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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

CIVIL DIVISION

March 15, 1971

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Dear Mr. Shaw:

The General Accounting Office has reviewed selected aspects of the Atomic Energy Commission's (AEC's) Liquid Metal Fast Breeder Reactor program being conducted at the Argonne National Laboratory facilities in Illinois and Idaho. Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53) and the Accounting and Auditing Act of 1950 (31 U.S.C. 67). The review was directed primarily toward an evaluation of Argonne's management of fuel procurement from commercial sources for the Experimental Breeder Reactor-2 (EBR-2).

EBR-2 is the primary fast flux irradiation facility, a sodium-cooled fast reactor, used for testing materials and fuels for use in liquid metal cooled fast breeder reactors. It was originally designed as a prototype to demonstrate central power plant operation, but in 1966 was changed to an irradiation test facility to meet the needs of the Liquid Metal Fast Breeder Reactor program.

Fuel elements are used in EBR-2 to irradiate experimental subassemblies containing fuel or fuel materials. An important step in the production of fuel elements is the bonding process, which is to provide a uniform, gas-free sodium bond between the fuel pin and the jacket to ensure maximum heat removal from the fuel element.

From 1954 to 1961 Argonne performed research on various bonding methods, including the vibratory and centrifuge processes. In the vibratory process, the elements are vibrated vertically to moisten the fuel pin and jacket surfaces. In the centrifuge process, the fuel elements are placed in slots on a centrifuge table and are rotated at high speeds.

The research program showed that under laboratory conditions centrifuge processing had been successful. However, Argonne selected the vibratory process for in-house production at the Illinois and Idaho sites because the centrifuge device would be relatively complex, difficult to repair, and limited as to the length and number of elements that could be processed simultaneously.

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Bonding problems were experienced during quantity production of fuel elements, and research was initiated to eliminate the problems. As a result of this research, certain modifications were made, and the process, now called the impact process, was developed and used to bond the remaining elements at Argonne's Illinois and Idaho sites.

From June 1960 to February 1961 Argonne produced about 11,000 fuel elements at Illinois for the EBR-2 by the vibratory and impact processes. From fiscal years 1965 to 1967 Argonne bonded approximately 24,000 fuel elements by the impact process at the Fuel Cycle Facility at the Idaho site.

In 1966, AEC approved Argonne's proposal to procure fuel elements commercially for use in EBR-2. Argonne considered commercial procurement necessary to ensure an adequate supply of fuel in the event of a breakdown of in-house facilities. More importantly, commercial sources of fuel were needed because of (1) an anticipated increase in EBR-2 operations as an irradiation test facility and (2) a proposed redirection of use of the in-house facilities which had been used for fuel production.

An Argonne planning document dated May 1966 proposed EBR-2 fuel procurement from commercial sources and stated in part that production facilities of the vendor would be visited and a careful inspection made to assure that the fuel specifications could and would be met. The document stated that the first shipment of commercially fabricated fuel would be carefully evaluated, including irradiation testing, prior to the delivery of large quantities of fuel. In a September 1966 study, Argonne again stated that the first shipment of commercially fabricated fuel elements would be carefully evaluated, including irradiation testing, prior to approval of volume production.

In June 1967, Argonne executed a negotiated fixed-price contract with a commercial source for 34,000 fuel elements at a cost of $2.5 million. With Argonne's approval, the contractor used the centrifuge bonding process. The contract provided for inspecting preproduction and production samples of EBR-2 fuel for compliance with specifications but did not provide for irradiation testing of the fuel elements before quantity production began.

We found no documentation concerning the justification for Argonne's decision not to provide for prequalification irradiation testing of the fuel elements. Argonne advised us that no documentation existed

concerning the decision but that such prequalification had not been considered practical because the risks involved were not great enough to warrant the incurrence of the additional costs of prequalification. In our opinion, if it was impractical to provide for irradiation testing of the fuel elements before large quantities were delivered, Argonne should have considered requiring the contractor to use the impact fabrication process to minimize the risk that the elements would be unsatisfactory.

Argonne received the initial delivery of about 200 commercial fuel elements in August 1968, but sample elements were not loaded into EBR-2 for irradiation tests until November 1968. The irradiated fuel elements were not available for examination until March 1969, partly because EBR-2 was shut down during January and February 1969.

