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URANIUM ENRICHMENT

Some Impacts of Proposed Legislation on DOE's Program

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Resources, Community, and
Economic Development Division

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The Honorable Morris K. Udall
Chairman, Committee on Interior
and Insular Affairs
House of Representatives

The Honorable Philip R. Sharp
Chairman, Subcommittee on Energy
and Power
Committee on Energy and Commerce
House of Representatives

The Honorable George Miller
House of Representatives

On November 10, 1988, you asked us to address several questions concerning a number of proposed uranium enrichment bills introduced during the 100th Congress. The bills would have restructured the Department of Energy's (DOE) uranium enrichment program as a government corporation to allow it to compete more effectively in the domestic and international markets. In addition, some of the proposals would have provided financial support to the domestic uranium mining industry by requiring DOE to purchase $750 million of uranium ore from domestic producers over a 5-year period and establishing a fund for the cleanup of uranium production wastes called mill tailings. Further, several proposals would have established a fund to pay for decommissioning the uranium enrichment facilities and required the corporation to recover only a small fraction of the current program's past unrecovered costs. Similar bills have been introduced this session.[1]

The questions you asked were directed at four main issues:

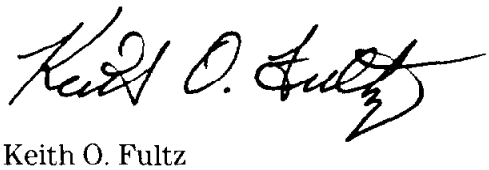
- The impact of the proposed purchase program on uranium prices, production, and employment.
- A proposed uranium mill tailings fund and a provision in some bills that might limit site owners' responsibility if environmental problems arise in the future.
- Competition from foreign enriched uranium producers.

[1]On July 6, 1989, the Senate Energy and Natural Resources Committee forwarded S.83 to the Senate for consideration. The bill would establish a uranium enrichment government corporation and authorize a mill tailings cleanup fund. Because this bill was introduced late in our review, we were not able to use it in our report.

the financial burden of cleaning up mill tailing sites. Producers have started to clean up most of the 29 active sites, and state initiatives have spurred actions at 4 sites included on the Environmental Protection Agency's (EPA) National Priorities List. However, the states and EPA oppose a provision in some of the proposed bills that might limit mill tailings site owners' responsibility to clean up future environmental problems.

- Excess uranium enrichment production capacity exists throughout the world; therefore, foreign producers are expected to compete heavily in the United States throughout the 1990s as utilities' contracts with DOE expire. Currently, Urenco and Eurodif, two European producers, charge their partners very high separative work unit prices--$178 and $193, respectively, but are willing to undercut DOE's $117 price to rid themselves of excess production and make inroads in the U.S. market. According to DOE, the Soviet Union, which has a large amount of uncommitted capacity, is becoming much more active in the U.S. market. DOE officials believe that the Soviet Union has recently offered U.S. utilities prices of $60 to $65 per separative work unit—nearly 50 percent lower than DOE's price.
- DOE estimates that it could cost more than $3 billion (1988 dollars) to decommission its three enrichment plants if all wastes are removed from the site and the buildings demolished. If the three sites were turned into permanent waste sites, this cost could be less than $200 million. However, these estimates do not include about $775 million needed to decontaminate, secure, and maintain the shutdown Oak Ridge gaseous diffusion plant and clean up abandoned gas centrifuge facilities. Further, DOE estimates that it could cost an additional $2 billion or more between 1989 and 2010 to bring the three enrichment sites into compliance with existing environmental legislation. These costs could increase if DOE's ongoing environmental assessments identify other needed actions. Thus, total decommissioning and environmental cleanup costs for the enrichment program could total almost $6 billion.
- According to a 1988 agreement between DOE's Offices of Nuclear Energy and Defense Programs, enrichment decommissioning costs, estimated to total $3.6 billion for planning purposes, will be shared by the commercial enrichment program ($1.6 billion) and the government ($2 billion). The government will pay for its share of costs through appropriations. DOE expects the commercial program to pay for some initial cleanup activities ($200 million) from annual revenues; however, as of the end of fiscal year 1988, DOE had not recovered anything from its commercial customers to pay for their share of final decommissioning costs—about $1.4 million.

Major contributors to this briefing report are listed in appendix I.



Keith O. Fultz
Director, Energy Issues

Tables

Abbreviations

DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
SWU	separative work unit

own two of the four mill tailing sites included on EPA's National Priorities List (Superfund).[1] In addition, Everest Mineral Corporation is a leading in-situ producer; the Ferret Exploration Co. is also an in-situ producer, while the other producers are conventional miners.[2] We also interviewed officials representing three of the seven states where uranium mines and active mill tailings sites are located—New Mexico, Colorado, and Wyoming—to obtain their views on the proposed legislation. We asked each company and state official for their views on

- the current uranium market,
- the impact of the proposed purchase program,
- the proposed mill tailings fund,
- current mill tailings remedial activities, and
- proposed bill language that could limit producers' environmental cleanup requirements.

We also interviewed the presidents of NUEXCO Information Services Company, a subsidiary of NUEXCO International Corporation, a large uranium broker and market information exchange company, and Nuclear Resources International, Inc., a uranium consultant company. They provided us with briefings and summaries of their companies' analyses of the proposed purchase program and conveyed their views on other uranium issues. We did not analyze or evaluate the assumptions and data used in their models.

Further, to answer questions on the proposed uranium mill tailings cleanup fund, we reviewed the Uranium Mill Tailings Radiation Control Act of 1978 and contacted the Director of DOE's Office of Remedial Action and Waste Technology, who is responsible for cleaning up inactive mill tailings sites. He provided us with background information on mill tailings cleanup costs and procedures. For specific information on the cleanup requirements placed on active site owners, we contacted EPA's Chief of Guides and Criteria Branch, Office of Radiation Programs, which establishes standards for active mill tailings sites. We also interviewed staff within NRC's Low Level Waste and Decommissioning Office,

[1]The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, commonly known as "Superfund," provides for the cleanup of hazardous wastes that present or have the potential to present a substantial danger to public health and welfare or the environment. Under the act, radioactive materials are considered hazardous substances. EPA has compiled a National Priorities List designating certain sites for immediate remedial action under Superfund and other environmental legislation.

[2]In-situ mining involves leaching the uranium from the ore without removing it from the ground. Conventional miners remove the ore from the ground and then crush, mill, and leach it.

incorporated where appropriate. As requested, we did not ask DOE, NRC, or EPA to review and comment officially on this report. We conducted our work between November 1988 and April 1989 in accordance with generally accepted government auditing standards.

mining, and as a byproduct of phosphate or copper mining. In-situ mining involves leaching uranium from the ore without removing it from the ground. A leaching solution is circulated through the ground, then pumped to the surface and the uranium concentrate is recovered. In-situ mining and byproduct production do not produce mill tailings that pose a radiation problem. Uranium concentrate is shipped to conversion facilities, where it is used to produce uranium hexafluoride, a gas that is used as feed material for the uranium enrichment process. After it is enriched, the uranium is made into fuel rods to be used in nuclear power plants.

In the early days of the atomic era, the Atomic Energy Commission was the sole purchaser of uranium ore, which it used for defense purposes. However, given the scarcity of supply and its responsibility to promote peaceful uses of atomic energy, the Commission's procurement policies reflected a concern for fostering and maintaining a U.S. uranium-mining industry. By 1970 all of the original government ore purchase contracts had expired, but the market for domestic uranium producers looked bright. Utilities, pursuing the promising commercial nuclear power industry, ordered over 200 new reactors in the 1960s and early 1970s. Many of these utilities, seeking a secure fuel supply, negotiated long-term contracts for domestic uranium ore—some are in effect today.

The U.S. mining industry peaked in 1980, when domestic miners annually produced over 40 million pounds of uranium concentrate and employed over 20,000 people—about 360 underground and open-pit mines were in operation. By 1980 production exceeded utilities' needs after utilities reacted to less than expected electricity demand and increased costs by cancelling over 70 nuclear plant orders and cutting back on planned construction. As a result, domestic uranium production and employment fell rapidly to about 13 million pounds and 2,000 people by 1987. Only about 37 mines operated in 1987, and by 1989, only 4 of the 20 mills operating in 1981 remained open. Also, an increasing proportion of domestic production came from in-situ and byproduct producers (about 34 percent in 1987 compared with 13 percent in 1982), reflecting, in part, their increased competitiveness due to relatively low production and labor costs.

Because of the optimistic demand expectations of the mid- to late-1970s and subsequent long-term contract commitments, U.S. uranium production annually exceeded utilities' needs through 1985. As a result, large inventories accumulated with both producers and utilities. According to

In March 1988, the Senate passed S.2097 to, in part, provide for a viable domestic uranium industry. Although several of its members subsequently introduced several comparable bills, the House of Representatives did not act on any of them. Various versions of the bills would have established a uranium revitalization fund through contributions and fees from states, mill tailings site owners, utilities, and a newly created uranium enrichment government corporation. The fund would have been used to pay for a DOE uranium purchase program and mill tailings reclamation activities.

