Chapter III

Nuclear Issues

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1. Standardization

ISSUE

The present procedure for the design, construction, and licensing of a nuclear powerplant is time-consuming, inefficient, and costly. An ERDA-supported standardization program could alleviate these difficulties.

SUMMARY

At present, virtually every nuclear powerplant is custom designed and built by a combination of suppliers. This procedure leads to very complex interfaces between the various suppliers, the utility, and the NRC. The incomplete status of the design at the time the construction permit is issued (conditioned upon the resolution of incomplete design features) and the changing regulatory requirements result in many design changes, imposition of retrofitted systems, delays, and cost increases. Standardization is a potential solution that is not feasible in the present environment of fragmented responsibility and rapidly changing regulatory requirements.

ERDA could support the development of a standardized design of a complete nuclear powerplant for which the NRC would issue a "license to manufacture. " Participation by all concerned parties would ensure a high-quality design. The licensing review of the utility's application would be limited to site-related issues and would require only a small fraction of the present licensing time and cost.

BUDGET SUMMARY

The budget for standardization activities is provided in the "Plant Design and Construction Technology" subsection of Light-Water Reactor Technology. Budget history tables do not provide a sufficiently fine breakdown to trace the relevant suggested budget from ERDA division through OMB. The LWR technology program budget is shown below.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
LWR Technology	4.0	51.9	51.9	12.5
Plant design & Construction Technology (Budget Outlay)	1 .15	[Not Available)		5.5

Although it cannot be determined what fraction of these funds will be used for standardization activities, the proposed budget indicates the possibility for substantially increased effort.

COMPARATIVE SUMMARY

The issue of standardization of nuclear powerplants has not been addressed in ERDA-76-1, However, the lesser (but significant) issue of standardization of selected plant systems and procedures is included under Plant Design and Construction Technology, A significant fraction of this program should be concerned with standardization of components, systems and design because of the potentially favorable impact upon reliability and safety. This action would be consistent with NRC's encouragement of NSSS vendors and architect-engineers to submit standardized safety analyses for their most commonly purchased NSSS's and designs.

QUESTIONS

1. Is ERDA willing to consider participation in a program to promote standardized nuclear powerplant design and construction and what form would this participation take?

2. Are there significant antitrust issues or other difficulties involved in specifying brands of pumps, valves, control systems, instruments, etc., or designs which clearly favor one supplier over another?

3. What are the advantages of standardization over present procedures if the latter were implemented more expeditiously? What is the evidence that standardization will actually reduce costs?

2. Performance and Reliability

ISSUE

Problems relating to the performance and reliability of light-water reactors have received insufficient attention since the AEC ceased nonsafety light-water reactor R&D.

SUMMARY

Until the late 1960's, substantial governmental research work was carried out on light-water-cooled nuclear power reactors. At that time, the AEC decided that LWR'S had reached commercial status area. Following that decision, a number of problems developed. First, the nuclear industry has been slow to see the need for and to initiate extensive IWD efforts of its own. Second, increases in reactor power levels greater than those warranted by existing technology resulted in component performance and reliability problems. Third, continuous AEC tightening of safety-related design criteria and operating restrictions over the past 6 to 8 years has resulted in economic penalties and reduction of plant operating flexibility, With respect to the first two problems, it is noted with approval that ERDA is planning to renew governmental support of R&D aimed at improving LWR performance and reliability. The third problem would seem to be NRC's responsibility. However, it is questionable whether NRC has adequate incentive for doing research to optimize the balance between costs and safety. Furthermore, it has little incentive to develop improved safety concepts or systems so long as it considers its primary responsibilities to the review of proposed systems for adequacy. The ERDA LWR safety program can serve both to control the costs of safety systems and reduce the unknown factors in safety-related areas, thereby possibly-increasing safety margins and reducing public fear.

BUDGET SUMMARY

Each of the five subsections of the LWR Technology section of the budget pertain to Performance and Reliability. The history of requests for this section is presented below.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	Division Request	ERDA Request	Request to Congress
LWR Technology	4.0	51.9	51.9	12.5

COMPARATIVE SUMMARY

This should be one of the high, short-term priority efforts within the Fission Reactors Program, although we would not expect the appropriation for it to exceed a few percent (perhaps 10 percent) of the Fission Reactors budget. This is because other program elements, notably the LMFBR Program, are at the stage of maximum funding requirements. Nevertheless, the LWR's must carry the nuclear power load for the next two decades. While the existing safety features of these reactors reduce the risk to the health and safety of the public to low levels, it appears that potential improvements in design and manufacture could improve reliability and safety. Such improvements would enhance both the usefulness and the acceptability of LWR's in our electric power system. ERDA has undertaken to provide assistance in this effort.

