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GAO's Views on DOE's New Production Reactor Selection Process

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Department of Energy Defense Nuclear Facilities Panel
Committee on Armed Services
House of Representatives

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Mr. Chairman and Panel Members:

We appreciate the opportunity to discuss the results of our review of the Department of Energy's (DOE) new production reactor (NPR) selection process. We were asked in June 1988 by Representative Vic Fazio to conduct the review because of the budget and national defense implications and are testifying today with his agreement. As you are aware, DOE has recommended construction of two reactors, one at its Savannah River Site in South Carolina and another in Idaho. These two reactors are needed to replace the aging tritium producing reactors at Savannah River which are presently shut down. Tritium is vital to our national defense in that it is used in nuclear weapons and must be periodically replaced. Our work has identified several issues which the Congress may find useful in reaching a decision on the direction and funding of the NPR program.

In summary, we found that DOE's August 8, 1988, report to the Congress that recommended a two-reactor strategy does not provide a complete and clear picture of all implications of implementing the strategy. In addition, subsequent events have affected the basis on which the strategy was developed. Specifically, our review disclosed that

-- Since DOE made its recommendation to the Congress, conditions have changed with respect to the reliability of the tritium producing reactors located at DOE's Savannah

River site in South Carolina. DOE's recommended strategy assumed that these reactors would continue to be a reliable source of tritium for at least 10 years. The reactors are presently shutdown and it is uncertain as to when they will be restarted and what actions will be required to assure reliability for several more years.

-- DOE's report to the Congress does not provide clear information concerning the total time frame necessary to construct and obtain tritium from the two suggested reactors. In addition, the DOE schedule does not provide any contingency for uncertainties in areas of schedule risk.

-- Some cost estimates are inaccurate because DOE used unrealistic assumptions in their development.

-- The benefits of demonstrating an inherently safe modular high-temperature, gas cooled reactor for commercial application may be achieved quicker under another DOE program.

I would now like to discuss these issues in some detail.

RELIABILITY OF TRITIUM

PRODUCTION HAS CHANGED

The changed conditions refers to the reliability of the tritium-producing reactors at the Savannah River Site and how this relates to the new production reactor decision or selection.

In December 1987, the Congress directed DOE to prepare and submit an acquisition strategy report for replacement production reactors to fulfill the nations long-term requirements for tritium. DOE was instructed to provide a recommendation to the Congress on the preferred alternatives for achieving replacement nuclear materials capacity, including (1) the number of production reactors required, (2) a comprehensive cost estimate for each reactor, (3) the preferred technologies, (4) the preferred sites, (5) and a time schedule for their acquisition, construction, and operation.

On August 8, 1988, DOE submitted its report to the Congress which recommended a two-reactor strategy--a heavy-water reactor at the Savannah River Site capable of producing 100 percent of goal, or the amount of tritium needed to satisfy national defense purposes; and a modular high-temperature, gas-cooled reactor at the Idaho National Engineering Laboratory which would produce 50 percent of goal.

In addition, the report also stated that, as a contingency, work should continue on tritium target development for the light-water reactor and on solving the institutional issues associated with the acquisition and completion of WNP-1 as a production reactor. WNP-1 is a partially completed light-water reactor located on DOE's Hanford Reservation near Richland, Washington. This reactor is owned by the Washington Public Power Supply System and was intended for commercial power production. However, construction of the plant was halted in April 1982 because of uncertainties in the future demand for electric power and financing difficulties.

In making its August 1988 recommendation, DOE assumed the tritium producing reactors operating at Savannah River would maintain their operational reliability during the period necessary to provide new production capacity, which according to DOE is about 10 years. However, the day before the Secretary of Energy announced his recommendations, the reactor operators experienced problems while restarting one of the reactors at Savannah River. Although the reactor was safely shut down, the event cast some doubt on the ability of the operators to properly operate the reactors. Since the reliability of the tritium-producing reactors at Savannah River is a key issue and most definitely affects the new production reactor program, I would like to discuss some of the decisions facing DOE which relate to these reactors.

Plans for future operation of the reactors depend on resolving numerous technical and resource problems. For example, restart dates depend on which safety improvements must be completed prior to restart and whether additional resources will be needed to complete these improvements. Also, restart power levels are important since they determine how much tritium will be produced. Decisions on power levels will depend on resolving such issues as whether components of the primary cooling systems can be expected to leak and to be detected before breaking, allowing timely and safe shut down to avoid a loss of coolant accident.

