer system would be designed for possible use at SMUD's Rancho Seco site. EPRI's role is to share with DOE the cost of designing the dry transfer system and to fund the development of the Program Test Plan, the collection and analyses of test data, and the reporting of the demonstration results. EPRI will be responsible for managing the transfer system design project. Based on the earlier work done by TN for EPRI, TN was selected to design the new transfer system.

It was determined by EPRI that additional scoping work was necessary in order to better plan the SMUD project. TN was therefore funded to perform two additional scoping evaluations of alternative transfer system scenarios to determine how system designs would be affected by differing scenario variables.

The first follow-on task was called "Scoping Evaluation of Alternative Spent Fuel Transfer Concepts" and the impacts of assuming variations in the following variables were evaluated:

1. Where the transfer is to be made

    - inside the reactor building (in-plant)
    - outside the reactor building but within the restricted area (on-site)
    - outside of the regulated area (off-site)

2. The degree of canistering of the fuel

    - single uncanistered assemblies
    - multiple assemblies in an unsealed transfer basket
    - multiple assemblies in a sealed canister
    - fuel in a vented canister

A simplified summary of the study results is as follows:

- In-plant transfers offer some cost saving over on-site transfers because of the availability of services such as access to ventilation systems, etc. Avoidance of constructing an external transfer facility would also achieve substantial cost savings. Public acceptance would also likely be facilitated.

  On the downside, however, it must be noted that not many reactors have in-plant space to perform such work and an optimum system design would be difficult to achieve.

Additionally, the routine impact on plant operations would be significant and in the event of an off-normal occurrence, such as a contamination release, the operational impact could be substantial. Also, the building and equipment would have to be maintained after the reactor had been decommissioned in order to effect fuel transfers.

- For the variable of canistering, the study indicated that it is a matter of trade-offs. For virtually any degree of canistering, sealed or unsealed, the transfer system benefits substantially. On the other hand, however, a major burden is added both to the reactor plant where the canistering must be done and to the remainder of the fuel disposal system where shipping efficiency is reduced and fuel repackaging is likely to be necessary. It is also evident that while fully sealed packages would be a major help in licensing, they would greatly complicate the system design and add substantially to the cost. Should a canister approach be pursued, a vented canister appears to be the most practical concept.

The conclusions of this evaluation suggested that alternative concepts may have merit for certain specific plants, but that the original storage reference case that assumed the transfer of uncanistered fuel in an on-site facility was a reasonable choice.

The second follow-on task by TN was to explore the degree to which a transfer system could best serve multiple roles such as an MRS, a shutdown reactor such as Rancho Seco, and the generic reference on-site storage case. This work was titled "Design Implications of Using Spent Fuel Transfer Systems at the MRS and Shutdown Reactors." The object of this study was to identify the unique needs of each different scenario and determine the degree to which it was practical to accommodate them in a single design.

During the course of the study, it soon became clear that the Rancho Seco requirements would necessitate major revisions to the reference design developed in the previous EPRI work. The primary need for a transfer system at Rancho Seco is to permit the plant to proceed with decommissioning, including shut down of its spent fuel storage pool. A transfer system would allow this to occur by providing a way to recover from a storage cask problem without returning the cask to a pool. Also, it would allow fuel to be transferred into a licensed transportation cask for off-site shipping, should the need arise.

In consideration of these factors, the DOE/SMUD/EPRI program was modified to include an on-site separate transfer facility that accommodates two large storage or transport casks. Relative to the MRS needs, the proposed design is appropriate in that it handles two large casks and has the potential for achieving relatively high through-put rates. The system also fits the MRS needs by being readily adaptable to long-term, continuous production-type operation. One additional advantage of the proposed concept is that this transfer system design requires less innovative hardware than the original TN preliminary design and does not require a specialty transfer cask with the complications of bottom loading.

A schematic of the presently conceived transfer system is shown in Figure 1. Typically, the transfer facility is a concrete structure consisting of two principal sections:

1. The Transfer Confinement Structure (TCS) at the upper level

2. The access area for source and receiving casks at the lower level.

One function of the TCS is to provide the confinement boundary that isolates the source and receiving casks. Plans are that fuel will be transferred using a lightly shielded transfer tube inside of a simple, moderately shielded transfer cell. The top of the two casks will be mated to the bottom of the cell. The upper level also contains the cameras and lighting used to monitor movement of the fuel and the

