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There are three Government-owned uranium enrichment plants in the United States: at Oak Ridge, Tennessee; near Paducah, Kentucky; and near Portsmouth, Ohio. These uranium enrichment plants use gaseous diffusion to enrich the uranium, a technology the Government has successfully used for 30 years. Because the capacity of the three plants is fully committed, in 1976 Congress authorized construction of an add-on to the Portsmouth diffusion plant. However, in 1977, the President announced that, instead of the add-on, the Department of Energy would build an equivalent-sized plant using a technology called gas centrifuge. Findings/Conclusions: The advantages of centrifuge technology and the difficulties in obtaining electrical power for a diffusion plant have led to the conclusion that the economic and technological benefits to be gained by using centrifuge technology may be worth the risk. It is uncertain, however, whether the project will be completed within cost and schedule estimates and what role private industry will assume in the project. There does not appear to be a clear advantage to building the plant at either Oak Ridge or Portsmouth. Cost comparisons show a \$200 million advantage at Oak Ridge. There will be some disruption associated with a relocation, and any decision on this matter should consider the effect any delay would have on the ability to meet enrichment demand. (RRS)

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REPORT BY THE

Comptroller General

OF THE UNITED STATES

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Centrifuge Enrichment: Benefits And Risks

RELEASED
3/9/78

The President decided to use the new centrifuge technology instead of the proven diffusion technology for the uranium enrichment plant to be built at Portsmouth, Ohio. This report addresses the appropriateness of (1) substituting the new technology and (2) building the plant away from the centrifuge development facilities at Oak Ridge, Tennessee.

The advantages of centrifuge technology and the difficulties in obtaining power for a diffusion plant led GAO to agree that the economic and technological benefits to be gained by using the centrifuge technology may be worth the risk.

There does not appear to be a clear advantage to building the plant at either Oak Ridge or Portsmouth. Cost comparisons show a \$200 million advantage at Oak Ridge, but this could be offset by a delay if the decision was made to relocate the plant at Oak Ridge.





COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-159687

The Honorable Howard H. Baker, Jr.
The Honorable Clifford P. Hansen
The Honorable James R. Sasser
United States Senate

This report addresses the issues you raised on the President's decisions to substitute the new gas centrifuge technology for the proven gaseous diffusion technology in this country's next uranium enrichment plant, and to build that plant near Portsmouth, Ohio. You requested us to review the appropriateness of (1) substituting technologies and (2) building the plant distant from the gas centrifuge research, development, and demonstration facilities at Oak Ridge, Tennessee--including consideration of the economic cost and the potential for delays.

Because of the short time available to complete our review, we relied primarily on information available in the Department of Energy's reports, analyses, project plans, and correspondence. We supplied this information through discussions with Department officials and officials of Union Carbide Corporation, Nuclear Division--the operator of the Department's principal centrifuge research, development, and demonstration facilities.

In summary, the advantages of centrifuge technology and the difficulties in obtaining electrical power for a diffusion plant led us to agree that the economic and technological benefits to be gained by using centrifuge technology may be worth the risk. It is uncertain, however, whether the project will be completed within cost and schedule estimates, and what private industry's role in the project will be.

There does not appear to be a clear advantage to building the plant at Oak Ridge or Portsmouth. Proximity to the development facilities has both advantages and disadvantages. While cost comparisons show a \$200 million advantage at Oak Ridge, this could be offset by a delay if the decision were made to relocate the plant to Oak Ridge. Certainly there would be some disruption associated with a relocation. Any decision on this matter should consider the effect any delay would have on this country's ability to meet enrichment demand.

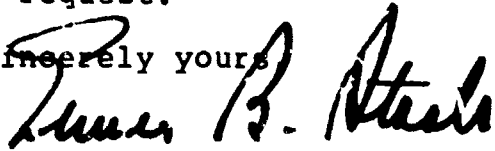
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The attached appendix I discusses our findings and conclusions in more detail. At your request, we did not take the additional time to obtain written comments on this report. It was, however, discussed with Department officials, and we incorporated their comments as we believed appropriate.