The dates of restart, attainable power levels, and maintenance outage times for all three Savannah River reactors will determine how much tritium can be produced. These factors will remain uncertain until a comprehensive management plan and full-resourced work schedules are developed. In addition, analysis of the condition and remaining useful lives of each reactor must be completed. DOE must also establish a credible decisionmaking process to ensure confidence in, and ability to implement operations plans for, these reactors until a new production reactor is on-line. In this connection, the Secretary of Energy has stated that the reactors will not be restarted until sometime in 1990.

Alternative sources of tritium are also very uncertain. While it may be feasible to restart the N-reactor at Hanford, numerous technical and political problems would have to be overcome. The same is true for conversion of civilian light-water reactors to produce tritium. The combination of civilian and military uses of atomic energy would represent a significant change in U.S. policy.

Some adjustments in tritium requirements may be possible, but DOE cannot make these changes unilaterally. Increased efficiency in the logistical pipelines that support the nuclear weapons stockpile may be possible. Coordinated action between DOE and DOD would be necessary and may be limited by cost considerations. Similarly, DOE may be able to economize on the quantities of tritium it maintains at its production facilities.

Adjustments in requirements may be limited by other factors as well. The entire nuclear weapons complex is aging and may be unable to sustain the stress of increased workload to process nuclear materials faster. Changes in operations at one facility such as the reactors can ripple throughout other facilities and cause bottlenecks or breakdowns.

Given the above, the need for a new production reactor is more acute than it was when DOE made its recommendation to the Congress. The entire nuclear weapons complex is aging, deteriorating, and has significant environmental and safety problems. Thus, while a new reactor will not provide a solution to the present problems, it should come on-line as soon as possible to provide a secured source or supply of tritium.

I will now give our views on the schedule for the new production reactors.

INADEQUATE SCHEDULE INFORMATION
AND SCHEDULE UNCERTAINTIES

DOE's August 8, 1988, report to the Congress did not provide a clear schedule for completing the new production reactors or when tritium would actually be realized. The report simply stated that approximately 10 years would be needed to provide new production capacity.

We found, however, that the 10 years did not include the time needed for testing, nor the time needed to produce and extract tritium. In the case of the heavy-water reactor, the schedule would thus have to be increased from 10 to 12.5 years because 1 year is needed for testing and 1.5 years for production and extraction of a full load of tritium.

The modular high-temperature, gas-cooled reactor is somewhat different in that it will be built in phases, but it will be a total of 16 years, instead of 10 years, before DOE will obtain the first full load of tritium or 50 percent of goal from this reactor. Again, the 16 years includes the time necessary to produce and extract the tritium. We recognize that after the first module is installed and put into operation DOE should, after 12 years, be able to obtain an amount of tritium equal to 12.5 percent of goal.

During the selection process, DOE did consider two additional reactor technologies--the liquid metal reactor and the light-water/WNP-1 reactor. While DOE did not recommend either of these reactor technologies, DOE did present schedules showing that the liquid metal reactor would take about 14 years and the WNP-1, which is partially complete, would take about 7 years to complete, including full tritium production and extraction. The chart displayed before you shows each of the four technologies evaluated by DOE. Shown are the number of years required before the first full load of tritium will be realized from each reactor, the percentage of the nation's tritium goal each reactor will supply, and the capital and life-cycle cost of each reactor. A similar chart is attached to this testimony.

It is worth noting, as shown in the chart, that in terms of tritium out, WNP-1 could be done quicker and at less overall cost. In September 1988, GAO issued a report[1] on completing WNP-1 as a defense production reactor. The report addresses both technical issues related to target development and institutional issues related to acquisition, and public and political acceptance.

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[1] Nuclear Science: Issues Associated With Completing WNP-1 as a Defense Materials Production Reactor (GAO/RCED-88-222, Sept. 21, 1988).

In addition to previously mentioned schedule increases, there is clearly potential for the schedule of each reactor to increase significantly. In this respect, during our review we noted several uncertainties, which DOE is aware of, but has not factored into its schedule. These include the safety review process, environmental challenges, and construction risks. I will briefly comment on these uncertainties.