The purchase program outlined in one of the bills (H.R. 4975) would have required DOE to buy $750 million of U.S.-produced uranium ore between 1989 and 1994, including $80 million of ore from small producers in 1989.[2] The purchases would have been determined by a quarterly competitive bidding process, and deliveries would have occurred within 12 months of the contract date. Purchases from individual producers could not total more than 1 million pounds per year. Also, sales to DOE would generally be limited to new domestic production and producer-held inventories. However, the proposed program would not prevent producers from diverting production or inventories committed to existing contracts to DOE and then meeting customers' needs through spot market purchases

Impact of the Purchase Program

All six of the uranium producers with whom we met strongly favored the purchase program because they believe it would raise prices and allow them to stay in business until inventories decline and demand increases. Otherwise, several producers say that the nation is in danger of losing an industry vital to its energy security.

The President of the Uranium Producers of America, representing most current producers, said that the purchase program would probably raise spot market prices from $11 per pound to between $20 and $25 per pound. More importantly, he believes the program would increase domestic production while utilities use up their excess inventories. After inventories are depleted in about 2 to 3 years, the association's President expects the market to "balance," with the annual utility demand equalling annual utility uranium requirements for enrichment services (about 40 million pounds). He expects prices would then stabilize at $20

[2]As discussed in section 1, on July 6, 1989, the Senate Energy and Natural Resources Committee forwarded S.83 that included a purchase program. Because of the timing of this bill, we were not able to include it in our review.

and, any new production would probably be offset by sales from inventories or spot market purchases that would be used to satisfy long-term contracts. The major benefit of the program would be to liquidate inventories and create higher prices, thereby allowing some producers to stay in business. He also said that no new mines would open since producers are short on capital, and the program will last only 6 years. Further, the president believed that few miners would go back to work and noted that even if employment doubled, only about 2,000 to 3,000 additional miners would be employed during the program.

In addition, NUEXCO Information Services, a subsidiary of a large uranium broker and market information development corporation, analyzed the purchase program in 1988 using its extensive uranium market data base and uranium market model. Under two different scenarios, NUEXCO's analyses show that the purchase program would result in limited new production and producers would be inclined to divert current production and inventories to DOE and meet existing contracts from spot market purchases.

Under the first scenario, NUEXCO assumed that U.S. producers could supply the government only from uncommitted production or inventories; i.e., a producer could not sell production or inventories committed to other contracts. In the second scenario, producers could deliver uranium purchased on the spot market to satisfy existing contracts to make up the 1 million pounds of newly produced uranium sold to DOE. NUEXCO estimated that under the restraints of the first scenario, the purchase program would result in DOE purchases of 24.7 million pounds of uranium. However, total production during the 6-year purchase program would only increase by about 14.2 million pounds. The effect on new production is even less under the second scenario. If producers are allowed to use spot market purchases to satisfy existing contracts, NUEXCO predicts that DOE would purchase almost 29 million pounds of uranium ore, but less than 30 percent (about 8 million pounds) would come from new production. DOE purchases under the two scenarios would cost an average of $30 and $26 per pound, respectively. Table 2.1 summarizes the results of NUEXCO's analysis.

Uranium Mill Tailings Issues

Questions

1. What is the effect of exempting the domestic nuclear industry from environmental laws other than the Uranium Mill Tailings Radiation Control Act at sites designated by Title II of S.2097 and its variants? Do the states with Title II sites favor repealing all federal and state environmental laws other than the Uranium Mill Tailings Radiation Control Act?

2. If Superfund cleanup is required at these sites, who will be financially responsible for the costs if companies are exempted from environmental laws other than the Uranium Mill Tailings Radiation Control Act?

3. Which uranium processing, mining, and mill tailing sites have thus far been included on the Superfund list? Please describe any remedial action taken under Superfund at each site.

Summary Response

NRC has identified 29 active mill tailings sites that require remedial actions under the Uranium Mill Tailings Radiation Control Act of 1978. Although some tailings at 13 sites resulted from government contracts, the act does not provide federal financial assistance for remedial actions. S.2097 and its variants would establish a fund to provide financial assistance to help producers clean up active mill tailings sites and includes a provision that, according to EPA officials, may exempt the producers from future responsibility under other federal environmental legislation once they meet the requirements of the 1978 act. As a result, EPA opposes the proposed provision; officials believe the producers should be held accountable for future cleanup activities that may be required by other environmental legislation. State officials that we contacted also oppose the proposed provision, fearing that they might be held accountable for future cleanup activities if the producers are not held responsible. Several EPA and state officials also told us that, should the provision pass, final interpretation would most likely end up with the courts. On the other hand, NRC staff believe that the uranium mill tailings act provides for adequate cleanup of active sites; therefore, they do not oppose the proposed language.

As a result of efforts by Colorado and New Mexico, four mill tailings sites have been included on EPA's National Priorities List. Officials from these two states say that their actions spurred multimillion dollar efforts, such as groundwater cleanup programs and stabilization activities, at the sites.

In any event, no federal funding is provided to active site owners, although 13 sites contain commingled tailings—tailings generated from both government and commercial contracts. About 27 percent of all tailings at active sites were generated under defense contracts. This percentage is not expected to change significantly because very little conventional uranium mining is occurring in the United States. Table 3.1 lists the active uranium mill tailings sites and volumes generated.

NRC regulations require active mill tailings site licensees to secure a bond, surety, letter of credit, or some other financial arrangement to ensure that adequate financial resources will be available to cover anticipated reclamation costs. As of March 1989, each owner of an NRC-licensed mill tailings site except the Tennessee Valley Authority, which is exempt from the requirement, had a financial surety in place, although the arrangements and amounts for three of the sites were being reviewed by NRC. The surety amounts for each site ranged from about $2 million (where about 30 percent of cleanup work is yet to be completed) to $58 million; these amounts may not cover all groundwater cleanup costs. NRC staff stated that the sureties are intended to show a good faith effort on the part of the owners to stabilize the mill tailings piles. According to NRC staff, if the owners find further contamination, NRC would increase the surety amount but would also lower the amount as reclamation actions are completed.

NRC also requires active site owners to submit a formal reclamation action plan specifying the steps to be taken to bring each site into compliance with existing standards. As of March 1989, all NRC-licensed site owners had submitted these plans, although NRC did not receive most of them until 1987 or 1988. As a result, only two plans had been approved by March 1989. According to NRC staff, three major reasons caused the delay. First, final EPA and NRC regulations under the act were not promulgated until 1985 and 1987, and owners then needed time to monitor their sites and prepare appropriate plans. Second, owners delayed submitting the plans, anticipating that legislation would be passed to provide federal funding for cleanup costs. Finally, the initial plans submitted were not adequate.

After the owners take the actions set out in the approved plan and NRC inspects the sites to ensure that cleanup has occurred, NRC's regulations require the owner to conduct post-remedial surveillance. According to NRC staff, they could require up to 10 years of site monitoring during the surveillance phase. The extended monitoring ensures that the reclamation actions have been effective and environmental conditions are stabilized and improved. At the end of the monitoring phase, the owner will be required to file a license termination request with NRC, which, if approved, would result in transfer of the site either to the state or the federal government.

for this purpose from the government, the Congress has not acted on this issue.

After the mill tailings act was passed, seven uranium companies filed lawsuits in the U.S. Claims Court against the government to recover anticipated expenses of cleaning up tailings piles generated while carrying out mining and milling operations under federal contracts. On October 31, 1988, the court dismissed these claims; and in December 1988, the companies filed appeals with the U.S. Court of Appeals for the Federal Circuit. NRC lawyers expect the court to take at least a year to resolve the appeals. The Court of Appeals' decision could then be appealed to the U.S. Supreme Court.

The mining industry has also sought legislation to obtain financial relief. During the last session of the Congress, the miners supported S.2097 and other bills that would have established a uranium mill tailings fund. State officials that we contacted also supported the proposed fund hoping that it would encourage cleanup activities.

S.2097 listed 26 active sites that qualified for reimbursement for reclamation actions from the fund. Contributions to the fund from states, mill site owners, the federal government, and nuclear power plant operators would have been disbursed to participating mill site owners. Disbursements from the federal government's contribution ($300 million to be paid by the new enrichment corporation) would have been limited to $4.50 per ton of tailings generated under contracts with the federal government. According to NRC staff, this amount probably would not cover groundwater cleanup costs that may be required.

Impact of S.2097 Language on Limiting Producers' Liability

Section 220 of S.2097 states that:

"The contributions made and work performed by the owners or licensees of the active sites . . . shall be the sole liability and obligation imposed under Federal laws in connection with the reclamation, decommissioning and other remedial action at active uranium and thorium sites: Provided, however, That nothing herein contained shall affect the obligation of every owner or licensee to provide for such long-term care or other reclamation requirements as are provided in the Uranium Mill Tailings Radiation Control Act of 1978, the regulations of the Commission thereunder, and the regulations of the Environmental Protection Agency thereunder."

