BIXBY

Bob
Earl

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Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

May 22, 1981

TO R. E. Tiller, Director
Reactor Operations and
Programs Division

FROM J. P. Hamric, Director
Nuclear Fuel Cycle and
Waste Management Division

SUBJECT TMI-2 FUEL REPROCESSING AT ICPP

Attached is a copy of the ENICO letter entitled "Preliminary Evaluation of Reprocessing TMI-2 Fuel at the ICPP/LWM-13-81," which was prepared in answer to your query. The information was given informally to you on May 11, 1981, by D. D. Deming. Programwise, we could not spare the FAST facility for one year to process the TMI fuels. If this fuel were assigned to us, we would dry store it indefinitely in caisson-type in-ground storage.

Attachment

RECEIVED
JUN 01 1981
EG&G Idaho, Inc.

May 13, 1981
LWM-13-81
Attachment

PRELIMINARY EVALUATION OF REPROCESSING TMI-2 FUEL AT THE ICPP

Introduction

The capability of reprocessing Three Mile Island Unit 2 fuel at the ICPP was examined with respect to a) compatibility of the fuel with available facilities, b) compatibility of the fuel with chemical dissolution processes, c) volume and composition of the waste, and d) estimated costs and impacts on existing reprocessing schedules. The unknown condition of the damaged fuel reduces the certainty in predicting the physical form in which the fuel would be delivered.

Fuel Description [1,2,3]

The TMI-2 core, as originally loaded consisted of 177, ZIRCALOY-4 Clad, PWR fuel assemblies fabricated by Babcock & Wilcox Co.; each weighed approximately 1600 lbs., was 165.6 in. long, and had cross-sectional dimensions of 8.5 by 8.5 in. The active length, excluding the steel end fittings, was 144 in. The fuel rods were in 15 x 15 arrays; each array contained 208 fuel rods, with guide tubes for 16 control rods and a central instrumentation tube.

The fuel rods were ZIRCALOY-4 tubes containing UO_2 fuel pellets. A small (indefinite) fraction of the fuel pellets contained dispersed Gd_2O_3 as a burnable poison. Other burnable poison rods contained 4% B_4C dispersed in Al_2O_3 pellets. The reactor control rods were an alloy containing 80% Ag, 15% In, and 5% Cd. The grid spacers, which held the fuel rods in position, were made of INCONEL-718 alloy. The upper and lower end fitting were Type 304 (and possibly 302) Stainless Steel.

The fuel had an original average enrichment of 2.57% ^{235}U, ranging from approximately 2.1% to 3.1% in individual assemblies. Before shutdown, the fuel underwent 95 full power days of operation, with a total burnup of 3100 MWD/MTU or about 10% of full burnup.

The physical and chemical forms of many of the materials in the core will not be known until the core is removed. It is currently believed that a substantial fraction of the fuel rods are warped, ruptured, and possibly fused; the existence of a variety of metal eutectics and alloyed species are expected.

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1) Metropolitan Edison Company, Final Safety Analysis Report - Three Mile Island Nuclear Station - Unit 2, Docket 50320-76, Volume 4.

2) Vic Uotinen, Babcock & Wilcox Co., Personal Communication, May 7, 1981

3) Robert J. Loyd, EG&G Idaho Co., Personal Communication, May 8, 1981

The current total mass estimate of the core is presented in Table I.

TABLE I

TOTAL MASS CONTENT OF TMI-2 CORE

ZIRCALOY-4, an unknown amount of which may be ZrO_2, $ZrO(OH)_2$ and/or $Zr(OH)_4$		23,000 kg
UO_2 (original)		93,000 kg
Pu	Approximately	150 kg
Fission Products	Approximately	200 kg
Ag-In-Cd alloy (80-15-5)		140 kg
Al_2O_3 containing 4% B_4C		900 kg
INCONEL-718		1,600 kg
Gd_2O_3 (dispersed in the UO_2)		Several kg

Current plans are to remove the damaged components from the core in pieces that can be inserted and sealed in 14 ft-long cylindrical, 13-in.-o.d., Type 304 or 316 stainless steel canisters. The stainless steel seal caps will probably contain rubber seals or O-rings. Individual canister contents will range from entire fuel assemblies to assorted pieces of debris, possibly including loose fuel pellets, scooped from the bottom of the reactor. A net loading of 5000 lbs. per cansiter is expected. Shipping from TMI is currently estimated to be early 1985.

ICPP Reprocessing Considerations

1) Physical compatibility with available facilities.

