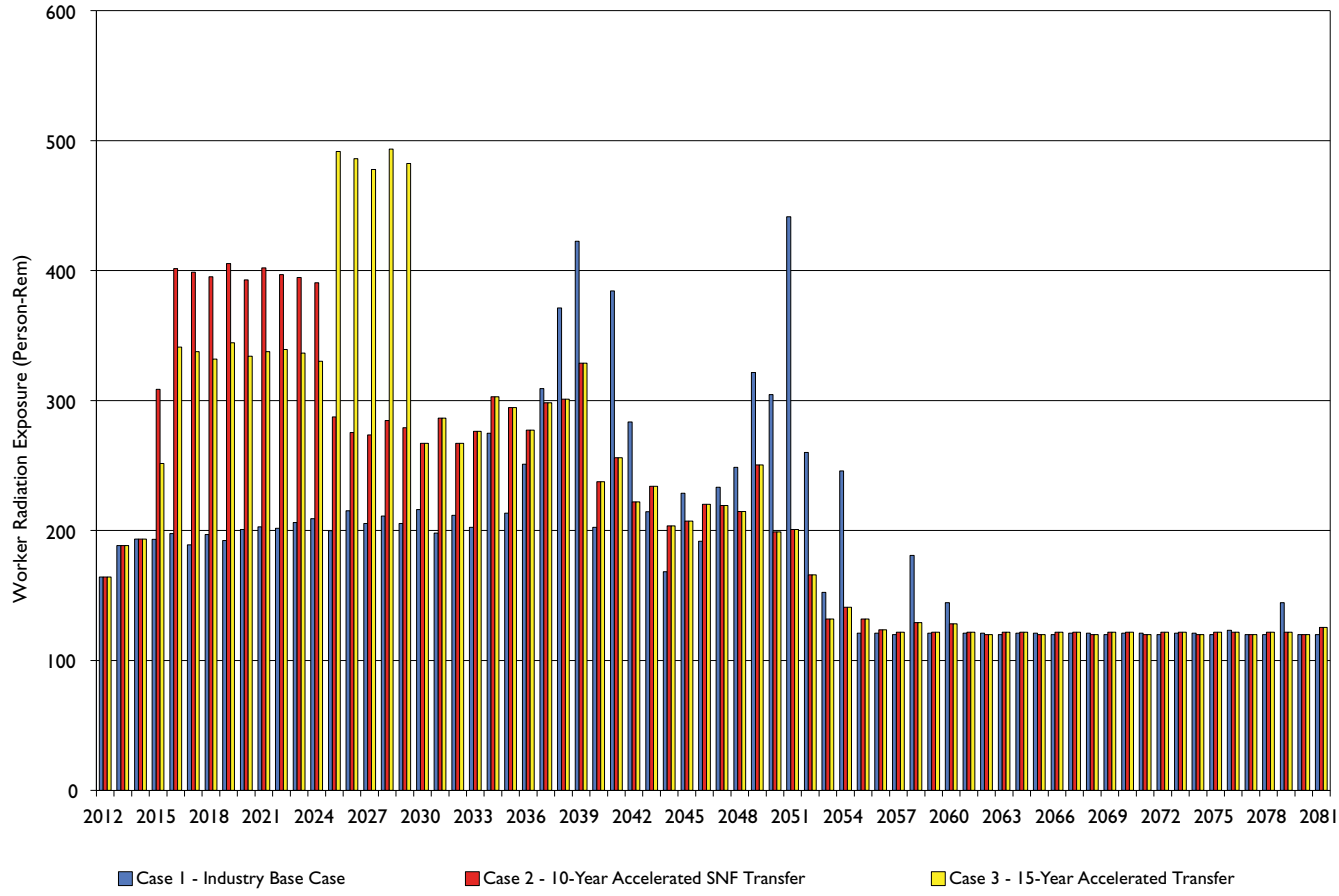
SPENT NUCLEAR FUEL

Risks and benefits of accelerated fuel transfer examined

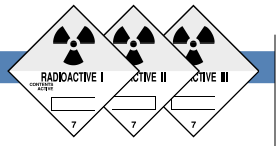
THE DAMAGE TO the spent fuel pool at Fukushima Daiichi's Unit 4 has renewed calls from public groups and policymakers to speed up the transfer of spent nuclear fuel from overcrowded pools to dry casks, which they see as inherently safer. That assumption, however, is questioned in recent reports from the Electric Power Research Institute (EPRI) and the U.S. Government Accountability Office (GAO).