Federal and state officials with whom we met said that a considerable amount of confusion and uncertainty exists concerning the impact of

Mill Tailings Superfund Sites

According to EPA officials, Superfund could be used to direct and pay for reclamation of mill tailings sites. As a general policy, however, EPA defers to the remedial action program authorized by the 1978 mill tailings act, which requires DOE, the states, and licensees to pay for cleanup activities. According to EPA officials, standards for reclamation under the mill tailings act are no less than those imposed on Superfund sites. Therefore, Superfund has not been used to clean up active sites. Nevertheless, as a result of state actions, four mill tailings sites are included on the National Priorities List. State officials say that their actions spurred cleanup activities by the owners at the four sites shown in table 3.2.

Table 3.2: Uranium Mill Tailings Superfund Sites

(Millions of tons)

Site	Owner	Location	Mill tailings
Uraven	UMETCO Mining Co.	Uravan, Colo.	11.0
Canyon City	Cotter Corp.	Canyon City, Colo.	2.7
Churchrock	United Nuclear Corp.	Churchrock, N.M.	3.6
Grants Mill	Homestake Mining Co.	Grants, N.M.	22.0

The Churchrock and Grants Mill sites were originally licensed by New Mexico, an NRC agreement state. However, since 1986, when New Mexico relinquished its agreement state status, NRC has had licensing and oversight responsibility for five active New Mexico mill tailings sites, including the two Superfund sites.

In August 1988 EPA and NRC signed a memorandum of agreement whereby NRC became the lead regulatory agency directing the closure of the Churchrock site. EPA will review and monitor all reclamation activities to ensure compliance with Superfund. According to staff in its uranium recovery office, NRC is reviewing United Nuclear's remedial action and groundwater cleanup plan for the site. The staff also said that United Nuclear has completed some interim stabilization steps, cleaned up an old mine used as a mill tailings dump site, and committed itself to cleaning up wind-blown tailings on- and off-site. The company has also initiated a groundwater-monitoring program and a system to pump out contaminated water for treatment in lined evaporation ponds.

According to NRC staff, EPA and NRC expect to conclude a similar memorandum of agreement soon for the Homestake Mining Company's site at Grants, New Mexico. The site is still operating, and some pile stabilization activities have occurred. NRC staff also told us that Homestake has

Decommissioning Issues

Questions

1. What is the range of costs to decommission DOE's three uranium enrichment plants?

2. Has DOE charged its customers any money for decommissioning the plants? If so, when did DOE begin charging its customers? How much has it charged?

3. Under current law, is decommissioning expense a cost that DOE is required to charge its civilian enrichment customers?

4. How much should DOE charge per SWU in order to ensure adequate funds to decommission the three plants at the end of 10 years?

Summary Response

DOE estimates that it could cost more than $3 billion (1988 dollars) to decommission its three enrichment plants if all wastes are removed from the site and the buildings demolished. If the three sites were turned into permanent waste sites, this cost could be less than $200 million. However, these estimates do not include about $775 million needed to decontaminate, secure, and maintain the shut down Oak Ridge gaseous diffusion plant and cleanup abandoned gas centrifuge facilities. Further, DOE estimates that it could cost an additional $2 billion or more between 1989 and 2010 to bring the three enrichment sites into compliance with existing environmental legislation. These costs could increase if DOE's ongoing environmental assessments identify other needed actions. Thus, total decommissioning and environmental cleanup costs for the enrichment program could total almost $6 billion.

According to a 1988 agreement, enrichment decommissioning costs, estimated to total $3.6 for planning purposes, will be shared by the commercial enrichment program ($1.6 billion) and DOE's Office of Defense programs and other government programs ($2 billion). DOE expects the commercial program to pay for some initial cleanup activities ($200 million) from annual revenues; however, as of the end of fiscal year 1988, DOE had not recovered anything from its commercial customers to pay for their share of final decommissioning costs—about $1.4 million.

We believe that decommissioning costs for the enrichment plants should be recovered from the beneficiaries of the services provided. DOE officials say that under existing law, they cannot recover future costs from customers and recently proposed legislation to, in part, establish a decommissioning fund to accumulate $1.4 billion by 2005. Under its proposal, a new enrichment corporation would deposit $40 million into the

1. Shutdown/decontamination activities (Phase I) to place facilities in a safe storage condition, e.g., removal of hazardous and/or radioactive substances.

2. Surveillance and maintenance activities, including fire protection, power, and general environmental monitoring until final decommissioning occurs.

3. Decommissioning and waste disposal activities (Phase II) to finally dispose of equipment and facilities, e.g., entombing of facilities or disassembly of all facilities and disposal at a low-level waste site.

DOE began Phase I activities at Oak Ridge in fiscal year 1988. Specific decontamination activities include (1) removing and incinerating several hundred thousand gallons of contaminated oil, (2) removing and disposing of up to 400,000 square feet of asbestos, and (3) cleaning up more than 200,000 square feet of contaminated building and process equipment surfaces. DOE also plans to move about 20 percent of the gaseous diffusion machines at Oak Ridge to its two other facilities. After completing Phase I activities in 1994, DOE believes that the Oak Ridge enrichment plant will be in an environmentally sound and safe condition and can be maintained for decades with a relatively low level of surveillance and maintenance. DOE spent about $9.3 million on Oak Ridge Phase I activities in fiscal year 1988 and expects to spend an additional $145 million by 1994.

Between fiscal year 1988, when the Oak Ridge plant was permanently shut down, and the beginning of Phase II in the year 2010, DOE also expects to spend about $434 million on surveillance and maintenance at Oak Ridge. In the interim, DOE will (1) assess alternative uses of the Oak Ridge buildings, (2) develop and review final disposal technology, and (3) collect funds to pay for decommissioning. Because DOE expects to operate the Paducah and Portsmouth plants until at least 2005, after which time Phase I activities will be initiated, Phase II activities for all three plants are not expected to begin until at least 2010. Table 4.1 shows DOE's latest estimates for Phase I and Phase II costs for each of the three plants.

Table 4.2: Enrichment Cost Allocation Between Commercial and Government Programs

(Cost in millions)[a]

	Government programs	Commerical cost	Total cost
Oak Ridge:			
Phase I (1988-94)	$103.6	$50.7	**$154.3**
Surveillance (1988-2010)	283.2	151.0	**434.2**
Phase II	848.0	357.0[c]	**1,205.0**
Paducah[b]	233.0	523.0	**756.0**
Portsmouth[b]	506.0	524.0	**1,030.0**
Total	**$1,973.8**	**$1,605.7**	**$3,579.5**

[a]1988 dollars.

[b]Paducah and Portsmouth Phase I, surveillance, and maintenance costs are not included in this allocation analysis.

[c]For planning, budgeting, and accounting purposes, DOE's enrichment program incurred these costs in fiscal year 1988.

Through fiscal year 1988, DOE's commercial uranium enrichment program had not collected even $1 for future decommissioning costs, but the program did use sales revenues to pay for initial cleanup and surveillance activities at the Oak Ridge site. The uranium enrichment program plans to fund its share of Oak Ridge Phase I, surveillance, and maintenance costs between 1988 and 2010 (about $202 million) from annual revenues received from utilities. This will still leave about $1.4 billion needed from commercial customers for final decommissioning activities associated with the three facilities. In the past, DOE has stated that it will begin collecting decommissioning costs 10 years in advance of shutting down an enrichment plant, thereby allowing the program time to adequately recover expected costs through revenues. This did not occur for the Oak Ridge plant that was permanently shut down in fiscal year 1988. DOE managers have also claimed that under existing law, they have no authority to set aside funds collected from their customers for costs yet to be incurred.

We have long stated that decommissioning costs should be paid by the beneficiaries of the service received.[1] Also, the possibility exists that future resources in terms of customers and/or revenues may not be adequate to cover costs. In an October 1987 report, we further stated that DOE needs to act on its responsibility to decontaminate and decommission the enrichment plants, and the Congress could encourage this by

[1]See Cleaning Up the Remains of Nuclear Facilities—A Multi-Billion Dollar Problem (EMD-77-46, June 16, 1977).

Several bills introduced during the 100th Congress would have established a fund for future decommissioning costs. Most of the bills would have required the new corporation to determine the amount of annual payments to the fund. One proposed bill, H.R.5181, would have required the corporation to pay $100 million annually to a decommissioning fund and authorized the Secretary of the Treasury to levy fees on licensed nuclear plants if the corporation's annual revenues were insufficient to make the payments. Although this bill would have transferred all of DOE's production facilities to the new corporation, some of the proposals would not have transferred Oak Ridge to the new corporation nor did they address how DOE would pay to decommission it.

