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1978 WINTER MEETING

WASHINGTON, D.C.

NOVEMBER 12-16, 1978

AMERICAN NUCLEAR SOCIETY

TRANSACTIONS

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OF THE AMERICAN NUCLEAR SOCIETY

1978 WINTER MEETING

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Sheraton Park Hotel
Washington, DC

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TECHNICAL SESSIONS

MONDAY, 9:00 AM, NOVEMBER 13, 1978

MONDAY, 2:00 PM, NOVEMBER 13, 1978

†Starts 2:30 PM.
‡Starts 3:30 PM.

TUESDAY, 9:00 AM, NOVEMBER 14, 1978

†Starts 10:00 AM.
*Special Session
FRS = Fast Reactor Safety
TRS = Thermal Reactor Safety

TUESDAY, 2:00 PM, NOVEMBER 14, 1978

†Starts 3:00 PM.

WEDNESDAY, 9:00 AM, NOVEMBER 15, 1978

†Starts 10:00 AM.

WEDNESDAY, 2:00 PM, NOVEMBER 15, 1978

†Starts 2:30 PM.

THURSDAY, 9:00 AM, NOVEMBER 16, 1978

TABLE II

Source of Decommissioning Funds

Cash and Commitments as of December 1, 1972 (Decommissioning Reserve Fund)	$ 4,113,826
Member Company Contributions - 1974 and 1975	2,809,402
Contribution from APDA	42,270
Revenue from Salvage Sales	564,580
Anticipated NELIA Refunds	350,000
	$ 7,880,078
Use charges, and other operating costs paid after December 1, 1972, from the above funds.	$ -365,090
Funds Available and Used for Decommissioning	$ 7,514,988

equipment so it can be sent to burial, how certain areas can be entombed, and many other aspects of how the plant is built could be of significant help in final decommissioning. How to dispose of contaminated and activated sodium coolant from a breeder reactor should be studied as part of building the plant. Engineers should anticipate that decommissioning will be an eventuality and should design to some extent to accommodate performing that task.

1. *Fermi I: New Age for Nuclear Power—A History of the First Large Breeder Reactor Electric Power Plant and Its Contributions to the Development of a Long-Range Source of Energy*, to be published by ANS in late 1978.
2. "Retirement of the Enrico Fermi Atomic Power Plant," NP-20047 and NP-20047 (Suppl. 1) by Power Reactor Development Company (Mar. 1974 and Oct. 1975).

LR-08603

4. Progress Report on Decommissioning of the Sodium Reactor Experiment, *G. W. Meyers, W. D. Kittinger (AI)*

The disposition mode selected for the last stage of the decommissioning of the sodium reactor experiment (SRE) at the Energy Systems Group's Engineering Field Laboratory near Los Angeles, California, was complete dismantlement. The primary objective is to remove all significant reactor-originated radioactive materials from the site. This final phase of the project began in 1975 with development work for accomplishing remote, underwater cutting of reactor vessels and components.[1] The project will be concluded in GFY 1979. This project is the major effort in a DOE-funded program of decommissioning eight nuclear facilities at the Field Laboratory.

Further objectives in the decommissioning of the SRE were to enable release of facility and site to unrestricted further use without surveillance requirements, to preserve the building structure to the extent of economic justification, and to perform the work within acceptable radiation exposure and safety guidelines for the workers, the public, and the environment. These objectives have all been met to date. The activities were designed and accomplished to meet radiation levels as low as practicable as well as to meet radioactivity concentration guidelines that were derived by AI and given concurrence by the DOE, NRC, and the State of California Health Department.

The SRE was a 20 MW(th), sodium-cooled, graphite-moderated thermal reactor which used enriched uranium fuel. Initial operation began in 1957. The last nuclear operation was in 1964 although the sodium systems were operated until 1967. The fuel elements and control rods were removed; the primary sodium was drained into the fill tank, and secondary system sodium was drained into drums. The reactor and support systems were placed in protective storage status, using nitrogen as a cover gas. A surveillance and maintenance program was initiated. The reactor operated for about 27,000 h and generated over 37 million kWh(e).

The planning, engineering, and development activities for the dismantling were initiated in 1974. Peripheral system removal began shortly thereafter. Interior system dismantling efforts began in 1976. The major tasks that have been accomplished are:

1. Safe removal of radioactively contaminated sodium; cleaning of sodium residues from the reactor vessel, piping, and components; and the reaction of bulk sodium and residues to status permissible for disposal. Techniques employed for melting and alcohol flushing or spraying were effective as removal schemes. Reaction with alcohol produced a product for safe disposal. Approximately 2500 lb of sodium were removed from components and treated.

2. Safe and controlled removal of very large and heavy, activated or interior contaminated equipment. The reactor loading face shield plug, reactor ring shield, fuel and moderator handling machines, and liquid and gas holding tanks were removed intact and shipped to a licensed commercial nuclear waste burial site. This disposal approach minimized radiation exposures and release risks, minimized costs, and yet did not add significantly to the waste volume commitment.

3. Removal of reactor vessel internals such as cooling piping, clamps, bellows, and grid plate in a radiologically safe manner. The complex configurations of piping were cut away remotely and underwater by shaped-charge

explosives and a plasma torch. Plasma torch techniques were adapted to cut other reactor components.