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As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 2 days after the date of the report. At that time, we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,



Comptroller General
of the United States

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EVALUATION OF THE DECISION TO USE
GAS CENTRIFUGE TECHNOLOGY

BACKGROUND

Natural uranium contains about seven-tenths of one percent of the energy-producing uranium-235 isotope. The remainder of the natural uranium, uranium-238, cannot be used in most nuclear reactors. The enrichment process separates the two uranium isotopes until the uranium-235 content is increased to the desired level. Light water reactors require uranium enriched to about 3 percent uranium-235.

There are three Government-owned uranium enrichment plants in the United States. These plants are located at Oak Ridge, Tennessee; near Paducah, Kentucky; and near Portsmouth, Ohio. They are operated by private firms under cost-plus-fixed-fee management contracts. Union Carbide Corporation, Nuclear Division, operates the Oak Ridge and Paducah plants, and Goodyear Atomic Corporation operates the Portsmouth plant.

These Government uranium enrichment plants use a technology called gaseous diffusion to enrich the uranium. The Government has successfully used this technology for the past 30 years.

With this technology, which requires large amounts of electrical power, uranium feed is forced through a series of filters that separate it into two streams. The lighter uranium-235 isotopes pass through the filters more readily than the other isotopes and become the product stream. The heavier isotopes are collected into the second stream, which is residual material.

The production capacity of the three diffusion plants is fully committed to meeting the demands of existing enriched uranium customers. As a result, in fiscal year 1976, the Congress authorized construction of an add-on to the Portsmouth diffusion plant to supply the next increment of enrichment capacity. At that time, the Energy Research and Development Administration--now part of the Department of Energy (DOE) 1--intended that the add-on would use diffusion technology.

1/Effective October 1, 1977, the Energy Research and Development Administration's responsibilities were transferred to DOE. Hereafter, actions taken before this transfer will be identified as DOE actions.

On April 20, 1977, the President announced that instead of building a diffusion add-on plant, DOE would build an equivalent-size plant using a different technology called gas centrifuge. With this technology, the uranium spins in a centrifuge machine until the lighter and heavier isotopes have separated into two streams--a product stream of enriched uranium and a waste stream of depleted uranium. DOE needs tens of thousands of centrifuge machines for the plant. The President later announced that, as authorized, DOE will build the plant at Portsmouth, Ohio.

The President made this decision, in part, because the centrifuge plant will require about 96 percent less electricity than an equivalent size diffusion plant. DOE officials said that recent reductions in projected enrichment demand are sufficient to allow any temporary excess demand to be covered by the enriched uranium stockpile which, in turn, will allow time to fully develop the centrifuge technology. DOE expects to complete the centrifuge plant in 1988, at a cost estimated to range from \$4.2 to \$4.5 billion, depending on the extent of private participation, in fiscal year 1978 dollars.

In reviewing the President's decision and DOE's plans to implement that decision, we addressed the following:

- What is the status of centrifuge development in this country?
- What was the basis for the administration's decision to use centrifuge rather than diffusion technology for the next enrichment plant?
- What are the uncertainties and risks associated with using centrifuge for the next plant and what are DOE's plans for resolving these risks and uncertainties?
- Is the location chosen for the plant appropriate or should it be built near the centrifuge research, development, and demonstration facilities in Oak Ridge, Tennessee?

To address these matters in the short time available, we relied primarily on information available in DOE reports, analyses, project plans, and correspondence. We supplemented this information through discussions with DOE officials and officials of Union Carbide Corporation, Nuclear Division--the operator of DOE's principal centrifuge research, development, and demonstration facilities. Also, we reviewed evaluations by five private companies of DOE's plans for building and operating the centrifuge plant.

STATUS OF CENTRIFUGE DEVELOPMENT

DOE has been developing centrifuge technology since the 1960s. It has not been commercially used in this country. Two other enrichment technologies--laser isotope separation and Dawson separation processes--are in the early research stage. If successfully developed, these technologies could considerably lower the cost of enrichment services. DOE, however, does not expect either of these technologies to be ready for commercial application before the 1990s.