In February 1989, the Subcommittee on Energy and Power, House Committee on Energy and Commerce, circulated a draft bill to other congressional members, industry, and DOE for comment. The draft proposal would not require the new enrichment corporation to assume decommissioning costs but rather would assess nuclear plant owners a direct fee based on electricity production. The funds collected would be paid into a decommissioning fund managed by the Secretary of the Treasury. The fund would pay all final decommissioning costs, expected to total over $3 billion, not just those associated with commercial sales. According to a subcommittee staff analysis, this arrangement would be equitable since the bill would also relieve utilities' responsibility for past unrecovered costs. We calculate these costs to total about $9.6 billion at the end of fiscal year 1988.

Gas Centrifuge Closeout Costs

DOE's decommissioning cost estimates do not include closeout costs for its gas centrifuge facilities. In 1985 DOE terminated its gas centrifuge program after spending about $3.4 billion to construct, test, and operate a pilot plant at its Oak Ridge enrichment facility and a full-scale plant at Portsmouth, Ohio. Subsequently, DOE initiated a gas centrifuge closeout program to dispose of all excess equipment and decontaminate the centrifuge facilities in order to make them available for other programs. In 1987 and 1988, DOE also signed two agreements—one with the Defense Logistics Agency and one with the Ohio Army National Guard—to provide certain facilities at Oak Ridge and Portsmouth for storage and other uses. Also, DOE has agreed to allow ALCHEMIE, Inc., a private chemical firm, to use some centrifuge equipment from the Portsmouth facility for chemical separation activities. As of June 1989, DOE and ALCHEMIE, Inc., were negotiating a lease that would permit the company to perform these activities at the Oak Ridge facility.

storing hazardous and/or radioactive waste, DOE does not classify these activities as remedial actions. DOE officials say that these activities are part of their environmental, safety, and health program and are needed to maintain compliance with increasingly stringent requirements. For example, they include an incinerator constructed at Oak Ridge to burn mixed (hazardous and radioactive) low-level wastes.

Table 4.3 summarizes total environmental, safety, and health costs, excluding decontamination and decommissioning costs, for the three enrichment plants.

Table 4.3: Projected Environmental Compliance Costs for DOE's Three Enrichment Plants, 1989 to 2010

(Millions of dollars)[a]

Program area	Oak Ridge	Paducah	Portsmouth	Total
Environment	$278.0	$275.0	$312.0	**$865.0**
Safety and health	356.0	225.0	308.0	**889.0**
Waste management	85.9	40.2	54.7	**180.8**
Remedial actions	144.0	76.6	119.0	**339.6**
Total	**$863.9**	**$616.8**	**$793.7**	**$2,274.4**

[a]1988 dollars.

Source: Environment, Safety, and Health Needs of the U.S. Department of Energy, DOE, Dec. 1988.

DOE officials are preparing a 5-year (fiscal years 1991-95) plan that will prioritize identified compliance activities at all DOE sites. DOE expects to complete this report by August 1989.

Table 5.1: Current Enrichment Production Capacity

(Million SWU/year)	
Eurodif	10.8
Urenco	2.4
DOE	19.3
Soviet Union[a]	3.0
Others	0.2
Total	**35.7**

[a]DOE estimates that the Soviet Union's actual capacity is greater than 10 million SWU per year, of which about 3 million SWU per year has historically been offered to western customers.

Source: DOE

Because of existing excess capacity and other factors, DOE's Sales and Marketing Manager expects the U.S. enrichment market to be the "battleground" of the 1990s. U.S. nuclear utilities represent the single largest market for enrichment services; plus, existing DOE contracts will begin to expire in the early 1990s. In addition, many public service commissions throughout the country are becoming much more cost conscious, increasingly directing utilities to buy the cheapest enrichment services available.

According to DOE, its actual production costs are now very competitive—about $70/SWU. However, this amount does not include general overhead, imputed interest, and a number of large fixed costs, including annual multimillion dollar payments to the Tennessee Valley Authority through 1994 for electricity contracted for but not needed and anticipated decommissioning and environmental cleanup costs. Also, since DOE cannot discriminate between buyers, officials say they cannot offer certain customers a discount price based on low marginal production costs. However, DOE has recently benefitted from favorable foreign exchange rates that increase its competitors' prices in the United States compared with the exchange rates that existed a few years ago.

As of April 1989, DOE's base price for both its foreign and domestic customers was $117 per SWU for the first 70 percent of a utility's total annual requirements. The remaining 30 percent of a utility's requirements is priced at $90 per SWU. In February 1989, DOE announced that its base price will increase to $122 per SWU in fiscal year 1990. Following the announcement, a DOE official told us that the increase is needed to keep pace with inflation. Further, he believed that foreign exchange rates allowed DOE to raise prices without a loss of market share.

Both Eurodif and Urenco have offered enrichment services to U.S. utilities at substantially lower prices than those shown in table 5.2 in order to capture a portion of the U.S. market and sell excess production. For example, Eurodif fully supplies a consortium of utilities that operates three U.S. nuclear plants under a 1984 contract at prices estimated to be slightly less than DOE's 1984 price. It also partially supplies three other utilities' needs. Urenco fully supplies two U.S. utilities under two separate contracts, although the reactors were not operating in early 1989.

In addition, on June 9, 1989, Urenco; Fluor-Daniel, Inc.; and three U.S. utilities—Louisiana Power and Light Company; Graystone Corporation, a subsidiary of Northern States Power Company; and Duke Power Company—announced the formation of Louisiana Energy Services, a new company that will build a $750 million enrichment facility in Louisiana. The company expects to begin building the plant in 1992 and start full production in 1996. Duke Power's Senior Vice President told us that the plant will produce about 1.5 million SWU per year, with about 350,000 SWU per year going to Duke Power (about 50 percent of its annual needs). According to the Senior Vice President, Duke Power's objectives are to compete with DOE and diversify its sources of supply because the company is concerned about increasing DOE enrichment prices, and the potential that prices could go higher as DOE identifies and pays for needed environmental compliance and decommissioning activities.

The Duke Power executive also said that most of the risk connected with the project concerns NRC's licensing of the plant. NRC staff told us that a private enrichment plant can be built in the United States if it meets NRC licensing requirements and a U.S. company is the majority owner. Although NRC has never licensed an enrichment facility in this country, in April 1988, NRC published an advance notice of proposed rulemaking in the Federal Register setting out the requirements that a plant would have to meet. After reviewing comments on the advance notice, NRC decided that additional regulations are not needed and that it could license an enrichment plant under part 50 of its current regulations.

Increasing Competition From the Soviet Union, China, and Japan

The Soviet Union, with an annual enrichment capacity of over 10 million SWU per year and about 3 million SWU available for sale each year, is DOE's largest single competitor for uncommitted sales. DOE officials would not speculate whether the Soviet Union's recent announcement that it was stopping production of high-enriched uranium for defense purposes would result in increased production of commercial SWU. With

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excess capacity and a need for hard currency, the Soviet Union has increasingly sought opportunities to sell directly to U.S. utilities and indirectly through brokers.

DOE officials believe that the Soviet Union has offered prices of $60 to $65/SWU, nearly 50 percent lower than DOE's price. DOE has also received reports that the Soviet Union, which is presumed to control large uranium resources, is now offering one price for both uranium ore and enrichment services. This would allow a utility to forgo the usual two-step process of buying uranium ore and then procuring enrichment services. Although U.S. utilities have not been inclined to buy Soviet SWU in the past, DOE believes that more and more are willing to test the market aided by brokers who swap Soviet SWU with European SWU. DOE estimates that sales of Soviet enrichment services to U.S. and western European utilities, brokers, and other suppliers resulted in losses of over $170 million to DOE between 1986 and 1988 and could result in additional losses of $90 million in 1989.

DOE points out that no U.S. trade prohibitions exist on utilities' buying Soviet SWU. In February 1989, the Chairman, Subcommittee on Energy Research and Development, House Committee on Science, Space and Technology, introduced H.R.1100, which would prevent U.S. utilities from purchasing Soviet SWU. DOE and NRC staff and others told us that the swapping of Soviet SWU in Europe would be virtually impossible to track because enriched uranium is essentially homogeneous, and the U.S. government does not have information on these international exchanges.

Other countries' enrichment activities could also affect future DOE sales. For example, although very little is known about the People's Republic of China's enriched uranium capability, DOE officials told us that China's sales agents have recently approached U.S. utilities. DOE officials told us that their best estimate of China's excess capacity is about 200,000 to 400,000 SWU annually. DOE expects that China will follow the Soviet's lead into the international uranium enrichment market because DOE believes that China has large uranium ore resources.

In addition, Japan is working on developing enrichment capability using a laser process similar to DOE's advanced vapor laser isotope separation process. Japan expects to supply its own annual requirements by the end of the century. In 1989, DOE expects to sell Japan about 3.2 million SWU—or about 75 percent of Japan's annual requirements.