4. Removal of the five concentric activated and contaminated structures of the reactor vessel. Radiation levels required water shielding and remote operation. A rotating mast manipulator equipped with plasma torch and video system was utilized to dissect the $\frac{1}{4}$-in. stainless-steel thermal liner, $1\frac{1}{2}$-in. stainless-steel core tank, and the $\frac{1}{4}$-in. outer tank. The concrete-embedded $\frac{1}{4}$-in. steel cavity liner was removed along with the concrete. Plasma torch cutting also sectioned the grid plate and tank bottoms by use of a specially designed manipulator arm. The $5\frac{1}{2}$-in.-thick steel thermal rings were removed from the vessel for remote-controlled and -contained oxyacetylene torch cutting.

5. Removal of the 4-ft-thick biological shielding, storage, and wash cells, hot fuel examination cell, other ground vaults. Removal required excavations to 40 ft below grade, selective separation of contaminated and activated surfaces or volumes, and special care for personnel safety and avoidance of contamination spread. It was found most cost and radiation control effective to preserve the building structure during the entire dismantling phase.

Activities that remain are those to accomplish final structure decontamination, removal of air cleaning and other support facilities, site repairs, final radiation surveys, and completion of the final report. The total project is estimated to cost about $10 million. A portion of the total cost funded the necessary tooling, technique, and operating parameter development work.

1. A. W. GRAVES, G. P. STREECHON, and D. A. PHILLIPS, *Trans. Am. Nucl. Soc.*, **27**, 760 (1978).

5. Financial Evaluation of Nuclear Plant Decommissioning Costs, *B. J. Ewers, Jr. (NSP)*

The financial evaluation of decommissioning a nuclear generating plant has four considerations. These include the method and associated cost of decommissioning, the economic methodology to evaluate these costs, selection and evaluation of methods to recover these costs, and subjective nonfinancial considerations. A structure which quantifies all but the latter is presented leaving the nonfinancial considerations such as political and regulatory feasibility for subjective evaluation.

Method and Cost of Decommissioning

The study prepared for the Atomic Industrial Forum Inc. serves as a base to evaluate the method and associated cost of decommissioning.[1] Three basic methods and associated costs extrapolated to 1978 dollars were Mothballing ($5 to 7 million), Entombment ($16 to 27 million) and Complete Removal ($53 to 63 million). These costs compare to an estimated 1978 inservice date construction costs for an 1100-MW nuclear plant of $500 million.

A negative net salvage cost equal to 10% of plant cost and an average service life of 30 years is typically used by utilities for plant depreciation purposes. This negative 10% net salvage would recover the estimated cost of decommissioning for most methods disregarding inflation. Figure 1 illustrates the inadequacy of the negative 10% net salvage for many combinations of inflation and decommissioning method.

Methodology to Evaluate Costs

To evaluate the financial impact on a utility, accounting and rate-making principles were considered. One

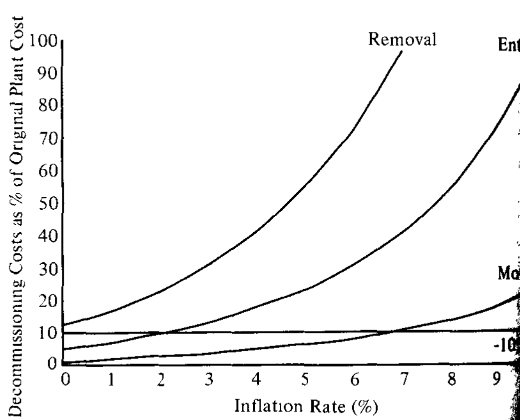

Fig. 1. Effect of inflation on decommissioni

basic goal, to match the timing of revenues
penses, is accomplished for capital expenditure
the noncash expense called depreciation when
generated from the capital asset will be receiv
the assets life. When this goal is considered for
of net negative salvage where capital is investe
end of the period, negative net salvage should lik
expensed through depreciation over the earning li
asset.

Maintenance costs incurred after the facility h
decommissioned were considered a net cost at
decommissioning equal to the capitalized cost
annual expense. Since one cannot charge as a
preciation expense items for which capital outla
not been made, the tax deductible expense in the
decommissioning was normalized or matched with
of the asset.

Economic tools that evaluate the effective cost a
ated with capital budget decisions require applicati
time value of money methodology. Utility companies
traditionally used some variation of a method call
present value of future revenue requirements.
comparative costs presented in Fig. 2 represen
present value of revenue requirements considering:
utility capital structure which results in a discount
of 10%; (b) an initial plant cost of $500 million (
dollars); and (c) an estimated 1978 decommissioning
of $50 million. These assumptions are used for dem
stration purposes only.

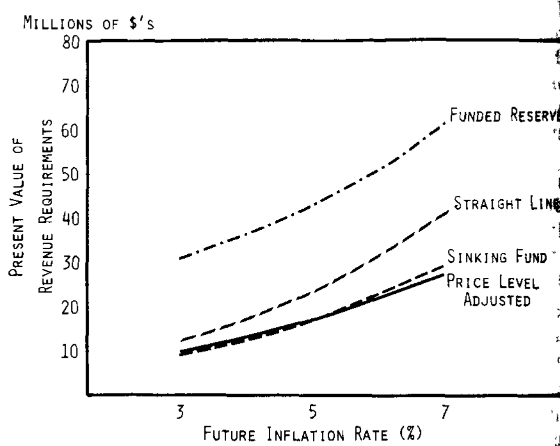

Fig. 2. Cost of decommissioning for various accou
methods and inflation rates.