It is of concern, however, that the LWR Technology Program is still in the early stages of definition. The program description is couched in general terms, and there does not appear to have been much progress since July 1975, despite the fact that the last half of 1975 was to have been used to develop a detailed program plan. Several important program elements are now being identified. If this initial effort is expanded, the program may yet attain its goals.

There may be difficult problems of equity in this undertaking. Some suppliers may benefit more than others. Such questions should be resolved and a balanced LWR Technology Program developed if these reactors are to provide their full benefits to the American public at a level of risk that is generally acknowledged to be acceptable.

QUESTIONS

1. How can ERDA provide assistance without altering the competitive balance among suppliers?
2. How will the components and systems to be improved be selected?

3. Floating Nuclear Powerplants

ISSUE

Floating nuclear powerplants (FNP's) offer potential improvements in LWR licensing and construction, but implementation is in doubt.

SUMMARY

FNP's are commercially available, although none have yet been built. After several years of design and sales effort, only four units have been sold to one utility, and all four of these units were recently delayed from the 1979-86 period to the 1984-90 time period. As a result, the supplier is in financial difficulty. If this company fails, the FNP, which represents a major step forward in standardization, will be eliminated for the foreseeable future as an option in meeting the Nation's energy generation needs.

The FNP is to be built in a factory setting favorable to rapid, high-quality construction and controlled costs. The plant design is to be approved by NRC prior to the issuance of a "license to manufacture"; hence, a utility has only to license the site. Indeed, the concurrent construction of the plant and the licensing and preparation of the site significantly reduces the time to install FNP's.

The present reservations about FNP's among utilities concern the licensability y of the plant and site, and the performance of the plant upon completion. ERDA should consider aiding utilities in the 1icensing process and guaranteeing operating performance if the reactor vessel melt-through problem can be satisfactorily resolved.

BUDGET SUMMARY

No budget has been identified for this activity.

COMPARATIVE SUMMARY

The subject of ERDA support for floating nuclear powerplants is not addressed in ERDA 76-1. This would indicate that ERDA has no present plans to encourage the FNP concept as one of the methods of supporting standardization and its potential benefits.

Major assistance probably is not required since the manufacturer is proceeding with construction plans, but many serious problems remain. The benefits of the concept are sufficiently great that FNP's could constitute a large proportion of future nuclear construction if the initial difficulties can be surmounted. Recent utility analyses indicate that the cost for a 2-unit plant sited at a lagoon could be $500 million to $1 billion less than that for a land-based, 2-unit plant of comparable size due to the assembly line construction of the FNP and the parallel construction of the plant and site, Such savings, however, are contingent upon the licensability and the reliable operation of the plants. The consequences of “being wrong” in deciding on FNP’s are so large that utilities so far have chosen the more expensive, but less speculative, conventional nuclear route. ERDA activity to encourage early resolution of the technical, environmental, licensing, and financial risks could serve to assure the early availability of the advantages of FNP’s.

QUESTIONS

1. Are the licensing questions of FNP’s so different from those of land-based plants that a utility committed to nuclear power would not accept the risk of delays and additional costs to resolve the issues involved?
2. Are there any reasons that an FNP would not be expected to reach rated power or be restricted to less than rated power by NRC, i.e., the question of the ice condenser experience as well as the upper head injection?

4. Helium-Cooled Reactors—Converters and Breeders

ISSUE

Helium-cooled reactors have some potential advantages not offered by water-er sodium-cooled plants, yet have a relatively low priority in ERDA’s program.

SUMMARY

The HTGR has never been accorded the degree of AEC support enjoyed by LWR’s, but private and foreign development have brought it to the point where it could become a significant factor. The HTGR and its potential successor, the very high temperature reactor (VHTR), can be used to generate electricity at much higher efficiencies (up to 50 percent) than LWR’s, but they may have even greater potential for producing industrial process heat. In addition, they would extend uranium resources and possibly present more easily managed safety and safeguards problems, although the spent fuel safeguards advantage is somewhat counterbalanced by the need to protect the clean fuel. The HTGR, however, is less developed than LWR’s, thus presenting cost, performance, and licensing uncertainties.