Eurodif and Urenco Price Information

For many years, two of DOE's main competitors have been Eurodif and Urenco, European consortia. Belgium, Italy, Spain, Iran, and France are the principal owners of Eurodif. Eurodif operates one large (10.8 million SWU/year) gaseous diffusion plant located in France and annually produces at about 75 percent capacity, leaving an excess annual capacity of over 2 million SWU per year. Most of its production is dedicated to its partners.

Urenco is owned by the United Kingdom, the Netherlands, and West Germany. It operates 3 gas centrifuge plants, 1 in each of the partner countries, capable of producing a total of about 2.4 million SWU per year, with annual capacity to increase to 3.1 million SWU by 1990. Almost all of Urenco's production goes to its partners. Excess production is estimated to be about 300,000 SWU per year. A DOE official told us that Urenco can easily expand its capacity by adding more centrifuge machines to its plants.

Information on Eurodif and Urenco prices is not publicly available. Further, partnership prices are sometimes complicated by unique arrangements. For example, Eurodif partners sometimes provide electric power as payment for SWU. However, on the basis of DOE's contacts, information provided by its customers, and the limited printed material available, DOE estimates that Urenco and Eurodif charged the following prices in their home markets from 1984 to 1988.

Table 5.2: Eurodif and Urenco SWU Prices

(Price per SWU)

Year	Eurodif	Urenco
1984	$115	$130
1985	116	115
1986	152	148
1987	191	173
1988	193	178

Source: DOE

DOE told us that these prices are generally associated with the contracts initially established with the partnership owners. Several of these contracts will expire in the early 1990s. DOE expects that the prices associated with new or renewed contracts will be substantially less. Further, the amount of uncommitted capacity that Urenco and Eurodif will have available depends on the terms of the new contracts.

Foreign Enrichment Competition

Questions

1. What do Eurodif and Urenco currently charge European and American customers per separative work unit (SWU) of uranium? How do these prices compare with those currently charged by DOE?

2. What is the current uranium enrichment capacity of Eurodif and Urenco? How much of this capacity is uncommitted for each year through the end of calendar year 2000?

Summary Response

Currently, Urenco and Eurodif, two European producers with annual production capacities totalling over 13 million SWU, charge their partners very high SWU prices—$178 and $193, respectively, compared with DOE's $117 base price. However, these European producers are willing to sell at much lower prices to U.S. utilities to rid themselves of excess production—about 2.3 million SWU per year—and make inroads in the U.S. market. The amount of uncommitted capacity for these producers through the year 2000 depends on the terms of new contracts to be negotiated with their partnership owners within the next few years. The Soviet Union also has a large amount of uncommitted capacity and is becoming a key player in the U.S. market. Future production from China and Japan could also affect DOE sales.

Overview of Worldwide Enrichment Capacity

Between 1974 and 1985, DOE's share of the free world's enrichment market fell from 100 percent to about 47 percent because of foreign competition, rising costs, and other problems. As a result, DOE initiated a number of steps to cut costs and improve services with the objective of at least retaining its market share. For example, DOE modernized its gaseous diffusion plants and restructured its contracts with utilities. In 1988, DOE supplied about 85 percent of domestic utilities' enriched uranium requirements of about 9 million SWU, and about 50 percent of the free world's needs of about 25 million SWU.

Because of the slowdown in the construction of nuclear power plants, an oversupply of enriched uranium production capability exists throughout the world. Annual free world needs average about 25 million to 26 million SWU; DOE and its foreign competitors can produce almost 36 million SWU per year for sale to western customers. Table 5.1 shows current enrichment production capability.

DOE plans to complete cleanup activities at the gas centrifuge facilities by fiscal year 1993. Prior to fiscal year 1989, DOE spent about $128 million on these activities. From fiscal year 1989 through fiscal year 1993, DOE expects to spend about $59 million to complete centrifuge closeout activities. According to a DOE official, these costs will be paid from revenues.

Environmental Costs

In the 1970s and early 1980s, the Congress passed a number of environmental laws. At the same time, environmental groups and others focused increased attention on specific waste control problems at individual DOE facilities. In response, DOE initiated a departmentwide assessment of its facilities to identify specific environmental problems and determine the actions needed to bring the sites into compliance with existing legislation. Many assessment activities, such as groundwater monitoring, are still underway.

As part of this effort, DOE conducted technical safety appraisals and environmental surveys of the three enrichment plants. These reports identified environmental, safety, and health problems at each site, such as contaminated waste seeping into groundwater, asbestos pollution, and air and liquid emissions that needed to be better controlled, and outlined remedial actions that DOE began to take in fiscal year 1988. For example, DOE removed and treated contaminated sludge at the Oak Ridge plant, built an incinerator to burn waste from the three sites, and upgraded groundwater-monitoring programs.

In December 1988, DOE prepared a report for the Senate Governmental Affairs Committee that identified the activities and associated resources needed to achieve and maintain compliance with current environmental, safety, and health requirements at each DOE facility. The report showed that DOE expects to spend about $340 million to assess, characterize, and clean up existing environmental contamination resulting from past releases of hazardous and radioactive substances. Further, DOE officials admit that the cost of remedial actions could increase considerably. They pointed out that site investigations and waste characterization are not complete, and past experience indicates that environmental compliance costs increase as more data become available.

The 1988 report also shows that DOE expects to spend about $2 billion on other environmental activities at the three sites. Although some of these activities will be directed at reducing and controlling water pollution from plant effluents, reducing air emissions, and controlling and

requiring DOE to include these costs in its pricing strategy now.[2] We pointed out that the sooner this is done, the longer DOE would have to recover these costs, thereby reducing the impact on the enrichment program and its prices. DOE actions taken on our recommendations are explained in the following section.

DOE-Proposed Decommissioning Fund

Recently, DOE changed its position on setting aside funds to cover decommissioning costs. The administration's uranium enrichment bill, introduced in April 1989, would authorize and require the new enrichment corporation to set aside revenues in a special fund to be used to decommission the three plants. According to budget documents, DOE expects the new corporation to pay $40 million into the fund in 1990, and $50 million per year thereafter. The budget documents also assume that this fund will be established in fiscal year 1990. Further, DOE's fiscal year 1988 annual uranium enrichment report shows that the commercial enrichment program incurred all estimated phase II costs for Oak Ridge ($357 million) and a portion of phase II costs for the other two plants ($58 million).[3]

Beginning in fiscal year 1990, DOE will include these costs in its enrichment prices and contribute a set annual amount into the decommissioning fund. DOE expects the fund to accumulate interest at the rate of 8 percent per year so that about $1.4 billion will be available for final decommissioning by 2005. Thus, if DOE continues to sell 10 million to 12 million SWU per year as expected, it will pay the decommissioning fund about $4 to $5 for each SWU sold. If DOE had to recover expected decommissioning costs earlier, say by the year 2000, the average fund payment per SWU would have to increase by more than $1. However, since DOE's decommissioning cost estimates are in 1988 dollars, this amount may not be sufficient to cover the commercial program's share of final decommissioning costs. Inflation could significantly increase these costs. For example, if inflation continues at 5 percent per year, costs estimated to be $1.4 billion in 1988 will increase to about $3.9 billion in 2010. Also, the costs will depend on the option ultimately selected and the technology available when final decommissioning occurs.

[2]Uranium Enrichment: Congressional Action Needed to Revitalize the Program (GAO/RCED-88-18, Oct. 19, 1987).

[3]DOE will continue to incur the rest of Portsmouth's and Paducah's decommissioning costs over their operating lives.

Table 4.1: DOE's Decommissioning Cost Estimates—June 1988

(Cost in millions)[a]

Activity	Oak Ridge	Paducah	Portsmouth
Phase I	$154.3	$46.0	$52.0
Surveillance and maintenance	434.2	[b]	[b]
Phase II	1,205.0	756.0	1,030.0
Total	**$1,793.5**	**$802.0**	**$1,082.0**

[a]1988 dollars.

[b]DOE has not estimated surveillance and maintenance costs for the Paducah and Portsmouth plants. These costs will depend on the length of time between plant shutdown and final decommissioning.

DOE's Phase II estimates, totalling about $3 billion for all three plants, assume that one of the more expensive decommissioning alternatives, such as removing and disposing of all process equipment and demolishing the buildings, will be the option selected. DOE expects that final decommissioning costs could be much lower, if the plant buildings are not razed and the resulting debris removed to a waste site. As an alternative, each site could be converted into a permanent waste disposal site. Although DOE has not prepared individual site cost estimates for this alternative, its 1988 draft strategy states that the final Phase II cost for all three sites could be less than $200 million.

Costs to Be Apportioned Between Commercial and Government Customers

After extensive discussions between DOE's Offices of Nuclear Energy and Defense Programs, DOE officials agreed in August 1988 that past SWU deliveries would be used to allocate responsibility for enrichment decommissioning costs between government and commercial customers. As a result of this agreement, Defense Programs will become the Oak Ridge site manager in fiscal year 1990 and will assume responsibility for most of the decommissioning costs. Defense Programs will pay for its share of the costs through appropriations. On the other hand, DOE's Office of Nuclear Energy will continue to operate the other two plants with the Portsmouth plant producing high-enriched uranium for defense purposes. Table 4.2 shows the enrichment decommissioning costs allocated between the commercial and government programs.

fund in fiscal year 1990 and $50 million into the fund each year, thereafter. The corporation would collect between $4 and $5 per SWU from commercial customers to meet the annual deposit. Other legislative proposals would require the collection of over $3 billion directly from nuclear utilities.

