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RESOURCES, COMMUNITY,
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MAY 9, 1983

RELEASED

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives



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Dear Mr. Chairman:

Subject: Usefulness of Federally Funded Acti-
vities at the Barnwell Nuclear Fuel
Plant (GAO/RCED-83-128)

In an April 9, 1982, letter you requested¹ that we respond to a list of questions relating to the Barnwell Nuclear Fuel Plant (Barnwell)--a privately owned, partially completed, commercial nuclear fuel reprocessing plant located in Barnwell, South Carolina--that has received Federal funding since fiscal year 1978. As agreed with your office, we focused our work on (1) the usefulness of Federally funded activities at Barnwell and (2) the status of Barnwell and its potential to become operational. We also agreed to provide you with a separate report on each area. This report presents our review of the usefulness of Federally funded activities at Barnwell.

Commercial reprocessing involves separating the remaining uranium and plutonium contained in the spent fuel of commercial nuclear reactors to recover the fissionable material for reuse as reactor fuel. Barnwell was intended to be the first large-scale commercial reprocessing plant in the United States.² Plant construction began in February 1971; however, before the plant could become operational, President Carter announced in

¹The Chairman, Subcommittee on Energy Research and Production, House Committee on Science and Technology, sent us a similar request on May 24, 1982.

²A smaller commercial reprocessing plant at West Valley, New York, operated between 1966 and 1972. Its owners terminated operations when they decided it would be uneconomical to make plant modifications necessary to meet new licensing requirements. A second plant, constructed in Morris, Illinois, in the late 1960's and early 1970's, never operated because of shortcomings attributed to design.

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April 1977 that commercial reprocessing would be indefinitely deferred in the United States. This decision was part of his nuclear nonproliferation policy aimed at preventing the spread of nuclear weapons capabilities. By deferring commercial reprocessing, President Carter expected to reduce the risks of nuclear weapons proliferation by minimizing the availability of plutonium which is recovered in reprocessing and can be diverted to construct nuclear weapons.

Following President Carter's announcement, Barnwell's owner--Allied-General Nuclear Services, Inc. (Allied-General)--considered mothballing the plant because there was no near-term potential for commercial reprocessing. However, the Congress authorized and appropriated funds for Barnwell in fiscal year 1978 and directed the Department of Energy (DOE) to fund research and development (R&D) activities at the plant. The legislative history indicates that the funding was expected to permit Allied-General to maintain its existing facilities and retain its key personnel. The Congress has continued annual appropriations for Barnwell providing in total about \$64 million through fiscal year 1982.

We found that the Government officials and industry representatives we contacted who are familiar with the R&D work at Barnwell and are knowledgeable about reprocessing generally believe that the R&D activities have been useful. Specifically, they believe that the R&D activities have been useful in advancing the technology to safeguard special nuclear material,³ furthering the understanding of various reprocessing concepts, and developing meaningful data on spent fuel handling techniques. Furthermore, we found that Barnwell's facilities have been adequately maintained and a majority of its key personnel have been retained.

The following sections (1) describe the objective, scope, and methodology for our review, (2) present the history of Barnwell and its federal funding, and (3) provide more detailed information on the results of our review.

OBJECTIVE, SCOPE, AND METHODOLOGY

Our objective in this review was to determine the usefulness of federally funded activities at Barnwell by determining whether the activities resulted in benefits in accordance with congressional intent. We reviewed the legislative history related to the federal funding to determine the congressional

³Special nuclear material includes plutonium and enriched uranium which can be used in nuclear weapons and as fuel for nuclear reactors, and any other material determined as special nuclear material by the Nuclear Regulatory Commission.

intent for such funding and DOE's role in administering such funds; we also examined DOE's budgetary documents and contracts and discussed them with DOE and Allied-General officials to ascertain how these funds were used. Our work focused on the usefulness of R&D activities at Barnwell which were specifically mandated by the Congress and on the extent that plant facilities have been maintained and key personnel retained from fiscal years 1978 through 1982.