The GCFR has been viewed as a backup to the LMFBR. It may, however, have sufficient advantages to warrant concurrent development. The breeding ratio is about 1.4, somewhat better than the LMFBR. The thermal efficiency is higher than the LMFBR, and the capital cost could turn out to be lower since the system is inherently simpler. There exist, however, serious uncertainties regarding the loss of coolant accident, since the power density is higher than the HTGR and the core heat capacity is lower, resulting in a faster temperature rise,

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Thermal Reactors	14.8	25,8	15.6	15.6
Fast Breeder Reactors	6.2	15.3	7.8	7.8
Reactor Safety	4.3	6.6	6.6	5.3

COMPARATIVE SUMMARY

The High-Temperature Gas Reactor (HTGR) appears to have sufficient advantages over LWR's to justify keeping it available as an option. Private industry, however, has found immediate deployment impractical and rapid development beyond its means. In view of uncertainties in the industrial commitment to these reactors, it may, therefore, be appropriate for ERDA to carry the program at about its present level until the industrial position becomes clearer. This level is probably not sufficient to assure development on a reasonable time frame, even with full industrial participation. A significantly higher level of Federal support will be needed to ensure success of the program even on the time scale envisioned by ERDA, i.e., operation of an essentially commercial reactor by the later 1980's. Since this is close to the expected commercialization period for the LMFBR, the resource conservation rationale for the HTGR loses much of its force.

The budget for HTGR fuel-cycle R, D&D (Issue Paper 15) is slightly greater than that for the HTGR itself. This appears to be out of proportion.

Continued ERDA development of direct cycle HTGR's and VHTR's for high-temperature process heat may not be justifiable if industry should abandon development of the steam cycle HTGR. This aspect of the ERDA program (at present only a contingency) may not be realistic. Major review of the Federal role in supporting HTGR technology will soon become necessary. The ERDA program provides for such major decision points within the next 12 to 18 months.

The Gas-Cooled Fast Reactor (GCFR) program is continued as a backup to the LMFBR. The program is presently in a program definition and technology development phase. A decision whether or not to proceed with a demonstration reactor project is expected in about 3 years. The present program and budget appear to be consistent with that goal. Since this program is also heavily dependent on HTGR technology, continuation may become unrealistic if the HTGR is dropped.

QUESTIONS

1. Will ERDA consider developing the HTGR now that funding is drastically lowered by the private sector?
2. Will development of the GCFR be continued if the HTGR is dropped?

15. Liquid Metal Fast Breeder Reactor

ISSUE

The liquid metal fast breeder reactor (LMFBR) has great potential as an "inexhaustible" long-term energy source, but it poses serious technological and societal problems.

SUMMARY

A successful LMFBR could provide the bulk of the electricity for the United States for millennia at a competitive price. The U-238 which would be used in the LMFBR is readily available and is otherwise useless. Much of the technology has already been demonstrated here and abroad during the past 25 years. Advocates believe that the LMFBR will be an attractive energy source, both economically and environmentally, and that a delay in the present schedule would cause the dissipation of expertise in the development program and probably would lead to a stronger ultimate demand for fossil fuel. In addition, some form of a breeder will be vital if fusion is to be a major source of energy in the twenty-first century, and the LMFBR is the most advanced and promising of the various alternatives.

Opponents of the present plan argue that a year or two delay would make possible a better design, that electric forecasts and uranium reserves do not require the LMFBR on an expedited schedule, that proper safeguards for plutonium will be impossible to design and implement, that plutonium toxicity is not well enough understood, that large technological and economic uncertainties remain, that there will be preferable alternatives, and that proceeding with the Clinch River demonstration will commit the United States so strongly to the LMFBR that it would be commercialized even if it turned out to be a bad choice.