Most of DOE's centrifuge research and development facilities are located at Oak Ridge, Tennessee. One of these facilities, completed in 1974, is a component preparation laboratory for developing centrifuge machine production techniques, and another is a component test facility or pilot plant for testing centrifuge machine reliability and operating methods. This latter facility, which was completed in 1974, contains smaller centrifuge machines than those that will be used at the Portsmouth plant.

DOE is constructing two additional research and development facilities at Oak Ridge which it will use to test centrifuge machines of the type to be used in the Portsmouth plant. Beginning in mid-1978, DOE will use the first facility to test centrifuge machine reliability and plant equipment. It will use the second facility--a demonstration plant--to further test the centrifuge machines and to duplicate the basic centrifuge machine grouping for the Portsmouth plant. The second facility is scheduled to be completed in early 1982.

Other Government centrifuge research and development facilities are located at Torrance, California, and at the University of Virginia. Neither of these two facilities is as large as the Oak Ridge facilities; however, the Torrance facility does have a component preparation laboratory.

BASIS FOR ADMINISTRATION'S DECISION

DOE cites several advantages for centrifuge as the basis for the administration's decision to use that technology rather than diffusion, including:

- Electrical power requirements which are about 96 percent less than for an equivalent size diffusion plant.

- Lower separative work unit ^{1/} costs (about \$86 as compared to about \$123 for diffusion).
- Potential for further technology improvements that does not exist with the older diffusion technology.
- Flexibility in plant size and siting. Centrifuge plants can be built in smaller, economical units.

Lower electrical power requirements

The Portsmouth centrifuge plant is to have an annual capacity of about 8.8 million separative work units. DOE estimates that it will need about 10 percent of the electrical power generated by a large, 1,000 megawatt ^{2/} powerplant to operate the plant. By contrast, an equivalent size diffusion plant requires the electrical power generated from at least three powerplants. As discussed below, obtaining this large amount of power would have been a substantial obstacle to overcome.

Until the President's decision, DOE was negotiating for electrical power with a power company for the then-planned diffusion plant. This company stated that it would consider furnishing power provided that it could set up a new subsidiary company with Government guarantees of the subsidiary's securities.

In addition, the coal powerplants to be constructed under this company's proposal would have had to be licensed under Ohio's powerplant siting law, enacted in 1972. It is uncertain whether or not the licensing requirements established by this legislation would have affected the supplier's ability to provide electrical power by 1988. The supplier would have had to apply for licenses at least 2 years before it planned to start powerplant construction. Before the Ohio State Power Siting Commission could have licensed the plants, it would have had to find, following a public hearing, that the proposed plants would comply with air and water pollution standards and other siting criteria.

^{1/}The production capacity of an enrichment plant is defined in terms of separative work units. This is a measure of the effort expended to separate a given quantity of uranium feed into a product and a waste stream.

^{2/}A megawatt is 1,000 kilowatts.

DOE has had difficulty obtaining electrical power to operate its existing enrichment plants at, or near, full capacity. In fiscal year 1977, for example, DOE operated them at only 80 percent of capacity because it could not obtain full power. Production capacity will remain below maximum until 1985, when DOE expects to have full power.

Any utility difficulties in supplying electrical power adversely affects the diffusion plants' production. For example, during the first half of fiscal year 1977 DOE lost 1,365,000 separative work units--about 14 percent--of its expected production when one electrical power supplier's construction schedules for two nuclear powerplants were delayed and it was unable to deliver the expected power.

DOE also has a policy to release electrical power to its suppliers to provide electricity for residential and industrial customers in an emergency. For example, during the unusually severe winter of 1976-1977 DOE lost an additional 184,000 separative work units when it permitted one electrical power supplier to direct some of DOE's power to other customers. Similarly, DOE has reduced its plants' production by 68 percent, or about 32,000 separative work units a day, because of the coal strike of 1977-1978 and the resultant loss of electrical power.