DOE's Decommissioning Cost Estimates

DOE currently enriches uranium in gaseous diffusion plants located in Portsmouth, Ohio, and Paducah, Kentucky. DOE placed its Oak Ridge, Tennessee, plant in standby condition in 1985 and permanently shut the plant down in 1987. The government built these plants in the 1940s and 1950s to produce enriched uranium for the nuclear weapons program. In the late 1970s and early 1980s, DOE also constructed a large gas centrifuge facility at Portsmouth, Ohio, and a centrifuge pilot plant at Oak Ridge. DOE terminated the gas centrifuge program in 1985, before full-scale plant operations began. Eventually, the gaseous diffusion plants will have to be decommissioned—the buildings and land decontaminated and waste disposed of—so that the sites present no significant radiation to individuals or the environment. The gas centrifuge facilities also need to be cleaned up before they can be used for other purposes.

At this time, DOE does not know the extent of decommissioning activities that will be needed at the three enrichment plants. A June 1988 DOE draft strategy paper set out a two-phased program to decontaminate and decommission the plants and identified several final decommissioning alternatives. The alternatives cited in the report ranged from "entombing" the buildings in place—i.e., filling them with material impermeable to water and fire and creating permanent disposal sites at the three locations—to "greenfielding"—i.e., removing and disposing of all building materials and equipment and returning the sites to their natural state. DOE estimated that decommissioning costs could range from less than $200 million to over $3 billion, depending on the option selected. However, these estimates do not include about $154 million to decontaminate the Oak Ridge gaseous diffusion plant, $434 million to provide security and maintenance at Oak Ridge until final decommissioning occurs, and about $187 million to decontaminate the gas centrifuge facilities at Oak Ridge and Portsmouth, Ohio.

DOE classifies decontamination and decommissioning activities into three categories.

cleaned up mill tailings around the site and, on the basis of an earlier agreement with the state, installed a system of fresh water injection wells at its property boundary to reduce the concentrations of radioactive material found in residential drinking water. Homestake also agreed to pay basic water service charges for affected residents for 10 years.

In Colorado, the state initiated lawsuits in 1983 under Superfund against the Cotter Corporation and UMETCO Minerals Company (a subsidiary of Union Carbide Corporation). In October 1986, the state announced that a consent decree agreement had been reached with UMETCO and Union Carbide that required the

- reclamation of tailings at the Uravan site, including placement of a 10-foot cap on existing piles;
- removal of more than 1.5 million cubic yards of solid wastes generated by mill operations; and
- establishment of a soil and groundwater cleanup program.

The program, projected to cost as much as $44 million, is expected to take 12 to 15 years to complete. According to UMETCO's President, over 50 percent of the actions have been completed at the site. Colorado state officials confirmed that UMETCO is making good progress under the agreed plan.

Further, in December 1987, Colorado reached agreement with the Cotter Corporation to clean up the old mill tailings at its Canyon City site. The company shut down its old facilities in 1979 and constructed a new mill adjacent to the site. The 1987 agreement applies only to the old site, and the cleanup is expected to cost Cotter, a wholly owned subsidiary of Commonwealth Edison of Chicago, about $11 million. The plan, in part, requires the company to

- remove soil from an old tailings pond considered to be the major source of groundwater contamination,
- install a hydrological groundwater barrier to intercept and collect water along the primary pathway of groundwater flow, and
- conduct groundwater flushing and remediation programs.

According to Cotter's President, the hydrological barrier is largely complete, and a new pump-back system designed to control and clean groundwater has been installed. In addition, many of the mill tailings piles have been stabilized. However, final decommissioning actions will not be completed until 2016.

section 220. Several officials stated that, if passed, the final interpretation would probably rest with the courts. Although NRC staff do not believe that the language would exempt the owners from cleaning up the active sites as required by the 1978 act, EPA and state officials oppose the proposed provision because of concerns about the consequences of relieving owners from future environmental cleanup activities that may be required. For example:

- EPA officials are concerned that the exemption, if passed, would prevent them from holding the producers responsible under the Comprehensive Environmental Response, Compensation, and Recovery Act (Superfund) if problems develop after the owners meet the mill tailings act's requirements.
- EPA's Director, Legislative Analysis, in formal comments on the proposed provision, stated that the provision for an exemption of Superfund liability would not be appropriate or consistent with past practice. He noted that cleanup under current requirements may, in some rare cases, be incomplete; therefore, public health and environmental protection are not served by providing waivers from future Superfund authority. The Director also stated that exempting a particular industry from certain environmental statutes is "questionable public policy and bad precedent."
- EPA Office of Radiation Programs officials noted that the proposed language would probably exempt the owners from other environmental requirements, such as new Clean Air Act regulations, that have not yet been finalized, and many others that are being reviewed and/or revised. Since the Congress or EPA has determined that the new requirements are needed to protect the environment, these EPA officials question the advisability of releasing owners from future responsibility.

State officials that we contacted also are concerned with the proposed language. They believe the states might end up paying for future corrective actions if the provision is passed. On the other hand, NRC staff said that they are not opposed to the proposed language in S.2097. They pointed out that NRC's regulations to implement the 1978 mill tailings act conform with current EPA standards. They also question the government's ability to hold owners responsible for future cleanup after ownership of the sites passes to the states or federal government.

If the mill tailings site is in an agreement state,[1] a similar process will be followed, although NRC's concurrence is needed to terminate the license. Ten of the 29 identified mill tailings sites are located in three agreement states—Colorado, Texas, and Washington. In 1986 New Mexico relinquished its mill tailings program to NRC because of budgetary constraints. NRC staff told us that the Colorado and Washington programs are lagging behind the federal program because of fiscal problems.

According to NRC staff, most mill tailings site owners have begun some cleanup and stabilization actions. For example, most have taken steps to collect the material that has blown off-site and covered the on-site piles with soil to minimize additional off-site contamination. Many have also initiated steps to monitor groundwater to determine the extent of radioactive and chemical contamination. According to NRC staff, only limited information exists on groundwater contamination. In most cases where groundwater contamination has been found, NRC and the owners have not yet determined the cleanup actions that should be taken. NRC staff also said that available technologies have not been entirely successful in reducing groundwater contamination. Nevertheless, NRC expects that environmental conditions at most sites will improve as milling ceases and the piles are stabilized.

Some industry critics and state officials say that owners' cleanup actions under the act have been slow and the industry has spent most of its time and effort pursuing legislative and legal means to obtain financial relief. NRC staff say that this may be true in some instances, but it is not true in all cases. They point out that NRC did not finalize mill tailings standards for active sites until 1987, and some mining companies have shown that they wish to complete their reclamation programs as quickly as possible.

Continuing Controversy Over Mill Tailings Cleanup Costs

The owners of active mill tailings sites have long contended that the federal government should pay that portion of the cleanup costs associated with federal contracts. In a 1979 report, we supported that position, recommending that the Congress provide assistance to active mill owners to pay for the cleanup of tailings generated under government contracts.[2] Although the mining industry has tried for many years to obtain funds

[1] As of October 1988, NRC had formal agreements with 29 states to regulate the possession and use of nuclear materials. These states must have programs comparable to NRC's.

[2] Cleaning Up Commingled Uranium Mill Tailings: Is Federal Assistance Necessary? (EMD-79-29, Feb. 5, 1979).

Table 3.1: Active Uranium Mill Tailings Sites and Volumes—May 1989

(Millions of tons)

Facility/location	Volumes generated: Federal contracts	Volumes generated: Commercial contracts	Total
Licensed by NRC:			
TVA-Edgemont, S.Dak.	1.6	2.0	**3.6**
UMETCO, Utah	•	2.2	**2.2**
Atlas Corp., Utah	6.0	4.6	**10.6**
Plateau Resources, Utah	•	0.05	**0.05**
Rio Algom, Utah	•	3.3	**3.3**
Exxon, Wyo.	•	11.3	**11.3**
American Nuclear Corp., Wyo.	2.1	3.8	**5.9**
Petrotomics, Wyo.	0.7	5.7	**6.4**
Minerals Explor., Wyo.	•	2.4	**2.4**
UMETCO, Wyo.	2.1	7.1	**9.2**
Western Nuclear, Wyo.	3.4	4.3	**7.7**
Pathfinder (Gas Hills), Wyo	2.7	8.0	**10.7**
Pathfinder (Shirley Basin), Wyo.	•	7.1	**7.1**
Bear Creek, Wyo.	•	4.7	**4.7**
Anaconda-Bluewater, N.M.	8.8	15.4	**24.2**
Homestake Mining, N.M.	11.4	10.6	**22.0**
BP America, N.M.	•	2.1	**2.1**
Quivera Mining, N.M.	10.0	23.0	**33.0**
United Nuclear, N.M.	•	3.6	**3.6**
Subtotal	**48.8**	**121.3**	**170.1**
Licensed by States:			
Conoco-Pioneer Nuclear, Tex.	•	8.7	**8.7**
Exxon Minerals Company, Tex.	•	0.5	**0.5**
Chevron Resources, Tex.	•	4.5	**4.5**
Western Nuclear Inc., Wash.	•	2.3	**2.3**
Dawn Mining, Wash.	1.1	1.8	**2.9**
Joy Mining Company, Colo	•	0.003	**0.003**
Cotter, Colo.	0.3	2.4	**2.7**
UMETCO (Uravan), Colo.	5.7	5.3	**11.0**
UMETCO (Maybell), Colo.	•	1.0	**1.0**
HECLA Mining, Colo.	•	0.5	**0.5**
Subtotal	**7.1**	**27.0**	**34.1**
Total	**55.9**	**148.3**	**204.2**

Source: NRC.