To determine the usefulness of the R&D activities, we reviewed the R&D projects and related progress reports, correspondence, and documents at Barnwell, DOE headquarters, and the DOE Savannah River Operations Office. We interviewed Government officials and industry representatives familiar with the R&D activities and who are knowledgeable about reprocessing to obtain their views on the usefulness of the R&D activities. These individuals included officials from DOE and various DOE national laboratories who monitor or coordinate work with Allied-General on the R&D activities; the Nuclear Regulatory Commission (NRC) who have licensing responsibility for Barnwell; the Department of State who monitor international reprocessing efforts; and industry representatives from organizations aware of the results of Allied-General's R&D work. These organizations included Bechtel, Incorporated; Electric Power Research Institute; Nuclear Assurance Corporation; Westinghouse Electric Corporation; Tennessee Valley Authority; and Virginia Electric and Power Company. To a great extent, we relied on the views of these individuals we contacted. However, we did compare the reasonableness of the views with information we gathered on our prior work relating to the Federal support of Barnwell and reprocessing.⁴

To determine the extent the Barnwell facilities have been maintained and key personnel retained, we toured the plant facilities and reviewed Barnwell's facility maintenance program and records for maintenance activities and plant operations. Furthermore, we discussed the above information with DOE and NRC officials and representatives from the Daniel Construction Company which maintained the Barnwell facilities from 1978 to 1980, and Bechtel, Incorporated which designed the plant to obtain their views on the extent the Barnwell facilities have been maintained. Finally, we obtained from Allied-General a list of individuals whom they considered key personnel in 1978 and compared this list with Barnwell's personnel records and documents to determine how many of these persons have been retained.

⁴The reports produced from our prior related work include "An Evaluation of Federal Support of the Barnwell Reprocessing Plant and the Department of Energy's Spent Fuel Storage Policy" (EMD-78-97); and "Nuclear Fuel Reprocessing and the Problems of Safeguarding Against the Spread of Nuclear Weapons" (EMD-80-38).

Our review was performed in accordance with generally accepted government auditing standards.

BARNWELL'S HISTORY AND ITS
FEDERAL FUNDING

Barnwell was designed to reprocess 1,500 metric tons of commercial nuclear spent fuel per year and was the first large-scale commercial reprocessing venture in the United States. The plant was to consist of five major facilities: (1) a nuclear spent fuel receiving and storage facility, (2) a chemical separations facility which processes the solid spent fuel into liquid uranium, plutonium, and waste products, (3) a uranium hexafluoride facility which prepares the uranium for its eventual re-use as reactor fuel, (4) a plutonium conversion facility which converts the plutonium to solid form, and (5) a waste solidification facility to solidify the liquid waste for final disposal. Allied-General has invested about \$250 million in essentially completing the first three facilities and partially developing conceptual designs for the latter two facilities.

When Barnwell's construction began in the early 1970's, commercial reprocessing was viewed by the Federal Government and representatives of the nuclear industry as an integral step in the nuclear fuel cycle. The reprocessing of spent fuel from commercial reactors would result in the recovery of residual uranium and plutonium from the spent fuel and possibly aid in nuclear waste disposal. The residual uranium and plutonium would be used again as reactor fuel.

By the mid-1970's, however, there was growing concern within the Federal Government about the proliferation of nuclear weapons. Since reprocessing recovers plutonium which can be used to construct nuclear explosives, concerns were raised that widespread reprocessing may lead to nuclear weapons proliferation. Primarily as a result of these concerns, President Carter indefinitely deferred commercial reprocessing in April 1977.

While the Congress was also concerned about the proliferation of nuclear weapons, it believed that Federal funding of R&D activities at Barnwell was desirable. Such activities could be used to help further the Nation's nuclear fuel cycle R&D efforts and help develop better systems for safeguarding plutonium. The legislative history indicates that the funding was expected to permit Allied-General to maintain Barnwell's existing facilities and retain its key personnel. For the past 5 years, since fiscal year 1978, congressional appropriations for Barnwell have ranged from about \$10 million to \$18 million each year. As of

the end of fiscal year 1982, a total of about \$64 million⁵ has been funded. Of this amount approximately \$35 million was used for R&D activities, and about \$29 million was used for maintaining the existing plant facilities.

In October 1981, President Reagan lifted the indefinite deferment on U.S. commercial reprocessing. At the same time he emphasized the importance of the private sector taking the lead in developing commercial reprocessing services. Consequently, the administration plans to request no further funding for Barnwell beyond fiscal year 1983. According to DOE officials, funding for fiscal year 1983 at about \$10.6 million is expected to terminate in July 1983 and DOE did not request funding for Barnwell for fiscal year 1984. Meanwhile, DOE officials are considering ways to encourage the private sector to complete Barnwell and make it operational.