BUDGET SUMMARY

SUMMARY TABLE
(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Base Program	191.0	267.0	240.2	227.2
Clinch River	107.0	237.6	237.6	237.6
Reactor Safety	46.0	70,5	70.5	54.4
Advanced Funds	14.5	17.5	17.5	15.5
Total	358.5	592.6	565.8	534.8

COMPARATIVE SUMMARY

The program and budget seem appropriate to the task of producing an LMFBR. The base program R, D&D is developing the information necessary to support the design of LMFBR's. The design of the Clinch River demonstration plant is well underway. Reactor safety studies should eventually resolve principal safety issues.

Questions as to the overall cost and schedule of the program have been less satisfactorily addressed. The CRBR cost estimate has recently risen to $1.9 billion (about $3000/kWe for construction costs) and this can be expected to rise further if additional licensing delays are encountered. If the slowdown in construction of light water reactors continues, need for the LMFBR will be postponed because of the lowered demand for uranium. If rapid LWR growth does not resume soon, and uranium resources live up to ERDA's expectations, a delay of several years could be tolerated, If high-grade ore is depleted faster than presently projected, the LMFBR might be useful on an expedited schedule. Activities that could reduce the costs of the CRBR include redesign of the plant with cost control a primary parameter, and a reduction in the program emphasis on building an entire breeder support industry. This latter point seems particularly appropriate now that ERDA has redefined the CRBR as an R, D&D project only. Increased use of foreign technology could also prove helpful in cost reductions. International cooperation is mentioned in ERDA 76-1, but it is not obvious that it will be used constructively. Recent reports of lower than expected breeding ratios in the European breeders emphasize the importance of cooperation in order to avoid potential problems.

QUESTIONS

1. What steps will ERDA take to resolve the principal safety issues relating to the LMFBR? On what time scale are these issues expected to be resolved, if proposed

facilities and programs are completed satisfactorily and on schedule? Does this schedule mesh with ERDA's proposed schedule for developing designs for commercial LMFBR's and for initiating construction of near-commercial breeder be made?

2. To what extent is ERDA investigating the possibility of a thorium cycle LMFBR?

3. When will a decision on proceeding with the near-commercial breeder be made?

6. Light-Water Breeder Reactor

ISSUE

The light-water breeder reactor (LWBR) concept has several advantages, but the need for it is questionable.

SUMMARY

The LWBR is the only breeder reactor now being seriously pursued by the United States that uses thorium rather than uranium as its primary fuel. The technology of the LWBR is based on that of the main line light-water reactor; the original idea of the LWBR is that it would afford an all but inexhaustible source of energy yet would require relatively little development, About $25 million per year has been spent on this concept for the past 9 years, and a demonstration LWBR is expected to operate in the pressurized water reactor vessel at Shippingport, Pa., by 1976. If a 1,000 MWe LWBR over 30 years requires as little as 1,500 tons of uranium, rather than the 3,000 to 5,000 required of other reactors, it could become a serious contributor to the nuclear energy programs, yet in the ERDA nuclear program there seems to be no mention of LWBR actually carrying some of the nuclear load at any time, and utilities have shown little interest in the concept.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Light-Water Breeder Reactor	39,5	47$0	41.0	37.0

COMPARATIVE SUMMARY

The ERDA-76 program for the LWBR represents a continuation of previous activities with one major exception. There is now added an Advanced Water Breeder Applications (AWBA) project "which is directed toward assisting U.S. industry in the evaluation and application of the technology developed and confirmed in the Light-Water Breeder (LWBR) Program to existing and future water reactor plants". This addition appears to respond to the question raised in the original OTA analysis: "What measures does ERDA intend to take to make LWBR technology more accessible to possible users of this reactor type?" No detail of AWBA is given. It is impossible, therefore, to judge how seriously AWBA is viewed by ERDA. There is still no evidence that LWBR is being factored into future planning of the U.S. energy system. This might imply that, despite AWBA, planners at ERDA are not counting on LWBR in the near term.

QUESTIONS

1. Why is LWBR not mentioned in ERDA projections of future nuclear mixes?
2. At what uranium price and rate of deployment does the LWBR look attractive?
3. What plans are there for incorporating developments in this program into existing type LWR cores (e.g., improved conversion ratios).

7. Molten Salt Breeder Reactor

ISSUE

Support for the molten salt breeder reactor (MSBR) development program is small compared to other reactors and maybe insufficient to permit evacuation within a reasonable time period.