Overview of the Uranium Mill Tailings Radiation Control Act

Until the mid-1970s, the sand-like wastes from uranium mills—commonly called "uranium mill tailings"—were not believed to be an environmental or public health and safety concern. As a result, the tailings were often left in large uncontrolled piles, some over 100 acres in size and over 200 feet deep. In the mid-to late-1970s, concern about the possible adverse health effects of exposure to low-levels of radiation over long periods of time resulted in the Uranium Mill Tailings Radiation Control Act of 1978. The act requires the cleanup of all mill tailings sites including those that were inactive—closed and/or abandoned—and those licensed to operate at the time the act was passed. Remedial actions at all sites must meet standards established by EPA. These standards, in part, require the companies to establish controls over the tailings that will last at least 1,000 years.

In addition, the act requires DOE to ensure the cleanup of inactive sites. DOE has identified 24 inactive mill sites, where virtually all of the tailings were produced under federal government contracts. The federal government will pay 90 percent of the costs; the states will pay the remaining 10 percent. By the end of fiscal year 1989, DOE expects to have spent about $584 million at the sites, and the participating states about $41 million, although some initial program expenses were paid exclusively by DOE. DOE plans to complete the program by 1994, at a total cost of almost $1 billion. However, DOE plans to reevaluate its groundwater protection program after EPA finalizes its proposed groundwater standards. The director of DOE's program expects that EPA's new groundwater standards may require additional actions and expenditures past 1994.

Further, the act requires owners to operate and clean up active sites—those licensed at the time the act was passed—using NRC and EPA regulations and standards. According to an NRC report, 29 active uranium mill tailing sites contain over 200 million tons of tailings—the largest site in New Mexico contains more than all of the DOE sites combined. As of December 1988, all but four mill sites had been permanently or temporarily shut down. On the basis of its experience with inactive sites, DOE estimates that it will cost the active site owners between $1 billion and $2 billion to clean up their sites. However, NRC staff expect that actual costs may be lower than DOE's estimate because many of the operators possess the heavy equipment and expertise to complete most needed actions, and the private sector can often complete these types of projects for less than the government's costs. In addition, an EIA report states that total costs are likely to be less than $500 million.

Table 2.1: NUEXCO Purchase Program Projected Results

(Millions of pounds)

	Scenario I	Scenario II
Total increased production 1989-94	14.2	7.8
Total DOE purchases	24.7	28.9
Average cost of DOE purchases	$30/lb.	$26/lb.

DOE Inventory Considerations

As of September 1988, DOE had a large uranium ore inventory--over 240 million pounds. Of this amount, about 156 million pounds are committed to future customer deliveries or working inventory, and 53 million pounds have been allocated for defense production purposes. Therefore, DOE has about 32 million pounds available to "overfeed" its enrichment plants. In supporting the proposed purchase program, DOE said that it would use the uranium to overfeed the plants, thereby saving an estimated $400 million in electricity costs and offsetting some of the $750 million purchase cost.

Of the 32 million pounds of uranium available for overfeeding, DOE expects to use about 18 million pounds in fiscal year 1989—up from 2 million pounds in fiscal year 1987—because production has increased, and DOE needs to keep its electricity costs within budget. After that, DOE plans to decrease the amount of ore used for overfeeding. Further, DOE plans to use only about 3 million pounds of uranium annually for defense purposes. Thus, if DOE reduces its annual overfeeding requirements to less than 6 million pounds as planned and some of the defense allocation is available to overfeed the plants, DOE would have about a 10-year supply of uranium ore on hand for overfeeding purposes.

or more per pound, allowing domestic producers to compete with foreign suppliers.

With one exception, all the producers with whom we spoke said that they had relatively small uranium ore inventories (1.5 million pounds or less) that would not affect the purchase program. (One would not provide us information on inventories.) One producer also told us that most producer-held inventories are committed to long-term contracts; therefore, they could not be sold to DOE. The President of the Uranium Producers of America said that U.S. producers held no more than 4 million pounds in stockpiles. Therefore, he believes that the purchase program would increase annual production to as much as 20 million pounds--up about 6 million pounds from current production—over the 6-year program and more than double employment from the current 2,000 workers nationwide.

EIA officials, responsible for collecting information on the uranium industry, have not formally evaluated the impact of a purchase program. They pointed out that the impact would partially depend on the competitive process used to purchase the ore and cautioned that the "psychology" of the process makes it difficult to predict prices. For example, they question whether producers would try to undercut competitors or bid a price that would cover all production costs. Further, they said that the impact of a purchase program would largely depend on the restrictions, if any, placed on suppliers using their inventories. According to an EIA report, Uranium Industry Annual 1987, suppliers held over 25 million pounds of uranium as of the end of 1987.

Since the proposed program would not prevent producers from selling inventories or new production to DOE and then using cheap spot market purchases to meet long-term contracts, one EIA official said that the purchase program might stimulate less new production than expected. The official also noted that past analysis shows that the most effective government program to aid the miners would be an embargo on foreign uranium. However, passage of the U.S.-Canadian Free Trade Agreement makes an embargo very unlikely.

A 1988 study, performed by Nuclear Resources International, Inc., under contract to EIA, projects that DOE would pay an average of about $28 or more per pound under the purchase program, and some new production would occur. However, the president of this company told us later that he believes the price would only rise to about $25 a pound

an industry official, utilities had an 8-year supply of uranium in inventory at the end of 1981. By the end of 1987, utilities still had 137 million pounds of uranium—a 4- to 5-year supply—while suppliers had another 25 million pounds of uranium ore stockpiled in inventory. According to a market expert, these excess supplies helped drop the spot market price[1] of uranium from about $40 per pound in 1980 to about $10 per pound in early 1989, considerably below the average production cost of most domestic producers. In constant 1980 dollars, the drop was even larger, to about $7 per pound.

Throughout the 1980s, U.S. producers also experienced increasing foreign competition. Canada developed its rich uranium ore resources and became the world's leading supplier. Also, Australia discovered large uranium reserves and could become a leading exporter if it chooses to develop its resources. In 1987, foreign producers supplied over 50 percent of the uranium that U.S. utilities delivered to DOE for enrichment, and in 1988, Canada supplied over 90 percent of the uranium imported into the United States.

The U.S. uranium-mining industry, facing financial hardships and increased foreign competition, sued DOE in 1984, to force it to restrict its enrichment of foreign ore. DOE resisted, in part, because it feared its customers would turn to foreign enrichment suppliers if they were required to purchase domestic ore before obtaining DOE's enrichment services. The miners dropped the lawsuit early in 1989 after the Supreme Court ruled that a nonviable domestic uranium industry alone does not require DOE to restrict its enrichment of foreign uranium ore and the Congress approved the Canadian Free Trade Agreement, which allows the unrestricted importation of Canadian ore.

Despite their problems, U.S. miners supplied over 40 percent of domestic utility uranium ore purchases in 1987. Most of these sales probably resulted from existing long-term contracts. Further, U.S. utilities have generally preferred to purchase a portion of needed uranium from domestic suppliers to maintain a safe supply. However, DOE officials told us that public utility commissions throughout the country are becoming more price conscious and increasingly insistent that nuclear utilities purchase the cheapest ore and enrichment services available.

[1]The uranium market has a two-tier price system. The spot market price is the price at which a supplier would be willing to provide uranium concentrate within a year. Only about 10 percent of market exchanges occur under the spot market. Most sales occur through long-term contracts. These prices tend to be higher and more stable, although utilities are increasingly forcing producers to tie long-term prices to the spot market.

Impact of the Proposed Uranium Purchase Program

Questions

1. What effect, if any, would the proposed purchase of $750 million of uranium from domestic producers have on employment in the domestic uranium industry?