R&D ACTIVITIES ARE CONSIDERED TO BE USEFUL

It is difficult to assess the usefulness of R&D when the results have not yet been applied. This is the situation with respect to the R&D activities at Barnwell because much of the activities apply to commercial reprocessing, yet no commercial reprocessing is taking place in the United States. Nevertheless, we found that the R&D work is considered useful by Government officials and industry representatives. The following sections discuss the R&D activities and their usefulness.

Overview of R&D activities

Since fiscal year 1978, DOE has contracted each year with Allied-General to conduct specific R&D activities. These activities have focused primarily on three areas: (1) safeguards development, (2) alternative fuel cycle evaluations, and (3) spent fuel handling studies. The following table shows the funding for these activities.

⁵This amount does not include about \$14 million which Allied-General has received since fiscal year 1978 for conducting specific projects related to other DOE programs such as defense and waste management.

Funding For R&D Activities From
Fiscal Year 1978 Through Fiscal Year 1982

<u>Activity</u>	<u>Amount funded (millions)</u>
Safeguards development	\$19.3
Alternative fuel cycle evaluations	10.4
Spent fuel handling studies	4.9
Other (note a)	<u>.7</u>
 Total	 <u>\$35.3</u>

a/This activity was an evaluation jointly performed by Allied-General and the Oak Ridge National Laboratory on the use of Barnwell in support of DOE's Breeder Reactor Program. This evaluation showed that, without additional facilities, Barnwell could not reprocess breeder fuel and still maintain its capability to reprocess commercial spent fuel.

The safeguards development activities have involved testing and evaluating systems at Barnwell that would physically help protect any facility from unauthorized access and systems that would help to measure and monitor the inventory for special nuclear material in a facility. Such protection and monitoring or accounting for special nuclear material are important to ensure that material such as plutonium is not diverted from peaceful nuclear activities and used to construct nuclear explosives. In our report "Nuclear Fuel Reprocessing and the Problems of Safeguarding Against the Spread of Nuclear Weapons" (EMD-80-38), we emphasized the importance of safeguards development activities and the need for special nuclear material accounting systems that could detect material diversions in a timely manner.

In collaboration with DOE national laboratories, Allied-General has tested, evaluated, and incorporated at Barnwell various laboratory safeguards concepts and models relating to both physical security and special nuclear material accountability. In the area of physical security, for example, Allied-General has tested, evaluated, and incorporated card entry and voice verification systems for personnel access control and has experimented with alarm systems and video techniques for monitoring sensitive process areas at the plant. In the area of special nuclear material accountability, Allied-General has tested and evaluated devices which measure liquid volume, inventory flow, and the concentration of special nuclear material in solutions, and has integrated these devices into a computerized

special nuclear material accounting system at Barnwell. Allied-General has also conducted runs (partial plant operations) through Barnwell's separation facility in which natural uranium solutions were processed to demonstrate the special nuclear material accounting system. According to Allied-General and DOE officials, these runs have demonstrated the system's potential capability of determining the inventory for special nuclear material once each hour and detecting diversions of as little as 100 grams (3.5 ounces) of such material. Since fiscal year 1978, Allied-General has published over 100 reports on its safeguards development activities.

For alternative fuel cycle evaluations, Allied-General's objective has been to study alternative reprocessing concepts which support the Nation's nonproliferation efforts. Specifically, Allied-General has looked at reprocessing for a thorium-based fuel cycle⁶ and has prepared flowsheets showing the processes. The advantage of the thorium fuel cycle from the nonproliferation point of view is that the cycle produces a highly radioactive material which would be more hazardous and complicated for fabricating nuclear explosives than the plutonium produced in the conventional fuel cycle. Similarly, Allied-General has conducted work on other techniques with potential nonproliferation advantages, such as coprocessing and spiking. Coprocessing is a method in which plutonium from spent fuel in a reprocessing plant is never completely separated from the uranium and thus complicates any attempts to divert the plutonium and use it to fabricate explosives. Spiking means introducing at some point in the fuel cycle a material that emits high radiation and would make weapon fabrication more difficult. Spiking could be applied to the plutonium after it has been separated in reprocessing to deter any efforts to divert the plutonium for weapon fabrication. Since fiscal year 1978, Allied-General has produced about 80 reports on these various concepts and their implications in regard to reprocessing.

For spent fuel handling studies, Allied-General's objective has been to assess spent fuel transportation, receiving and storage techniques, using Barnwell's spent fuel receiving and storage facility as a model. The assessments were to have generic application not only to reprocessing plants but also in transporting nuclear fuel to and from nuclear powerplants. Specifically, Allied-General has tested and assessed spent fuel casks⁷ handling techniques. In this regard, they have

⁶Thorium is an element that can be converted into a fissionable material for fueling nuclear reactors.