DRY TRANSFER CONCEPT

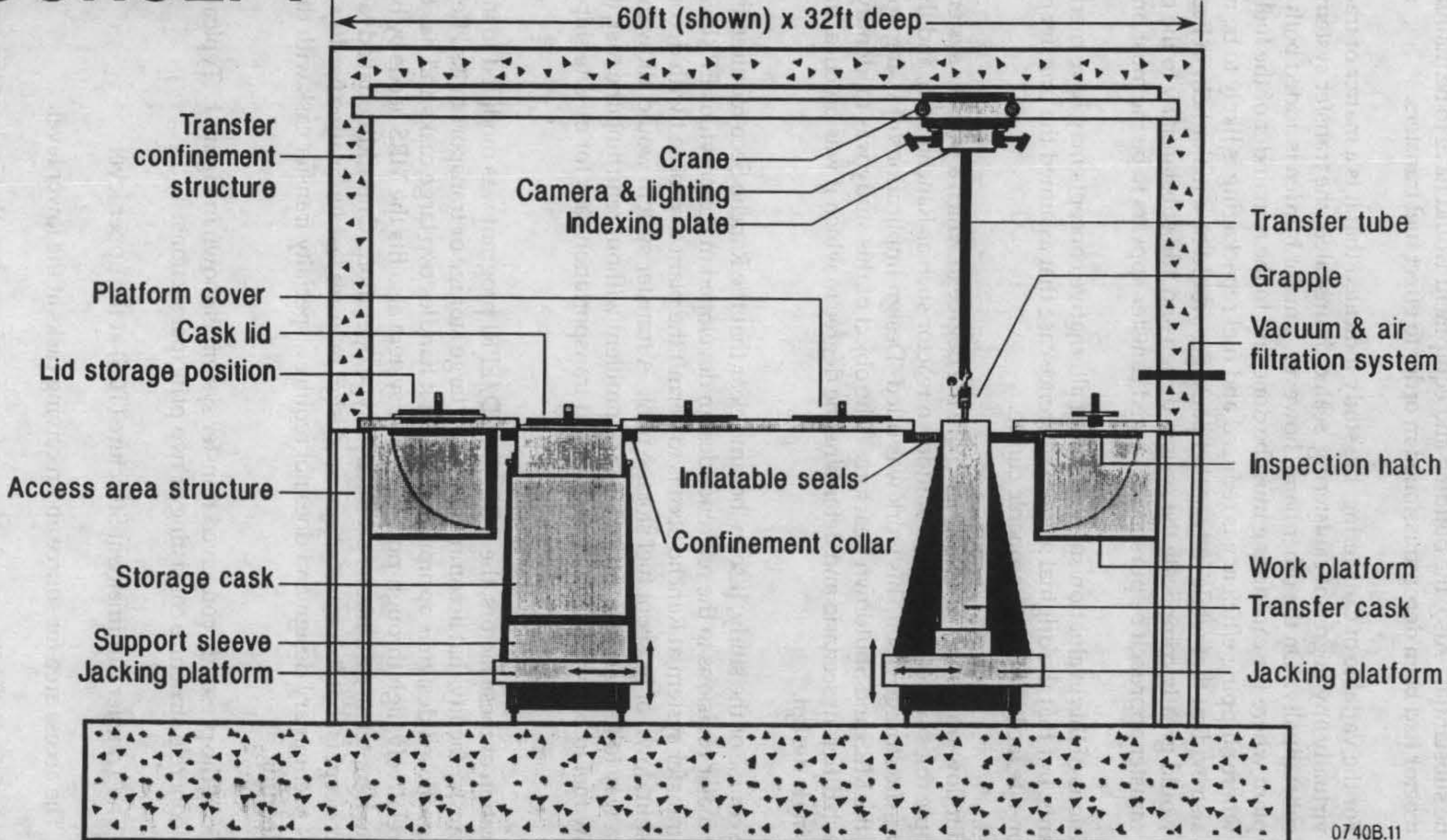

FIGURE 1

hoists and grapples necessary to execute the fuel transfer. During the transfer, the equipment must also perform the following functions:

- support and align the fuel assemblies or canisters during removal from the source cask and insertion into the receiving cask basket;

- restrict the fuel or canister motion during transfer within the TCS;

- minimize the contamination spread during fuel or canister movement.

The lower access area will be used to bring in the casks, position and seal the casks into the upper cell access ports, and perform various operational steps that are part of lid removal and replacement. While the upper area is expected to become lightly contaminated, the lower area will be maintained as a clean zone.

PROGRAM STATUS

As of September 1992, the program is still in the planning stage with the cooperative agreements between DOE, SMUD and EPRI not yet in place. It is anticipated that these will be completed by the end of the year. The detail design phase is projected to last about 12 months, and this will be followed by a cold demonstration of the key engineered equipment used in the transfer system. As part of the design scope, documentation will also be assembled into a package that will meet the requirements for an NRC license application.

EPRI and TN have been involved in the development of the on-site transfer system concept for nearly four years, and it now appears that it is on the road to becoming a reality. While past experience has shown that multiple-party, cooperative programs can be complicated and slow to develop, they also have the potential for delivering substantial rewards. Both EPRI and TN look forward to working with DOE and SMUD in making the fuel transfer system a success.