Although DOE officials are reasonably certain that the plants will have at least the expected power deliveries, situations and losses such as those mentioned above cannot be predicted or prevented. On the other hand, because a centrifuge plant uses 96 percent less electrical power than a diffusion plant, DOE does not anticipate any problems in purchasing the power necessary to operate the centrifuge plant. DOE officials told us that they have requested 21 utilities to indicate their interest in supplying electrical power for the Portsmouth plant, and they plan to start negotiations in 1978.

Lower separative work unit costs

DOE estimates that centrifuge plant separative work unit costs will be about \$37 lower than from a diffusion plant addition. This estimate is based on recovering the (1) estimated operating costs that would be incurred and (2) amortizing the capital expenses over a 25-year period. The following tables compare these cost estimates and the cost per separative work unit.

Comparison of capital and annual operating
cost estimates for a diffusion add-on
and a centrifuge enrichment plant

<u>Estimates</u>	<u>Diffusion add-on</u> (millions of 1978 dollars)	<u>Centrifuge</u> (1978 dollars)	<u>Difference</u>
Capital cost	\$2,900.0	\$4,200.0	\$1,300.0
Interest on capital cost	<u>754.0</u>	<u>1,092.0</u>	<u>338.0</u>
Total capital cost	<u>\$3,654.0</u>	<u>\$5,292.0</u>	<u>\$1,638.0</u>
Power cost	\$ 662.0	\$ 25.8	\$ (636.2)
Other operating cost	<u>21.2</u>	<u>147.9</u>	<u>126.7</u>
Total operating cost	<u>\$ 683.2</u>	<u>\$ 173.7</u>	<u>\$ (509.5)</u>

Comparison of the unit cost of separative
work for a diffusion add-on and a
centrifuge enrichment plant

<u>Estimates</u>	<u>Diffusion add-on</u> (1978 dollars)	<u>Centrifuge</u> (1978 dollars)	<u>Difference</u>
Capital	\$ 45.70	\$66.20	\$ 20.50
Other operating	2.40	16.80	14.40
Power	<u>75.20</u>	<u>2.90</u>	<u>(72.30)</u>
Total costs per sepa- rative work unit	<u>\$123.30</u>	<u>\$85.90</u>	<u>\$(37.40)</u>

DOE believes the diffusion plant cost estimates are firmer than those for the centrifuge plant because (1) it has had extensive experience with diffusion technology, and (2) the centrifuge cost estimates are based on 1975 conceptual designs--rather than detailed designs--for a plant to be built at Oak Ridge, adjusted to:

--escalate the capital cost by \$960 million, using an annual inflation rate ranging from 8 to 10 percent to reflect fiscal year 1978 dollars;

--add \$440 million to reflect the capital costs of technical support, the addition of a third centrifuge

machine manufacturer, and changes in centrifuge machine design; and

--add \$200 million to reflect additional capital costs to build the plant in Portsmouth rather than Oak Ridge (see p. 14).

DOE is developing new cost estimates using October 1977 materials prices and wage rates. These new estimates will still be based on the conceptual design drawings but will include more current construction wage rates at Portsmouth and unit prices for materials. A DOE official said he does not expect any significant change in the total project cost.

This revised cost estimate will still be tentative because DOE does not have experience with a production size centrifuge plant, nor is there an existing industrial capability to manufacture the centrifuge machines and related components.

Centrifuge machine costs provide a good example of the tentative nature of the estimates. DOE estimates that about \$1.8 billion of the \$4.2 billion capital cost--or 43 percent--will be needed to buy centrifuge machines from two or more private companies. None of these companies, however, has developed a capability to manufacture machines in the necessary quantities. Furthermore, DOE has not finalized the design specifications which it will use to buy centrifuge machines. Thus, it is difficult to estimate what the final machine cost for the plant will be.

We noted, however, that the total capital and operating costs over a 10-year period could increase by about \$3.5 billion and still be competitive with the cost of enriched uranium produced by a diffusion plant. This is because of the higher power costs--over \$6.6 billion for the 10 years--of operating the diffusion plant.