SUMMARY

The MSBR program is presented by ERDA as a potential backup for solid fuel breeder reactors. It uses an inherently different nuclear technology, and hence provides technological insurance. Even if fast breeder reactors prove to be commercially successful and environmentally acceptable, the MSBR, based on thorium rather than uranium, would enlarge the options available for future energy systems and offer substantial advantages such as more easily managed safety and safeguards problems. There are unique problems associated with the development of the MSBR, however, which must be solved.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Molten Salt Breeder Reactor	3.3	9.5	4,3	0

COMPARATIVE SUMMARY

Termination of this program appears to have been decided without the benefit of the technical information that was to have been obtained from the program outlined in ERDA-48. That program was judged in the previous OTA review to be marginal for obtaining the needed information, The division request of $9.5 million for FY 77 is probably the minimum to realistically keep the option open.

The demise of this program is unfortunate as it deprives the country of an alternate approach to breeding (and hence to a major long-term energy source) which presents quite different technical solutions to many of the problems of nuclear energy. For example, with the MSBR, fuel-recycle facilities are automatically decentralized and collocated with the reactors. In addition, more options are available for the safeguarding of fuel, and reactor safety appears to be a less significant issue than with the LMFBR.

QUESTIONS

1. On what basis has ERDA abandoned the Molten Salt Breeder Reactor?
2. Will the MSBR be revived if the gas-cooled reactors are dropped or the LWBR proves unsatisfactory?
3. What studies have been made of the advantages of the unique system characteristics of the MSBR, particularly those relating to safeguards and reactor safety?
4. Given that ultimate success of the breeder program is of major importance to the Nation's energy future, to what degree has the assurance of success been reduced by loss of this option?
5. What level of funding would be required to maintain the MSBR Program as a realistic alternative to the Fast Breeder Reactor Program, so that commercial deployment of MSBR's could be undertaken by the end of the century, if needed?

8. Nuclear Environmental Effects

ISSUE

There is a continuing need for the evaluation of the environmental effects associated with nuclear energy sources.

SUMMARY

In the establishment of biomedical and environmental research priorities, ERDA has not identified clearly the continuing efforts needed in the assessment of environmental issues associated with nuclear-based technology. These efforts must be maintained on long-term studies of radionuclide accumulations and recycling in the aquatic and terrestrial environments. Other programs that should receive increased attention are concerned with reprocessing facility releases and impact/recovery studies of accidental releases from reprocessing facilities and reactors to local or regional areas.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Nuclear Portion of Biomedical & Environmental Research (BER) (Budget Outlays)	60.3	(Not Available)		58.4
Operational Safety R&D (most of the OMB request to Congress is for nuclear-related R&D)	6.9	15.7	12.1	7,7
Nuclear R&D Portion of Environmental Control Technology (Budget Outlays)	Approx. 9.2	(Not Available)		Approx. 10.2
Reactor* Safety	0	39.6	34.6	33.3

*Note, The Reactor Safety Program is not new; it was funded by NRC in FY 76.

COMPARATIVE SUMMARY

ERDA 76-1 Volume 2 and the budget figures show a continuing increase in the emphasis on the non-nuclear sector of the Environmental Research Program. This is reasonable because nuclear environmental and health hazards are probably better understood than those from other sources. Although it is entirely appropriate to strengthen the fossil power environmental program, the question could be asked if it is appropriate to reduce the Nuclear Environmental Program after accounting for inflation. From FY 76 to FY 77, inflation will have decreased the nuclear portion of the Biomedical and Environmental Research Program by at least 15 percent,

QUESTIONS

1. In order of priority, what are the remaining questions connected with the environmental impact of nuclear energy?
2. How does ERDA evaluate the economic consequence of accidental releases that would restrict agricultural operations?

9. Plutonium Toxicity

ISSUE

The toxicity of plutonium may pose a serious threat to a plutonium-based nuclear option, such as the LMFBR or plutonium recycle in light-water reactors.

SUMMARY

Suggestions have been made recently that plutonium may be much more hazardous than had been previously believed to be the case. Though these claims have been specifically denied by the British Medical Council, ERDA scientists, and many other scientists and scientific groups, the issue remains a lively one requiring a more definitive resolution than exists at present.

BUDGET SUMMARY

The budget level, though not explicitly stated, appears to be adequate for the eventual resolution of this issue.