First, the safety review process facing DOE is basically unknown. Legislation was enacted in September 1988 setting up a DOE Defense Nuclear Facilities Safety Board. However, no members have yet been appointed, and its specific requirements are unknown. In this regard, DOE has testified before the Congress that the new production reactors will "provide a level of safety assurance that meets or exceeds that afforded to the public by licensed commercial nuclear power plants . . . ." This suggests intensive safety reviews equivalent in many respects to those conducted by the Nuclear Regulatory Commission in its oversight of commercial plants. In this respect, it will be a new experience for DOE because none of DOE's production reactors have undergone such a review.

Second, DOE's schedule shows an orderly transition from issuance of a final environmental impact statement to the beginning of detailed design and procurement of long-lead construction items. Environmental challenges, similar to ones faced in the commercial nuclear power industry, are likely to occur and could cause schedule problems. While it is difficult to speculate as to whether or not significant delays may be encountered, there is clearly potential risk to the schedule.

And last, construction risks may have the greatest potential of all uncertainties to increase the schedules for new production reactors. DOE's construction schedule is very optimistic in that it shows 5.5 years from start of construction to fuel loading for the heavy-water reactor and a similar schedule for the modular high-temperature, gas-cooled reactor. During our review, we noted that new commercial reactors, for which the technology is well-known, completed between 1977 and 1980 took about 9 years for the same basic construction period, i.e., from start of construction to fuel loading. This indicates that DOE believes it can construct reactors of new and different design in about two-thirds the time required by the commercial industry to construct a reactor using well-known technology.

For a further comparison, the scheduled construction time to complete the WNP-1 reactor, which is presently 63 percent complete, is 4 years. DOE estimates, on the other hand, that it will be able to construct a new reactor from scratch in only 5.5 years. In other words, DOE's schedule anticipates taking 1.5 years longer to construct an entire plant than to complete one that is 63 percent complete.

In addition to the uncertainties I have just discussed, I would like to mention one more. This concerns the ability of any of the reactor technologies to produce goal quantities of tritium. While all technologies can eventually meet goal, there are outstanding technical questions which have to be resolved for each technology which might delay reactor development. These involve design, fuel and target technology, and other technical problems. For instance, the heavy-water reactor will employ a new design which may require some research and development to ensure its success. The modular high-temperature, gas-cooled reactor is a new technology and many technical problems may have to be resolved. If the schedule for resolving these problems is not met, then the overall schedule may increase. This brings me to the next issue which is cost.

COST INFORMATION IS UNCLEAR

DOE was directed by the Congress to provide a comprehensive comparative financial analysis and cost estimate of alternatives considered.

DOE contracted with Martin Marietta, its operations contractor at Oak Ridge National Laboratory, to perform the cost study. At DOE's direction, the contractor developed cost estimates for each of the four technologies, assuming each would produce 100 percent goal quantity of tritium and take 10 years to construct. We believe the methodology used by DOE's contractor was uniformly applied to all technologies.

DOE decided to accept the concept of duality and recommended the construction of more than one reactor at more than one location. Just prior to making its recommendation to the Congress, DOE began to look at various options such as two different technologies producing 100 percent of goal, one technology producing 100 percent of goal and one producing 25 percent of goal, or two reactors using the same technology with each producing 75 percent of goal or each producing 50 percent of goal. In total, DOE was looking at 18 different options. During a short period of time, DOE developed cost estimates for each option.

The estimates were developed using Martin Marietta's cost information for full-sized reactors and scaling them down to develop costs for less than full-sized reactors. In our judgment, DOE's scaling assumptions were not realistic and resulted in improper and unrealistic cost estimates for the various options. For example, DOE's estimates showed the net life-cycle cost of a full-sized modular high-temperature, gas-cooled reactor that would produce 100 percent of goal was less than that of a half-sized reactor which would produce 50 percent of goal.

In addition, after calculating the cost of a half-sized, gas-cooled reactor to be built on a 10-year schedule, DOE decided to change the schedule to 16 years. DOE, however, did not increase the estimated cost to allow for the stretched out schedule, nor did it perform a detailed cost analysis to support its position that no cost increase would occur. We believe it is unrealistic to assume that you can take 6 years longer than originally planned to construct a facility and not incur any increased costs. At a minimum, carrying or finance charges on work in progress, as well as administrative overhead, would increase.