Much of the public sees the accelerated transfer of spent nuclear fuel to dry storage as the safe thing to do, but two reports highlight the downsides of such a strategy.

According to the EPRI report, *Impacts Associated with Transfer of Spent Nuclear Fuel from Spent Fuel Storage Pools to Dry Storage After Five Years of Cooling, Revision 1,* it is uncertain whether the potential risks of the accelerated transfer of



A comparison of industrywide worker radiation exposure using the industry base case, a 10-year transfer program, and a 15-year program. (Graphs: EPRI)



spent fuel from spent fuel pools to dry storage would outweigh the benefits.

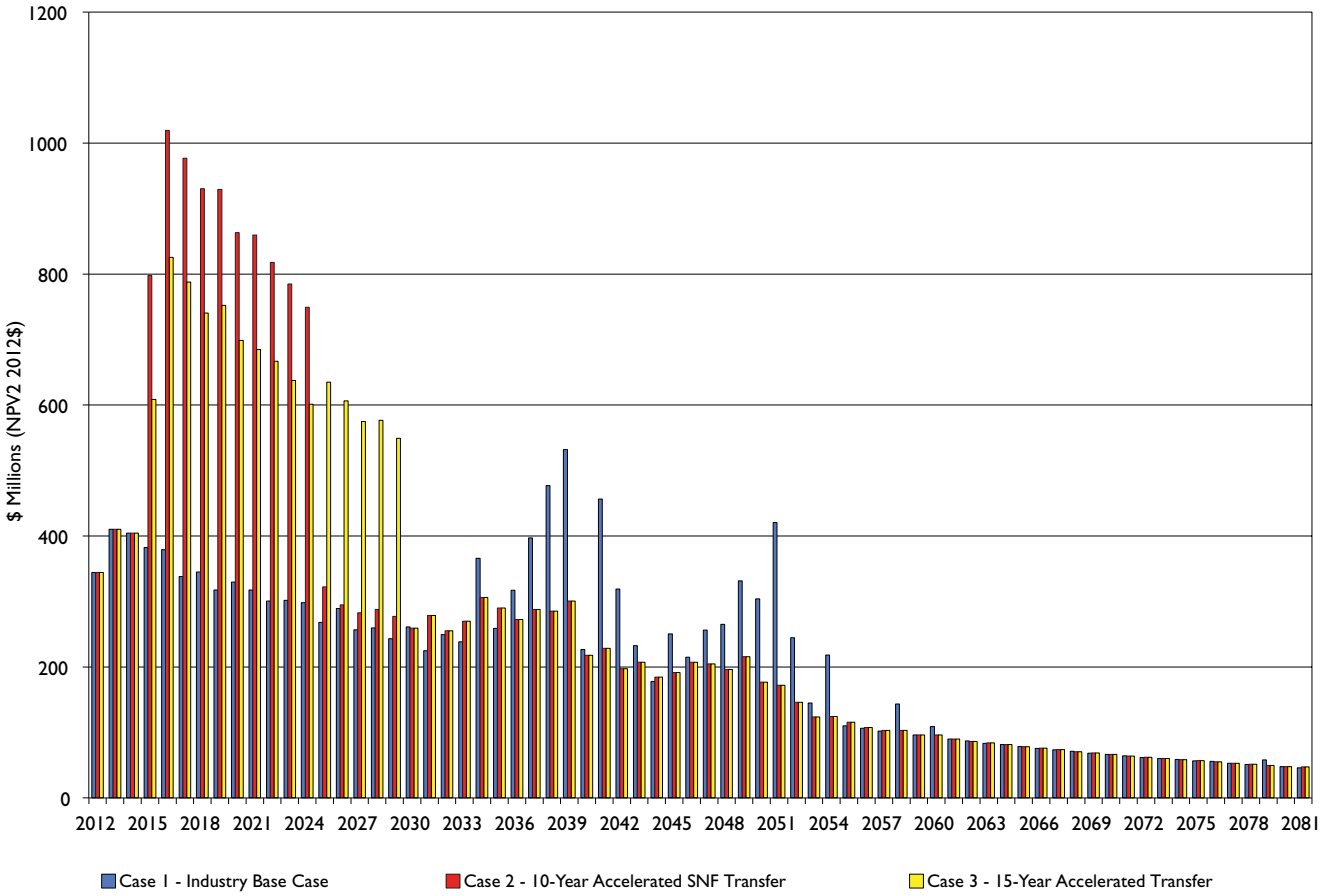
While moving spent fuel to dry storage early would have the benefit of reducing spent fuel pool inventories, thereby reducing pool decay heat and potential source term, the study found significant risks in increased radiological exposure to workers, as well as increased costs to the U.S. nuclear industry.