COMPARATIVE SUMMARY

The issue of whether the current radiation protection standards for plutonium and other transuranium elements are adequate is still unresolved. The positions of the ERDA scientists and their critics are unchanged. The EPA, NRC, and the Federal agencies responsible for setting radiation protection standards have yet to rule on the formal petition of the critics to amend the plutonium standard. The EPA, NRC, and the critics appear to be awaiting the final report on the plutonium toxicity issue by an ad hoc committee of the National Academy of Sciences (NAS). The NAS report is in the final review stage and should be available shortly. Final resolution of this issue, contingent on long-term animal studies, is anticipated by 1985.

It should be noted that our understanding of the physical details of how radiation interacts with living cells is primitive. Little such work is being funded by ERDA.

QUESTION

1. What is the evidence that land contaminated by plutonium can be restored to a usable condition at a reasonable cost?

10. Waste Disposal

ISSUE

Satisfactory handling of nuclear fission wastes appears to be technologically feasible, although it has yet to be demonstrated. Other problems exist, mainly societal and institutional, which greatly influence the nature of the demonstration required.

SUMMARY

Spent fuel discharged from a reactor contains radioactive fission products which must be isolated from the biosphere for approximately 700 years as well as actinide elements (uranium, plutonium, americium, curium, and other heavier elements) which are radioactive for hundreds of thousands of years. Because there are no chemical reprocessing plants currently operating in the United States, spent fuel elements from nuclear powerplants are stored temporarily in water basins at the powerplants. Commercial facilities are being designed and constructed, however, to receive the spent elements and remove almost all of the uranium and plutonium, which can be recycled into new fuel, while the residue must be disposed of in solidified form. Several options for this exist, each with different short- and long-term economic and societal costs and benefits. If the wastes are sequestered

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without further separation, the long-term radioactivity between 700 and about 1,000,000 years of the approximately 1 meter^3 per reactor-year is several times that of natural pitchblende ore; but if diluted to the original volume of mined uranium ore, the radioactivity is less than that of the ore. If the actinide elements are also removed during reprocessing and recycled and "burned out" in the reactor itself, the toxicity after 700 years is essentially negligible thereafter.

Projected costs for almost all the water disposal options are small compared to the total value of associated power produced.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Waste Management Commercial	13.0	104.3	104,3	75.0

COMPARATIVE SUMMARY

The substantial increase in funding for this activity indicates that ERDA is taking the issue seriously. Resolution of the issue (which now appears feasible) will eliminate a major obstacle in the path of nuclear expansion. The FY 77 program appears well balanced and accelerated at about the maximum rate consistent with maintaining high quality. There is no mention, however, of research involving virtually complete actinide separation. The subsequent actinide burnup in reactors is covered with an unspecified budget under the Basic Energy Sciences Program. Since this would essentially eliminate the long-term radioactivity (after 700 years), it would appear to be a potentially valuable area to study. The program confirms ERDA's awareness of the societal and institutional problems involved in waste disposal. It is to be hoped that ERDA addresses these issues as actively as it is the technological issues.

QUESTIONS

1. What reservations does ERDA have concerning the disposal of solid waste in salt formations (as at Carlsbad, New Mexico)?

2. What priority and level of funding does ERDA assign to the actinide burnup plan?

3. What is to be done about the so-called alpha wastes (e.g., plutonium-contaminated tools, gloves, etc.) where the activity-per-unit volume is low, but the volume is so large that total activity is comparable to the high-level wastes?

4. What waste management scheme will ERDA implement if plutonium recycling does not materialize?

11. Safeguards for Nuclear Materials

ISSUE

Safeguards must be adequate to prevent the theft or loss of fission materials, with subsequent clandestine construction of nuclear weapons.

SUMMARY

Only about 20 pounds of reactor grade plutonium oxide, or comparably small quantities of other fissionable materials, are required to make a crude nuclear bomb, Furthermore, the information needed to design and construct nuclear weapons is readily available. Preventing diversion of small amounts is difficult because fissionable material must be processed and handled in multiton quantities annually. Plutonium, which is already produced in large quantities in light-water reactors, is an even larger component of the LMFBR fuel cycle. While it is widely agreed that past safeguards practices have been inadequate, a number of measures are under consideration to improve the safeguarding of nuclear materials in the United States. There are important international aspects to the problem, however, since, once diverted, the materials are rather easily concealed and transported.