2. Would the uranium purchased come from existing stockpiles held by domestic producers?

3. What effect, if any, would the proposed $750 million uranium purchase program have on the price of uranium?

Summary Response

Domestic uranium ore production and uranium mining employment have fallen dramatically since 1980 because of less than expected demand and increased foreign competition. Market conditions have also created large uranium inventories that may significantly reduce the intended impact of the proposed DOE purchase program. Existing industry models indicate that, although the purchase program would increase uranium ore prices to perhaps $25 per pound, producers would sell their inventories to DOE and use short-term market purchases to meet existing customer requirements, thereby limiting the amount of new production. DOE would use the uranium to "overfeed" its two operating enriched uranium production plants, thereby saving an estimated $400 million in electricity costs and offsetting some of the purchase program's costs.

Uranium producers believe that the purchase program may increase mining employment by more than 2,000 workers nationwide. Further, the program is needed to allow them to stay in business until utility-held inventories decline and demand increases. Otherwise, they say the nation is in danger of losing an industry vital to its energy security.

Overview of the Uranium Mining Industry

Uranium is a silvery-white, radioactive metal that fuels nuclear reactors. It is also used to produce various radioactive materials for medical, industrial, and research purposes. In the United States, both open-pit and underground methods are used to mine uranium ore; these methods are generally referred to as "conventional mining." Uranium mills, usually located near the mines, extract uranium concentrate from the ore by crushing, milling, and leaching the ore. The waste piles created by this process are called "mill tailings."

Significant amounts of uranium concentrate are also produced in the United States by "nonconventional" methods, such as solution or in-situ

which oversees producers' efforts to clean up active sites. We asked these officials for their views on the proposed mill tailings fund and discussed the impact of a provision in some of the proposed bills that might exempt domestic producers from complying with other environmental laws in the future. We also obtained EPA's official comments on the draft provision. In addition, we interviewed the Research Director, Southwest Research, Inc.—a nonprofit research organization active in efforts to spur cleanup actions in New Mexico—and reviewed testimony the Director presented to the House Committee on Interior and Insular Affairs on the proposed mill tailings fund.

To obtain information on DOE's international competitors, we interviewed DOE's uranium enrichment Sales and Marketing Manager and obtained DOE's best available information on competitors' prices and market strategy. Although foreign producers' prices are generally not publicly available, DOE has developed information obtained from a variety of sources, including its customers. We also spoke to the Senior Vice President of the Duke Power Company to obtain information on the status of its plans to construct a centrifuge enrichment facility in the United States with URENCO—a European enriched uranium producer.

In addition, to answer questions on DOE's decommissioning costs and funding strategies, we interviewed DOE's uranium enrichment Director of Operations and Facility Reliability and his staff. We also reviewed DOE's latest reports and plans for decommissioning and other environmental actions at its three enrichment facilities including its 1988 draft decommissioning strategy report. In addition, we reviewed DOE's 1990 uranium enrichment congressional budget request setting out expected decommissioning and environmental expenditures and examined DOE's legislative proposal to establish a fund to pay decommissioning costs after the year 2000. To further evaluate environmental costs, we reviewed a December 1988 report on needed future environmental activities that DOE prepared at the request of the Senate Governmental Affairs Committee. The report, Environment, Safety, and Health Needs of the U.S. Department of Energy, summarizes the costs of environmental, safety, and health activities needed to bring all DOE facilities, including the three enrichment plants, into compliance with existing environmental legislation.

We discussed the facts presented in this report with officials in DOE's Office of Uranium Enrichment and EIA, EPA's Office of Radiation Programs, and NRC's Low-Level Waste and Decommissioning Office. They generally agreed with the facts but offered some clarifications that were

Objectives, Scope, and Methodology

On November 10, 1988, the Chairman, House Committee on Interior and Insular Affairs; the Chairman, Subcommittee on Energy and Power, House Committee on Energy and Commerce; and Representative George Miller asked us to respond to several questions concerning proposed uranium enrichment legislation. The questions address four issues: (1) the impact of the proposed uranium ore purchase program on prices, production, and employment, (2) a proposed uranium mill tailings fund, (3) competition from foreign enriched uranium producers, and (4) future decommissioning costs of DOE's enriched uranium production facilities.

As an initial step, we reviewed the various uranium enrichment and mining bills proposed during the 100th Congress including S.2097, H.R.4934, H.R.4489, H.R.4975, and H.R.5181, and testimony given by DOE, uranium producers, utilities, and other interested parties on them. Most of these bills have been reintroduced this session. For example, in May 1989, congressional sponsors introduced H.R.2278, a bill very similar to last session's H.R.5181. Further, on July 6, 1989, the Senate Energy and Natural Resources Committee forwarded S.83 to the Senate for consideration. The bill would establish a uranium enrichment government corporation and a "voluntary" utility uranium purchase program. It would also authorize a mill tailings cleanup fund. Because this bill was introduced late in our review, we were not able to use it in our report.

To obtain information on the uranium industry, we contacted the Energy Information Administration's (EIA) Office of Coal, Nuclear, Electric, and Alternate Fuels Division and reviewed various EIA reports on uranium resources and the viability of the uranium industry. We also obtained an EIA contractor's analysis of the uranium market and discussed existing models of the uranium mining industry with EIA officials.

In addition, we contacted the president or other high-ranking officials of six uranium production companies. Three of the companies—Energy Fuels Corporation, Everest Minerals Corporation, and Chevron Resources Company—are among the top five producers over the past 3 years; one—Cotter Corporation—is a former producer which exited the industry in 1984; and another--Ferret Exploration Company of Nebraska—plans to begin production in 1990. Two of the producers also

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- We believe that decommissioning costs for the enrichment plants should be recovered from the beneficiaries of the services provided. DOE officials say that, under existing legislation, they cannot recover future costs from customers until authorized by the Congress. DOE recently proposed legislation to the Congress that would authorize a uranium enrichment government corporation and establish a decommissioning fund to accumulate $1.4 billion by 2005. Under its proposal, a new enrichment corporation would deposit $40 million into the fund in fiscal year 1990 and $50 million into the fund each year, thereafter. The corporation would collect between $4 and $5 per separative work unit from commercial customers to meet the annual deposit. Other legislative proposals would require the collection of over $3 billion directly from nuclear utilities.

Sections II through V contain detailed responses to your questions.

To answer your questions, we contacted officials within DOE, EPA, and the Nuclear Regulatory Commission (NRC), who are responsible for the uranium enrichment program and other activities affecting domestic uranium mining as well as six uranium producers and representatives of three states involved with uranium mill tailings cleanup efforts. We also reviewed related documents and studies. Our objectives, scope, and methodology are discussed in detail in section I.

We discussed the facts in this report with DOE, EPA, and NRC staff and incorporated their views where appropriate. As requested, we did not ask the agencies to review and comment officially on this report. Our review was conducted between November 1988 and April 1989 in accordance with generally accepted government auditing standards.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the appropriate congressional committees; the Secretary of Energy; the Chairman, NRC; the Administrator, EPA; and the Director, Office of Management and Budget. We will also make copies available to others upon request. If you have further questions, please contact me at (202) 275-1441.

- The costs to decommission DOE's uranium enrichment production facilities.

Since 1969, DOE has enriched uranium ore for commercial nuclear power plants at three gaseous diffusion plants.[2] During the early years of the program, utilities ordered over 200 nuclear plants; many also signed long-term contracts with domestic producers for needed uranium ore. However, expected electricity demand fell in the 1970s, and by 1980 rising costs and safety concerns led utilities to cancel about 70 nuclear plants. Further, foreign competitors cut into both DOE's enrichment and domestic miners' uranium markets. As a result, DOE's enrichment program and domestic uranium miners fell on hard financial times.

Throughout the 1980s, DOE took a number of steps to improve its competitive position and for several years has been seeking legislation to restructure the program as a corporation so that it can compete more effectively. Domestic miners, whose annual production fell from over 40 million pounds in 1980 to about 13 million pounds in 1987, are also seeking congressional help in the form of a purchase program as well as funds to help clean mill tailings resulting from past production sold to the government.

In summary we found that:

- Uranium market experts believe and existing market models show that the proposed DOE purchase of $750 million of uranium from domestic producers may not significantly increase production because of large producer-held inventories. Further, the program, at best, may increase mining employment by 2,000 to 3,000 workers nationwide. DOE officials say they would use the uranium to "overfeed" the enrichment plants, thereby saving an estimated $400 million in electricity costs and offsetting some of the purchase program's costs.[3] Domestic producers claim that the purchases would raise prices, increase production, and allow them to stay in business until inventories decline and demand increases. Otherwise, they say, the nation is in danger of losing an industry vital to its energy security
- State officials and uranium ore producers that we contacted favor legislation to establish a fund that would help pay for some of the costs of

[2]Two of these plants, one in Portsmouth, Ohio, and another in Paducah, Kentucky, are still operating. DOE permanently shut down its Oak Ridge, Tennessee, plant in 1987.

[3]"Overfeeding" means adding more uranium to the enrichment process than utilities provide. The additional uranium reduces electricity costs during the production of enriched uranium.