The report, published on August 31 and released on September 13, updates a 2010 EPRI report on a study that was done in response to perceived vulnerabilities of nuclear fuel pools to terrorist attacks following the events of September 11, 2001 (*NN*, Jan. 2011, p. 63). That study assumed that the transfer of five-year-cooled irradiated fuel from pools to dry casks could be done in five years. The new study, based on industry feedback, used a more realistic time frame of 10 to 15 years.

The revised study and report also reflect the "renewed calls from policymakers, individuals, and organizations" following the Fukushima Daiichi accident for the accelerated transfer of spent fuel from wet to dry storage. To that end, the EPRI report includes an assessment, not performed in the original study, of the amount of decay heat and radionuclide source term reduction in spent fuel pools due to the lower number of used fuel assemblies contained in the pools. As cesium—particularly Cs-137—is one of the principal radionuclide contaminants surrounding the Fukushima Daiichi plant, the new study examined the reduction of Cs-134 and Cs-137 inventories in fuel pools resulting from an accelerated transfer program to dry storage.

According to EPRI, any analysis associated with a policy decision to accelerate the transfer of spent fuel from spent fuel pools to dry storage should include a balanced assessment of the benefits and risks of such a decision, including the reduction in spent fuel pool source term, lower density of spent fuel, and lower heat load in the spent fuel pool, as well as the impacts on nuclear power plant operation associated with such a policy decision.

In evaluating the dose and cost impacts of an accelerated transfer program, EPRI used two scenarios: one taking 10 years to move all spent fuel that has been cooled for



A comparison of the annual costs of an accelerated program to transfer spent nuclear fuel using the current industry base case, a 10-year program, and a 15-year program.

at least five years to dry storage, and the other taking 15 years to complete the transfer. These scenarios are examined in comparison to the current practice—the industry base case—in which spent fuel is removed from fuel pools as necessary to accommodate fuel assemblies that have been removed from the core during refueling outages.

Using these two scenarios, the EPRI study found that estimated radiological impacts to workers would increase by 1650 person-rem under the 10-year plan and by 2090 person-rem under the 15-year plan when compared to the industry base case. In addition to the dose increase, the study found that compared to the base case, an additional 128 to 193 dry storage casks would need to be loaded under the two scenarios, which would increase the risks associated with cask handling and the loading of dry storage casks with shorter-cooled, high-burnup spent fuel.

There would also be a significant economic impact to the domestic nuclear industry, according to the study, with increased costs of transferring and storing spent fuel at reactor sites. The cost of transferring spent fuel to dry storage is estimated at $3.8 billion to $3.9 billion for the 10-year plan, and $3.5 billion for the 15-year plan, an increase of 22 to 38 percent over current operating costs. This includes the costs associated with the procurement of dry cask storage systems, cask loading work, construction of spent fuel storage installations, and annual operation and maintenance.