The 14-ft-long canisters are several inches too long to be charged intact to the FAST dissolvers. The expected 5000-lb net weight of each canister further precludes direct charging to the FAST dissolvers which have maximum charge limits of 1800 lbs. Removal of the fuel material from the canister so it could be charged in smaller portions would be required.

2) Chemical compatibility with ICPP Processes.

Modification of existing processes would be required to resolve the following possible problems:

A. INCONEL-718 grid spacers

INCONEL-718 will not dissolve in current or anticipated ICPP dissolvents. Each fuel assembly contains approximately 9 kg of

INCONEL-718 in the grid spacers that hold the fuel rods and control rod guide tubes in place for the entire length of the assembly. Removal of the grid spacers before dissolution would require the complete disassembly of every fuel assembly. A possible alternative would be modification of the facility for the use of dissolver baskets to recover undissolved pieces from the dissolver.

B. Insoluble burnable poison rods

Approximately one third of the fuel assemblies contain burnable poison rods. These rods contain a total of 900 kg of Al_2O_3 pellets with 4% B_4C. Neither of these materials will appreciably dissolve in current and projected ICPP dissolvents. Depending upon their physical form, they would remain as solid pieces in the bottom of the dissolver, or be slurried in the dissolver product.

C. Silver-indium-cadmium control rods

Seventy 2-kg control rods, made of an 80-15-5 Ag-In-Cd alloy, will be present. Laboratory testing would be required to determine the behavior of this material in ICPP chemical solutions.

3) Wastes

Based upon the currently planned Fluorinel flowsheet, the entire TMI-2 core would yield approximately 420,000 L of high-level liquid waste. Since it received a low burnup and will have cooled greater than 5 years, the heat load from fission product decay should not be greater than from existing ICPP wastes. The resulting calcine volume would be about 70 m^3.

If the entire 150 kg of Pu is left in the waste, the average Pu concentration will be approximately 0.36 g/L or 22 nci/L. The calcined waste would contain approximately 1.9×10^5 nci of Pu/g, which is not significantly different from the average 2.3×10^5 nci/g in presently stored calcine.[4] However, the TMI-2 Pu is mostly ^{239}Pu, while the ICPP calcine is mostly ^{238}Pu. Provisions would have to be made to isolate the TMI calcine in a separate bin to prevent the ^{239}Pu-rich calcine from influencing selection of long-term waste management options for defense waste calcine.

4) Cost estimate

Preliminary ROM calculations indicate that the entire core could be reprocessed in approximately one year of FAST operation. The scheduled reprocessing of Navy fuel would be delayed accordingly. The operating cost estimate (excluding any development or facility modification) is $50 million in 1983 dollars. The estimated 1983 value of 81,000 Kg of 2.5% enriched uranium is $60 million.[5] Calcining the waste would require about 40 days, or 15% of a 270-day operating year, corresponding to $6 million. Calcine storage is estimated at $1.0 million.

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4) J. R. Berreth, ENICO, Personal Communication, May 8, 1981

5) H. G. Spencer, ENICO, Personal Communication, May 8, 1981

Preliminary Recommendation

Based upon the considerations listed above, it is recommended that TMI-2 fuel not be reprocessed at the ICPP.

SUMMARY OF TMI-2 FUEL REPROCESSING CONSIDERATIONS AT ICPP

PHYSICAL COMPATIBILITY	- CANISTER SIZE: 168" CANISTER VS. 166" FAST DISSOLVER HEIGHT STAINLESS STEEL - WEIGHT: 5000 LB. CANISTER VS. 1800 LB. DISSOLVER CAPACITY.
CHEMICAL COMPATIBILITY	- INCONEL-718 GRID SPACERS - POISON RODS, B_4C IN AL_2O_3 - AG-IN-CD CONTROL RODS
PLUTONIUM	- APPROXIMATELY 1.9×10^5 NANO CI/G IN CALCINE, MOSTLY ^{239}PU.
COST/BENEFIT	- APPROXIMATELY ONE YEAR DELAY IN FAST PROCESSING SCHEDULE - $50 M REPROCESSING OPERATING COST (1983 $) - $7.0 M WASTE CALCINING & STORAGE COST (1983 $) - $60 M OF RECOVERED URANIUM (1983 $) - MODIFICATION COSTS FOR FLUORINEL PROCESS AND CALCINE STORAGE - - NO ESTIMATE

PRELIMINARY RECOMMENDATION

NOT TO REPROCESS AT ICPP, BASED UPON:

A. DELAY IN REPROCESSING SCHEDULE FOR NAVY FUELS,

B. NEED FOR MODIFICATION OF FAST PROCESS AND CALCINE STORAGE FACILITIES.

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