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# DECOMMISSIONING IN THE MATURE NUCLEAR POWER INDUSTRY

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The average life of a nuclear power reactor or of a spent fuel reprocessing plant may be approximately 40 years. Thus, in the year 2005, decommissioning of these facilities will begin, and, eventually, the number of plants decommissioned per year will equal the number of new plants built. Thus, 30 reactors built in a given year in the 1970s will require 30 replacements in the 2010s. Similarly, reprocessing plants will be replaced as the old plants are made obsolete or worn out.

Present trends in decommissioning practices lead to estimated costs which probably will be prohibitive to the power economy of future generations. Two approaches to the problem could reduce the cost significantly. One would require the development of techniques of conditioning a radioactive facility in place such that radionuclides would be fixed and kept from the food chain during their radioactive decay. The other would require design features in the facility which would permit essentially unlimited reuse of the facility and its site.

The general goals to decommissioning are (1) to ship as much accumulated radwaste to a permanent repository as is practicable, (2) to leave the site such that no surveillance will be needed after 50 years, (3) to allow no return of radioactive and nonradioactive waste to man via the food chain, (4) to protect the casual public from direct radiation, and (5) to leave the land in a reusable condition.

Preplanning for decommissioning a facility should begin with the initial design of the plant. However, when the actual decommissioning event approaches, one must make a site survey and inventory of all radioactive and chemically hazardous materials. A site safety analysis report and an environmental impact statement will be followed by the development of a detailed plan. The plan will include procedures and a schedule for the decommissioning operation.

The case of decommissioning a fuel reprocessing plant is described as an example. The components of the plant to be examined are: fuel storage basin, separation process shielded cells, process equipment, out-of-cell piping, storage tanks for radioactive solids and liquids, off-gas stack, decontamination equipment, high-level waste solidification and treatment equipment, contaminated soil, and final cleanup equipment. The operation begins with the decontamination of the plant and the removal of solid high-level and actinide wastes to an interim or permanent repository. Those portions of the site which have less than a *de minimus* level of contamination can be isolated and treated separately. The equipment which retains contamination will be dismantled, although it may prove necessary to recover certain nonreplaceable metals and alloys as world demand exceeds the supply.

The shielded cells, large waste storage tanks, and fuel storage basins will be prepared for use as long-term storage vaults. This is the step in which multiple barriers will be placed between the residual contamination and the environment. These barriers will be physical and chemical in nature, and their function will be primarily to keep groundwater or floodwater from transporting radionuclides to the food chain. Physical barriers include rip-rap of rock or layers of clays, the latter providing a means of healing cracks in cell walls by plastic flow and resistance to the movement of water by swelling. Chemical barriers (or conditioners) will be particularly important in fixing transuranic element residues and could be alkaline compounds or precipitants which would ensure that plutonium and other transuranium elements would remain in the highly insoluble state in the event that the storage container were penetrated by water. These barriers can be installed inside of the cells, but it would be preferable to install external barriers during the initial construction of the facility.

It is also possible to use the chemical and physical barriers as fill around highly contaminated equipment or gravel which is placed in these storage vaults for long-term storage. Vault preparation will require careful sealing of all openings into the cell such as piping, the cell shielding lid, and any doors or entry maze. In this condition, such a cell will be well protected from permanent damage by floods and earthquakes.

Chimneys and stacks used for venting process gases and cell ventilation air will collect radioactive particles over their lifetime. A liner of bricks over an impervious coating on the concrete shell will permit the inside of the stack to be decontaminated by the removal of the bricks with their accumulated contamination; the waste would be placed in a storage vault. The stack could be reused or knocked down as nonradioactive fill for other parts of the plant.

Contaminated sand and gravel from the area near the plant will be placed in the various stacks and vaults along with conditioning (barrier) chemicals.

Where possible, the superstructure of cells and buildings will either be recover. or, if permanently contaminated, will be placed in the storage vaults. The sealed, filled cells and storage vaults will be covered with 10 to 20 feet of dirt and gravel and, where necessary, rip-rapped with boulders or material such as the concrete stack.

The area will be left in a form not readily eroded by wind and water and planted in native vegetation. The area should have a security fence surrounding it for an interim period of approximately 50 years, after which time the area will be turned back to grazing, parks, or other possible uses.

Records should be kept of the decommissioning operation for future reference.

It should be noted that certain equipment used in the decontamination and decommissioning operation will be needed until near the end of the operation. Provision must be made to incorporate this equipment in the final storage vault or transport it to the next site needing decommissioning.

Techniques for reusing an old plant include the use of replaceable liners for shielded cells, replaceable piping and instrumentation, decontaminatable stacks, and relineable fuel storage basins.

The location of a plant should take into account the needs of its eventual decommissioning. Perhaps the single most critical feature is ready access to a waste repository, preferably a repository on the processing plant site, for example, an excavation in a deep geologic formation. In addition, the climate and surface erosion should be such that the covered canyons (cells), tanks, etc, will not be subject to unusually severe erosion.

It is possible that by siting many processing plants and fuel fabrication plants on single large central nuclear reservations, the decommissioning operation can be further simplified by a system of rebuilding old plants, by the use of common decommissioning equipment and personnel, and by the isolation afforded by the large site. The care needed in locating such a large site would reduce the impact on man and his environment of the decommissioned facilities.