Potential for technology improvements

DOE is making major improvements to the three existing diffusion plants to significantly increase their capacities. The planned Portsmouth diffusion add-on would have included these improvements. DOE does not expect any additional major improvements in the diffusion technology but does expect that experience in constructing and operating the centrifuge plant will lead to future improvements with this technology.

Flexibility in size and siting

DOE says that a centrifuge plant with a 3 million separative work unit annual capacity--about one-third the size of the Portsmouth plant--could be built and operated economically, while diffusion plants cannot be built and operated economically in sizes smaller than about 9 million separative work units per year. DOE points out that it would be easier to find suitable sites for smaller plants, and that incrementally building several smaller plants would keep enrichment capacity and demand more closely aligned.

RISKS AND UNCERTAINTIES ASSOCIATED WITH USING CENTRIFUGE TECHNOLOGY

There are risks associated with using centrifuge technology for the next increment of enrichment capacity. Furthermore, although DOE originally proposed to rely heavily on private industry to construct and operate the plant, industry's role has not been defined.

Risks

The major drawback to using the centrifuge technology for the next enrichment plant is the risk associated with depending on a commercially unproven technology. Completing the project on schedule depends heavily on (1) achieving the expected operating reliability and production capability of the tens of thousands of centrifuge machines to be installed in the plant and (2) establishing the capability to manufacture these machines and related components on time.

DOE and the private companies with access to the technology express confidence in the centrifuge machines to be used in the Portsmouth plant. As discussed earlier, however, DOE will not begin testing these machines until May 1978, and will not begin operating them in a production mode until January 1982. Thus, their confidence is based heavily on engineering judgement rather than actual operating experience with the Portsmouth plant model.

DOE has recorded over 200 machine years operating time with the smaller pilot plant centrifuge machines. Centrifuge machines have failed more frequently than predicted in the 1975 centrifuge conceptual design report; however, damage to failed machines has been less than DOE officials anticipated.

While DOE now predicts a higher rate of centrifuge machine failure, it also anticipates, based on pilot plant operations, lower individual machine repair costs. Therefore,

there may be little or no increase in net operating costs resulting from more machine failures. DOE's annual operating cost estimate for the Portsmouth plant, excluding power costs, is about \$148 million, or 20 percent of the separative work unit cost. About one-half of this cost is for machine replacement parts and materials. Theoretically, a 100 percent increase in machine replacement and repair costs would only increase the separative work unit cost by about \$9--from \$86 to \$95.

Another major risk is whether or not the centrifuge machines will reach expected production goals. DOE has not reached separative work unit production goals from several test runs in the pilot plant. DOE officials pointed out, however, that the pilot plant does not have the environmental conditions needed for achieving optimum separative work capacity. They said they have isolated the causes of these problems and will make the necessary adjustments to the Portsmouth plant. If the centrifuge machines do not operate as expected, DOE will not achieve its expected annual production from the Portsmouth plant.

Finally, capability to manufacture the large quantity of centrifuge machines and related components does not now exist, nor is there assurance of an adequate supply of certain critical materials 1/. DOE has started to develop this manufacturing capability by granting private companies access to classified centrifuge technology and qualifying four companies to build small centrifuge machines for the pilot plant. DOE has also made preliminary inquiries on possible sources of supply and availability of critical materials and is now awaiting reports on the quantities needed for this project.

Uncertainty about private industry's role

In April 1977, DOE proposed hiring up to three private companies--in addition to the contractor responsible for operations--to assist it in designing, constructing, and operating the Portsmouth centrifuge plant. The objective was to encourage private industry to construct and operate future uranium enrichment capacity without Government assurances.

Under this proposal, each company would be responsible for (1) supplying and installing centrifuge machines and

1/The identification of these materials is classified.

related equipment, (2) participating in design, (3) designing separate support facilities, and (4) operating the plant. DOE estimated that this level of participation would increase the project's cost from \$4.2 billion to \$5.1 billion in fiscal year 1978 dollars, primarily for building the separate support facilities.