⁷Casks are containers used for transporting or storing nuclear spent fuel.

developed data on the casks' loading and unloading times, labor requirements, and the potential for radiation exposure. Similarly, Allied-General has developed concepts and conducted studies on spent fuel disassembly and compaction techniques. Since fiscal year 1978, Allied-General has completed over 45 reports on Barnwell's spent fuel handling techniques.

Usefulness of R&D activities

The Government officials and industry representatives we contacted generally believe that the R&D activities have been useful. Specifically, they believe the activities have advanced the technology to safeguard special nuclear material, furthered the understanding of various reprocessing concepts, and developed meaningful data on spent fuel handling techniques.

Through the safeguards development activities, Allied-General has demonstrated the operability of various safeguards concepts. DOE, NRC, and State Department safeguards officials consider the development and demonstration of the special nuclear material accounting system at Barnwell a significant accomplishment. Current accounting methods for special nuclear material rely basically on physical accounting of such material which necessitates periodic plant shutdown and cleanout. NRC regulations require that such accounting be taken every 2 or 6 months depending on the type of special nuclear material handled by the facilities. A major drawback of the accounting methods is their inability to timely detect diversion of special nuclear material. A loss of such material could remain undiscovered until the next inventory is taken--which could be as long as 6 months. The material accounting system developed at Barnwell could provide more timely detection of any loss of special nuclear material in that the system, according to Allied-General officials, would provide hourly detection. As a result, DOE safeguards officials said that they are considering incorporating in several DOE nuclear facilities many of the system's devices and instruments. In addition, NRC is in the process of considering new requirements for more timely detection of anomalies such as inventory discrepancies in facilities (for example, fuel fabrication sites) that handle highly enriched uranium and plutonium. According to NRC safeguards officials, the special nuclear material accounting system developed at Barnwell could be used to meet more timely detection requirements at these facilities.

Furthermore, the work related to the development of the special nuclear material accounting system at Barnwell has produced results useful to the Tokai Advanced Safeguards Technology Exercise. This is a joint program sponsored by Japan, France, and the United States for carrying out research, development, and testing of advanced safeguards technology. Based on

Allied-General's testing and evaluating of a device for measuring solution volume, the program adapted a similar device to the Tokai reprocessing plant in Japan for further international safeguards research and development. A State Department safeguards official said that Allied-General's work has demonstrated techniques that would enhance international safeguards.

The alternative fuel cycle evaluations have been cited by DOE, NRC and State Department officials as useful in furthering the understanding of various reprocessing concepts, particularly as they relate to nonproliferation. Data developed from the evaluations were used to provide support for the U.S. input to the International Nuclear Fuel Cycle Evaluation. This group was organized in October 1977 when 40 countries and 4 international organizations gathered to undertake a 2-year technical and analytical study of various aspects of the nuclear fuel cycle relating to the nonproliferation issue. This study included evaluations of various reprocessing alternatives. Work in this area at Barnwell has similarly been used as reference material in furthering DOE's work in evaluating various reprocessing concepts.

The spent fuel handling studies have been useful in developing meaningful data on spent fuel handling techniques. According to utility representatives we contacted, they have obtained data and observed Allied-General's demonstration of spent fuel cask handling procedures. They said that they have used the data developed at Barnwell as a standard in estimating their own cask handling requirements. They also said that they have found the spent fuel disassembly and compaction information useful in furthering their knowledge of these techniques for possible future incorporation at spent fuel storage facilities.

DOE officials added that if commercial reprocessing does take place in the United States, the R&D efforts may become more useful. The safeguards systems and spent fuel handling techniques developed at Barnwell could be put to actual use if Barnwell becomes fully operational as a commercial reprocessing plant and also be adapted to future reprocessing facilities in the United States if widespread commercial reprocessing takes place. Furthermore, the various reprocessing concepts evaluated at Barnwell could be further developed and applied to actual reprocessing.

BARNWELL'S FACILITIES HAVE BEEN
ADEQUATELY MAINTAINED AND A MAJORITY
OF KEY PERSONNEL HAVE BEEN RETAINED

Intrinsically linked with conducting R&D work at Barnwell has been the maintenance of Barnwell's facilities and retention of its key personnel. About \$29.5 million has been spent on

maintenance activities. DOE officials believe that the facilities have been adequately maintained. Furthermore, they believe that a majority of Barnwell's key personnel have been retained. Based on our review of Allied-General's maintenance activities and personnel records, we concur with these conclusions.