Conversely, the study found that an accelerated transfer program would reduce pool inventories by an estimated 67 to 78 percent for a representative pressurized water reactor plant, and 73 to 78 percent for a representative boiling water reactor plant. According to EPRI, this would decrease the decay heat remaining in the pools by an estimated 23 to 32 percent for both PWR and BWR plants and would reduce the potential source term from cesium by an estimated 43 to 53 percent for a PWR, and 47 to 48 percent for a BWR.

In its summary of conclusions, however, the EPRI report notes that neither the decay heat nor the combined Cs-134 and Cs-137 inventory is reduced as much as the spent fuel inventory is reduced. For this reason, the report states, it is unclear whether the *potential* risk reduction due to lower amounts of decay heat and cesium in the spent fuel pools would offset the *real* increased risks, increased occupational safety hazards, increased operational impacts, and increased costs associated with a policy decision to transfer spent fuel from spent fuel pools at an accelerated rate.

The full report can be found on EPRI's Web site, at <www.epri.com>, with a search for product number 1025206.

GAO report

A report by the GAO, released on September 14, also examines the benefits and challenges of transferring spent fuel from wet to dry storage. And while the report, *Spent Nuclear Fuel: Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges,* identifies many of the same risks and benefits stated in the EPRI report, it takes even less of a stand on the issue, drawing no conclusions regarding the advantages and disadvantages of either option—continued wet storage or accelerated transfer to dry storage.

Such judgments, however, were beyond the scope of the report. Instead, the GAO was asked by its congressional requesters to simply examine, "in light of concerns over the nation's growing quantities of stored spent nuclear fuel, ongoing security threats, and safety concerns raised by events in Japan," the key risks posed by spent fuel stored at commercial nuclear power plants and the benefits and challenges of transferring the fuel from wet to dry storage. The GAO was also tasked with examining the amount of spent fuel that is expected to accumulate at sites before it can be removed, a figure that the GAO, citing the Nuclear Energy Institute, estimates

to be 140 000 metric tons by 2055, when most currently operating reactors will have been retired.

As a result of its inquiry, the conclusion reached by the GAO was related less to the information it had been provided than to how that information had been delivered—or rather, not delivered. That is, the GAO said that when it requested pertinent studies from the Nuclear Regulatory Commission, the agency had difficulty identifying and locating the needed documents.

"Because a decision on a permanent means of disposing of spent fuel may not be made for years, NRC officials and others may need to make interim decisions, which could be informed by past studies on stored spent fuel. In response to GAO requests, however, NRC could not easily identify, locate, or access studies it had conducted or commissioned because it does not have an agency-wide mechanism to ensure that it can identify and locate such classified studies," the GAO said in its report.

To ensure that generational knowledge is not lost and to help guide policy decisions, the GAO recommends that the NRC develop a mechanism that would allow classified studies to be easily referenced and accessed.

In response to the recommendation, Michael Weber, the NRC's deputy executive director for materials, waste, research, state, tribal, and compliance programs, said in a statement that the NRC "will review its current internal practices for maintaining and assuring access to classified documents to determine whether additional document management measures should be implemented."

In regard to issues surrounding the transfer of spent fuel from wet to dry storage, the GAO report cites the same positives (reduced risks from less-dense fuel pools) and negatives (increased potential for accidents, worker dose rates, and costs) contained in the EPRI report, as well as a few not investigated by EPRI. These include the potential benefit of having a greater volume of spent fuel ready to be transported to an offsite facility, as well as a number of management challenges after the spent fuel has been moved to on-site dry storage, including the repackaging of stranded fuel, community opposition, site management costs, security, transportation planning, and continuing taxpayer liabilities.

In its report, the GAO notes the NRC's position that because both wet and dry storage provide a safe means of storing spent fuel, the agency does not require the accelerated transfer of spent fuel from pools to dry storage. The report also states that "industry representatives" told the GAO that they "question whether the cost of overcoming the challenges of accelerating the transfer from wet to dry storage is worth the benefit, particularly considering the low probability of a catastrophic release of radiation."

The GAO's report can be found on the GAO Web site at <www.gao.gov/products/GAO-12-797>.