We believe that because of these and other questions concerning cost, DOE's cost estimating approach did not allow for adequate comparison between different options. In addition, we would like to point out that the costs presented on the chart before you are only estimates. In this respect, we would like to note that the recent history of the nuclear industry shows that the average final cost of constructing commercial reactors in the United States has exceeded initial cost estimates by a factor of seven, including inflation. Also, DOE's proposed two-reactor strategy has the added uncertainty of not yet having detailed reactor designs, without which it becomes very difficult to develop a firm estimate.

According to DOE's current schedule, a final decision on the new production reactors will be made in late 1991. At that time, DOE will be asking the Congress to make a very large cost commitment which will stretch out over a number of years. We believe that DOE and the Congress need much better cost information than is presently available in order to make that final decision.

BENEFIT DUPLICATION

I now want to discuss benefit duplication which concerns one of the technologies recommended--the modular high-temperature, gas-cooled reactor. One advantage of selecting this technology is the possibility of demonstrating an inherently safe reactor for our commercial nuclear power industry.

In light of the global warming issue and concerns over reactor safety, there is merit to demonstrating such a reactor for future power generation. However, the new production reactor program is not necessarily needed to demonstrate the modular high-temperature, gas-cooled technology for commercial application. In this respect, we noted during our review that DOE is, and has been for several years, funding a program directed specifically toward demonstrating a commercial modular high-temperature, gas-cooled reactor. The Advance Reactor Program Office under the Assistant Secretary for Nuclear Energy has initiated design work on such a reactor, and is working closely with the Nuclear Regulatory Commission on licensing and certification matters.

Presently, the DOE commercial modular high-temperature, gas-cooled reactor program is ahead of its NPR counterpart. In addition, owing to the involvement of the Nuclear Regulatory Commission and the commercial program's close ties to the commercial power industry, DOE's commercial program is likely to be better suited to transfer the technology to the commercial sector.

In fact, it is our understanding that one utility has expressed a strong interest in a commercial gas-cooled nuclear plant and is taking initial planning steps toward determining the feasibility of acquiring such a plant. DOE's commercial program officials estimate a completed commercial modular high-temperature, gas-cooled reactor could be on line by 2002.

DOE has recognized that the two modular high-temperature, gas-cooled reactor programs are duplicative and in March 1989 issued a document coordinating the two efforts. The document identifies common design and development activities and also notes differences in the programs. However, the fact still remains that DOE is spending money in two different programs to develop a similar reactor technology.

GAO'S VIEWS ON DUALITY

Before concluding, I would like to comment on one other aspect of the new production reactor strategy which DOE, the Department of Defense, and the Congress will have to decide--this is the issue of duality.

We realize that from a budget standpoint duality is costly, and as a result, should be fully analyzed from a cost benefit as well as national security standpoint before a final decision is made. Such a cost benefit analysis should assist the Congress in prioritizing funding decisions, especially given that DOE funding needs for the weapons complex for maintenance, upgrade, new construction, environmental cleanup, and decommissioning/decontamination of facilities are also considerable.

CONCLUSIONS

In conclusion, DOE has recommended a two-reactor strategy that, at best, will provide tritium for national defense purposes in 12.5 years. The same strategy will provide a back-up reactor after 16 years that will provide 50 percent of the tritium necessary to meet national defense needs. Schedule uncertainties may further increase the time required to realize tritium from the recommended strategy.

Given the importance of tritium to our national defense and the need for a new production reactor or reactors, it is important that DOE thoroughly assess all available options for tritium production and provide clear and accurate information to the Congress concerning the options. DOE has not yet provided an in-depth or realistic analysis of schedule, costs, and benefits associated with an acquisition strategy.

RECOMMENDATION

Accordingly, we recommend that, prior to reaching a final decision on the new production reactors, now scheduled for late 1991, DOE provide the Congress with an in-depth analysis of schedule, costs, and benefits of each option.

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Mr. Chairman, this concludes my statement. I would be pleased to respond to any questions a+ this time.

ATTACHMENT I

NPR Options

Options	Tritium Out	Percent of Goal	Capital Cost	Life Cycle Cost
	(Years)		---(dollars in billions)---	
HWR	12-1/2	100	$ 3.2	$ 19.7
MHTGR	16	50	3.6	18.6
WNP-1	7	80	2.2	12.1
LMR	14	100	4.4	18.0