Because of this additional cost, DOE changed the proposed scope of possible private industry involvement. Rather than construct separate support facilities, DOE would construct common facilities with some modifications to accommodate up to four companies. Furthermore, DOE would restrict the private companies' roles during design and construction to reviewing and commenting on specific project plans. They would not design any equipment or facilities as originally proposed. During operations, the private companies would be responsible for operating and maintaining the plant within overall operating constraints established by the responsible operating contractor, and would not be authorized to modify plant design. DOE projects that this approach would add about \$300 million (fiscal year 1978 dollars) to the project's cost--\$200 million for facility modifications and \$100 million for the companies' participation.

DOE recognizes that the influence private companies could have on the project diminishes as time goes by and their potential for gaining experience declines similarly. Also, in March 1977, the companies which have expressed an interest in participating in the project told DOE that a limited role, such as that described above, would not provide satisfactory experience to permit purely commercial decisions to be made on follow-on capacity. Thus, the major question that must be answered in reaching a decision on this matter is whether the benefits to be gained from this limited industry participation is worth the additional cost.

IS THE LOCATION APPROPRIATE?

DOE, in its 1975 conceptual design study discussed earlier, said there would be significant advantages to building the centrifuge plant near the development facilities at Oak Ridge. The Energy Research and Development Administration's Acting Assistant Administrator for Nuclear Energy, in a March 1977 memorandum to the Acting Administrator, also cited several advantages to building the plant at Oak Ridge, including its proximity to the development facilities. He also recognized that there would be an advantage to building it away from these facilities in a more "production" oriented atmosphere and that a change from the Portsmouth site would require new authorizing legislation--an action which would most likely

delay the project. On July 11, 1977, DOE announced that the President had approved the Portsmouth site for the centrifuge plant as originally authorized.

We inquired about the expected impacts of building the first centrifuge enrichment plant at Portsmouth rather than at Oak Ridge. Specifically, we asked about the:

- advantages and disadvantages of building the plant away from the research, development and demonstration facilities;
- relative cost of building the plant at Portsmouth rather than at Oak Ridge; and
- potential for project delays associated with each site.

Distance from development facilities

The 1975 conceptual design study concluded that significant advantages would be gained by building the plant near the development facilities because technical personnel would be available during construction, start-up and operation. DOE officials say, however, that this advantage is not now significant because centrifuge technology is sufficiently developed to allow its transfer to any site.

To assist in transferring this technology, DOE is assigning the developers project-related management responsibilities. The management structure includes major roles for the developers in designing and constructing the plant as well as in designing, buying, and testing the centrifuge machines. Thus, DOE believes that the current project plan incorporates both the advantages of involving development personnel in the project while, at the same time, building the plant away from research and development facilities where there may be a tendency to continue development work at a production plant.

Cost of plant location

DOE's cost estimates show that labor costs at Portsmouth would add about \$270 million in fiscal year 1978 dollars to the project's cost. These additional costs, however, could be offset by eliminating the \$70 million in land improvement costs that would be needed at Oak Ridge, resulting in a net \$200 million added cost to build the plant at Portsmouth rather than Oak Ridge. According to DOE, this would add an additional cost of \$3 per separative work unit at Portsmouth.

DOE computed these costs based on its 1975 conceptual design study and a later determination and comparison of site and labor costs at Portsmouth versus Oak Ridge. As we noted earlier, the conceptual design study cost estimates are tentative and subject to change after detailed design is completed. In addition, because the 1975 cost estimates were based on an Oak Ridge location, DOE is revising them to reflect the site change. This revision could change the estimated cost for building the plant in Portsmouth and could therefore change the cost difference computed between Portsmouth and Oak Ridge.

Potential for project delay

In July 1977, DOE estimated that it would take about 11 years to complete the project at Portsmouth and 10-1/2 years at Oak Ridge. DOE officials attributed this 6-month difference primarily to site-related work at Portsmouth which would not be necessary at Oak Ridge.