Allied-General's maintenance program was designed to preclude or minimize premature failure and deterioration of mechanical, electrical and electronic systems, equipment, and structures. It consisted of preventative and corrective maintenance procedures to identify and correct problems. Our review of Barnwell's maintenance records indicates that Allied-General has been following its maintenance program. Although deferred scheduled maintenance activities did occur, the deferrals were for equipment not used or rarely used in conducting R&D activities.

We also reviewed the records at Barnwell on periodic runs which Allied-General conducted. These were operations conducted through parts of the plant primarily to demonstrate plant equipment processes and the safeguards special nuclear material accounting system. We believe that the extent problems did or did not occur during the runs would provide a good indication of how well the facilities have been maintained. We specifically looked for problems that may have resulted from a lack of proper maintenance, such as equipment failures which caused significant downtimes.

Since fiscal year 1978 Allied-General has conducted 10 separate runs lasting from 7 days to almost 4 months, and totaling over 200 days of operation. We found that few major problems were reported and that these problems caused a total of less than 2 days of downtime. Moreover, the problems encountered were corrected. Thus, it appears that the runs were relatively successful and did not indicate any lack of proper maintenance.

While the success of Allied-General's maintenance efforts will be truly evident only if Barnwell becomes fully operational, Allied-General's extensive maintenance activities and relatively successful runs appear to confirm DOE's belief that the facilities have been adequately maintained. Furthermore, an NRC official and the industry representative we contacted who are familiar with the Barnwell facilities agreed with DOE officials that the plant facilities have been adequately maintained. Although one industry representative pointed out that there are

technical concerns⁸ that need to be addressed to enhance the operability of the plant, he said that these concerns are not the result of inadequate maintenance activities.

We also reviewed Allied-General's personnel records to determine whether Barnwell's key personnel have been retained. Although prior to our evaluation neither Allied-General nor DOE officials had identified the key personnel needed to be retained, we obtained a list developed by Allied-General officials, upon our request, of individuals whom they considered essential in December 1978. The list consisted of 336 individuals whom Allied-General considered as having skills necessary to operate and maintain Barnwell as a reprocessing plant and would be costly to replace. DOE officials basically agreed with Allied-General's list of key personnel. They said that Allied-General's list is extensive and includes individuals with the unique expertise needed to operate and maintain Barnwell.

In reviewing Barnwell's personnel records, we found that Allied-General's list of key personnel included individuals who appeared to have the expertise and skills needed to operate and maintain the plant. These individuals included Barnwell's management staff, nuclear engineers, chemists, control room operators, welders, and maintenance technicians, who are familiar with reprocessing, chemical processes and the construction and operation of Barnwell. Of the 336 individuals designated as key personnel by Allied-General, 230 remained as of December 1982, representing a retention level of about 68 percent. In addition, more than half of Barnwell's management staff have been retained. Furthermore, Allied-General officials pointed out that since December 1978, they have hired approximately 100 additional people to conduct various R&D activities. These officials stated that they believe a number of these people have acquired a good understanding of the Barnwell operation and if a new key personnel list was formulated, they would be included because of their experience and training.

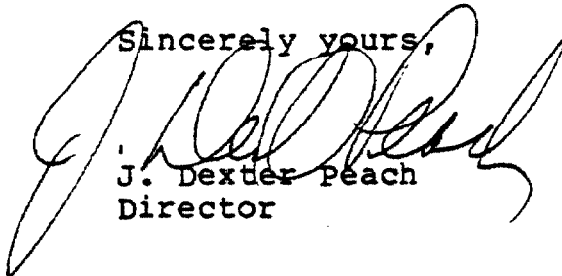
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We did not obtain formal comments on this report. However, the information presented in this report was discussed with Allied-General, DOE, and NRC officials to ensure accuracy.

⁸Technical concerns will be discussed in a report that we are currently preparing on the status of Barnwell and its potential to become operational.

As arranged with your office, we plan no further distribution of this report until 3 days from the date of the report. At that time, we will send copies to the Chairman, Subcommittee on Energy Research and Production, House Committee on Science and Technology, who sent us a similar request. We also plan to send copies to the Office of Management and Budget; the Secretary of Energy; and other interested parties. We will also make copies available to others on request.

Sincerely yours,

A large, stylized handwritten signature in black ink, appearing to read 'J. Dexter Peach', is written over the typed name and title.

J. Dexter Peach
Director