As a result of the foregoing delays, initial irradiation tests of these elements were not completed until May 1969. At that time about 22,000 of the 34,000 fuel elements had been delivered by the contractor and accepted by Argonne as meeting specifications.

The initial irradiation tests in May 1969 indicated that most of the fuel elements were slumping--the fuel pins shortened in length inside the jackets, and the diameter in the lower region of the elements expanded slightly.

Without knowing the cause of the slumping problem, Argonne instructed the contractor to discontinue using the centrifuge bonding process for the manufacture of fuel elements. During May, after the initial tests and examination of the fuel were completed, Argonne determined that the slumping in the fuel elements had been caused by the centrifuge bonding process selected by the contractor and approved by Argonne. Subsequently the contractor delivered the remainder of the fuel elements in an unbonded condition.

After the slumping problem was disclosed, Argonne was concerned as to whether any of the contractor's fuel could be used in the EBR-2 reactor. As a result of this problem, Argonne had to determine, through further irradiation tests, whether these fuel elements could safely achieve the approved burnup level.

While evaluating the quality of the commercially-produced fuel, Argonne initiated in-house production of EBR-2 fuel elements and decided to procure, in addition to those elements already contracted for, about 9,000 fuel jackets and 600 kilograms of uranium alloy to

be bonded under the impact method and completed at the in-house facilities at Argonne's Idaho site. The additional procurement was estimated to cost about $775,000.

Argonne has endeavored to determine the cause of the slumping problem and to institute corrective measures to ensure that the commercially-produced fuel elements will safely achieve the approved burnup level. We were informed by the Division of Reactor Development and Technology site staff that AEC Headquarters staff decided that Argonne should reheat, and rebond when necessary, the commercially-produced fuel to ensure the safe achievement of the approved burnup level which was increased in November 1969 to a higher level than that in effect at the time of the contract with the commercial source. As of January 1971 Argonne had heat treated about 8,100 of the 22,000 bonded fuel elements obtained from the contractor.

We estimate that, in addition to the undetermined Argonne costs of analyzing the slumping problem, AEC will incur estimated costs of $279,000, as tabulated below, to determine the cause of the slumping problem and to complete the corrective measures.

Argonne	
Contractor's services related to slumping problem	$152,000
Heat treating about 22,000 fuel elements to ensure that subsequently approved burnup level can be safely achieved	110,000
Savannah River	
Research studies concerning radiation-induced shortening of fuel elements	17,000
	$279,000

The EBR-2 project manager informed us that a possible modification of fuel element acceptance criteria may eliminate the need for rebonding fuel elements which have been or will be heat treated.

CONCLUSION

Although Argonne recognized, prior to the commercial procurement of fuel elements for the EBR-2, that the fuel elements should be evaluated by irradiation testing before delivery of large quantities,

no provision for such testing was made. Further, the contractor was permitted to use a fabrication process which had not been proven under quantity production conditions and which, even under laboratory conditions, had not been evaluated through irradiation testing.

As previously noted, we found no documentation concerning the justification for the decision not to provide for prequalification irradiation testing of the fuel elements. Argonne advised us that no documentation existed with respect to the decision but that such prequalification had not been provided for because the risks involved were not great enough to warrant the additional costs of prequalification.

We believe that, if it was impractical to provide for irradiation testing of the fuel elements before large quantities were delivered, Argonne should have considered requiring the contractor to use the proven fabrication process to minimize the risk that the elements would be unsatisfactory.

In our opinion, in future procurements of commercially-produced fuel, Argonne should give specific consideration to the need for prequalification irradiation testing, and, if such testing is not provided for, should document the bases for its determination that without such testing adequate assurance exists that the fuel elements produced by the contractor will perform satisfactorily.

The Division of Reactor Development and Technology advised us that Argonne has agreed to consider the need for prequalification irradiation testing in future fuel procurements and to document the bases for its decisions in this regard. Therefore, we are making no recommendation concerning this matter.

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We wish to acknowledge the cooperation extended to us by your staff during our review. We shall appreciate being advised of any actions taken relating to the matters discussed in this report.

Sincerely yours,

Philip A. Bernstein

Philip A. Bernstein
Assistant Director

Mr. Milton Shaw, Director
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