DOE officials pointed out, however, that it has already taken steps to build the centrifuge plant at Portsmouth. For example, it is constructing a new administration building, has transferred some project personnel to Portsmouth, and is negotiating the architect-engineer contracts based on the Portsmouth site. For this reason, the manager of DOE's Oak Ridge Operations Office, who has overall management responsibility for building and operating the centrifuge plant, told us that the earlier schedule advantage at Oak Ridge may have been eliminated. Furthermore, he estimated that there could be as much as a one year delay in completing the project if the plant were to be relocated at Oak Ridge. He said this could occur primarily because a change (1) would destroy the project's momentum, (2) would require the relocation of project personnel, and (3) might necessitate a renegotiation of architect-engineer contracts. He emphasized, however, that his estimate was based solely on his professional judgement rather than a detailed analysis of what affect such a move would have on the project's completion.

CONCLUSIONS AND OBSERVATIONS

There are some risks associated with depending on a commercially unproven technology to supply the next increment of enrichment capacity. These risks are related primarily to (1) using centrifuge machines which have never been used in a commercial production environment and (2) establishing an industrial capability to manufacture these machines and related components in time to meet the scheduled completion date. The advantages of centrifuge technology, however, and the difficulties

obtaining power for a diffusion plant lead us to agree that the economic and technological benefits to be gained by using the centrifuge technology may be worth the risk. Obtaining sufficient power to operate a similar size diffusion plant presents a substantial obstacle to supplying enrichment capacity when needed.

The cost of the project is a major uncertainty because current estimates are based on conceptual rather than detailed engineering design and cost studies. This is, however, the best available information. Furthermore, final project costs could increase by almost \$3.5 billion over current estimates and still be competitive with the cost of enriched uranium produced by a diffusion plant.

Private industry's role in constructing and operating the centrifuge plant is another uncertainty requiring early resolution. DOE is considering hiring up to three private companies--in addition to the contractor responsible for operations--to operate the plant. DOE officials told us that this issue is under review. In our view, an immediate decision on this issue is vital, but should be made in the context of the Government's position on encouraging private industry's entrance into the uranium enrichment market. If the Government wants to encourage private industry's entry--an approach that could add to the project cost--hiring multiple operators could be beneficial because more companies would be gaining experience with the centrifuge technology; however, maximum benefit would be gained if DOE involved these operators early in plant design and construction rather than just plant operation.

On the other hand, if the Government does not want to encourage private industry's entry into the enrichment business, hiring multiple operators will provide little or no benefit to the Government given the current status of the project and the increased cost of using more than one operator.

In view of industry's position that a limited role would not provide satisfactory experience to permit purely commercial decisions to be made on follow-on capacity, it is questionable whether the approach DOE is now considering would significantly encourage private industry's entrance into the uranium enrichment market. There may be other alternatives to provide industry experience in operating centrifuge enrichment plants. For example, DOE could use the demonstration facility it is now constructing to train employees of interested private companies.

This brings us to the question of where the plant should be built. Based on the tentative estimates, there is a \$200 million cost advantage for building it at Oak Ridge, but this could be offset by a possible delay in completing the plant if a decision was made to relocate it to Oak Ridge. Certainly, because DOE has taken steps to build the plant at Portsmouth, there would be some disruption associated with such a relocation, but it is difficult at this time to quantify what affect it would have on completing the plant. In any event, a possible decision on relocating the plant at this time must take into consideration the possibility of any delay, and the effect it would have on the ability to meet enrichment demand.

Equally valid arguments can be made on both sides of this issue as exemplified by the fact that DOE has modified its position on the effect locating the plant away from development facilities would have on completing the project. In our opinion, there does not appear to be a clear-cut advantage for either Oak Ridge or Portsmouth, particularly in view of the uncertainty associated with the cost and schedule estimates that have been made to date.

United States Senate

WASHINGTON, D.C. 20510

January 26, 1978

The Honorable Elmer B. Staats
Comptroller General of the United States
441 G Street, N.W.
Washington, D. C. 20548

Dear Mr. Staats:

In his April 20 address to the Congress concerning the energy crisis, the President indicated that he thought the next increment in the United States' uranium enrichment capacity should be a full sized gas centrifuge plant instead of an expansion of the gas diffusion plant which is located in Portsmouth, Ohio. In a later announcement, he indicated that his preference for siting the new gas centrifuge plant was at Portsmouth, Ohio. The Congress will have an opportunity to review these two decisions early this year. It is estimated that the gas centrifuge plant construction will involve an expenditure of more than \$4 billion over a period of ten years. Considering the size of the investment of federal funds that is contemplated, it would seem that Congress is obliged to give all aspects of the gas centrifuge decision a thorough review.

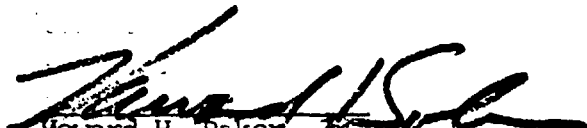
Gas centrifuge enrichment technology has been undergoing a careful development in the United States for more than 20 years. The Equipment Test Facility (ETF) located at Oak Ridge National Laboratory, began centrifuge reliability testing in December of 1971. Two Component Preparation Laboratories (CPL) were completed at Oak Ridge in 1975 and are equipped with prototypical tooling and processes to further the development, demonstration, and evaluation of production techniques. The Centrifuge Plant Demonstration Facility (CPDF), currently under construction at Oak Ridge, is a gas centrifuge pilot plant whose main purpose is to demonstrate the technology processes, procedures and methods that are intended to be used in subsequent largescale production size centrifuge plants, such as the one the President has now proposed at the Portsmouth, Ohio location. The CPDF is expected to be operating by December of 1981. The results that have come from early developmental work indicate that America will be in a position to switch over to the new, energy efficient, gas centrifuge technology in the near future.

Mr. Staats
 January 26, 1978
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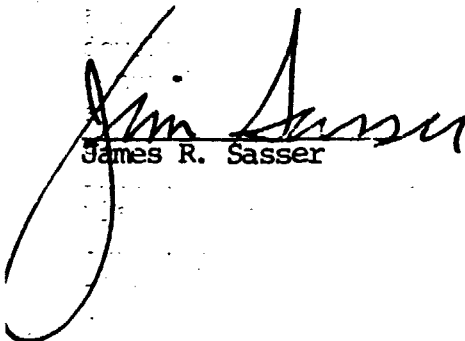
The General Accounting Office has already completed an overview of United States Enrichment policies in their November 18, 1977 report to Congress entitled, "Uranium Enrichment Policies and Operations: Status and Future Needs." Members of our staff met informally with staff members of the GAO late last year and learned that the GAO is currently undertaking a general review of gas centrifuge technology and the factors involved in building a full sized centrifuge plant at Portsmouth. We have learned that earlier studies, which were carried out by the Energy Research and Development Administration, indicated significantly higher costs would be incurred in building a centrifuge plant at Portsmouth instead of Oak Ridge. In view of the magnitude of the investment of federal funds that will be made and the unquestioned need to expand America's enrichment capacity without undue delay, we request you to immediately initiate a review of the proposal to substitute the gas centrifuge technology for the diffusion technology at this time and to build the first full scale gas centrifuge plant at a site which is distant from the pilot plant which is under construction and the laboratories which have performed so much of the earlier developmental work on gas centrifuge technology. We would hope that the review would include consideration of the economic cost and the potential for delays that would be involved in building the plant at Portsmouth, Ohio as compared with Oak Ridge, Tennessee.

In view of the fact that Congress is likely to review the President's gas centrifuge proposals early next year, we request that you advise us as soon as possible regarding your conclusions. In any event, please provide us with a status report of your review no later than February 6, 1978.

Sincerely,


 Howard H. Baker, Jr.


 Clifford P. Hansen


 James R. Sasser