BUDGET SUMMARY

SUMMARY TABLES

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Safeguards for Nuclear Materials	13.6	29.8	29,8	25.7

COMPARATIVE SUMMARY

Support for the Nuclear Materials Security and Safeguards subprogram in ERDA is slated to substantially increase between FY 76 and FY 77. ERDA 76-1, Volume 2, and the budget indicate that ERDA is aware of the importance of developing physical safeguard systems and more precise materials inventory systems, ERDA appears to be cooperating with the IAEA, but it is not possible to establish from ERDA 76-1 how extensive this effort is. A good deal of ERDA's R, D&D in physical systems could eventually have application to IAEA systems, even though the R, D&D is at present directed toward domestic application.

On the other hand, ERDA 76-1 does not address several of the broader questions related to nuclear safeguards. The only work to assess the social, industrial, and economic impact of various safeguards options is apparently a projected NRC study, for which no budget level was given. In addition, it is not clear from ERDA 76-1 how NRC and ERDA split up the safeguards work between them, nor how well the results of the one are integrated into the plans of the other. There are apparently no plans to make a comparative assessment of the risks and safeguards costs of different fuel cycles, particularly thorium cycles. Finally, it is not clear how the safeguards assessments will be placed in the broader context of the comparative total environmental, social, and technological impacts of the various large-scale energy generating options, both nuclear and non-nuclear.

QUESTIONS

1. To what extent would the safeguard problems be eased if the entire nuclear power program were shifted from uranium-plutonium to thorium-uranium?
2. What are the implications for safeguards if plutonium recycle in LWR's is further delayed?

12. Siting

ISSUE

Nuclear Regulatory Commission policy changes for siting could influence reactor and supporting system design.

SUMMARY

The Energy Reorganization Act (ERA) of 1974 calls for the Nuclear Regulatory Commission (NRC] to report to the Congress on the clustering of nuclear reactors and supporting facilities in "nuclear parks. " Nuclear parks offer several advantages: easier safeguarding of fissionable material, lower unit construction cost, probably increased safety, and less disruptive construction (since the work force is stable), Disadvantages include higher vulnerability in the event of war, creation of heat islands, and increased expense of transmitting power from the remote site. If nuclear park siting becomes a general practice, certain technical problems would require more serious study and resolution: electrical transmission of extremely large blocks of power; the simplification of transport systems between reactor and chemical plant; the incorporation of interim waste disposal facilities on the nuclear park site; and the design of different reactor systems that are better suited to park siting, Though siting policy and the possibility of nuclear parks is largely the responsibility of NRC, the matter is so vital to the entire future of the nuclear energy enterprises that ERDA should be strongly involved in the development of the concept from the beginning,

COMPARATIVE SUMMARY

The ERDA-76 program does not respond adequately to the questions related to siting posed by OTA. The NRC study on nuclear energy centers has just been completed but this study was confined to the siting of LWR's. A primary long-term question that could dominate the entire course of nuclear energy development is the siting policy for breeder reactors. Simply stated, should breeder reactors be collocated with their supporting facilities, or should they be dispersed? Hardly any question is more central to the future of the nuclear enterprise than this one; hardly any is more difficult to settle. ERDA should carry out a definitive study of the siting of breeders in self-contained energy centers. The results of these studies ought to be available by FY 78, so that at that time the debate on a national policy for siting breeders can be based on solid information rather than on conjecture.

QUESTIONS

1. If nuclear park siting is required, how would this affect (a) the ERDA safeguards program; (b) the types of reactors ERDA develops; (c) the transport systems ERDA develops; and (d) the climatological effects program of ERDA?
2. Is ERDA planning to examine the social and institutional implications of nuclear parks?
3. What are the implications of confining breeder reactors and their subsystems to nuclear parks?

13. Uranium Resources

ISSUE

The lack of precision in present uranium resource estimates and questions as to the rate of expansion of uranium production capability make resource-related issues difficult to address.

SUMMARY

Since the adequacy of the domestic uranium resource base has an important bearing on ERDA's and utilities' nuclear strategy, and especially on the timetable for breeder reactor development, a much more precise evaluation is needed than in presently available or anticipated, To keep pace with the Nation's energy needs as projected by ERDA, substantial expansion of domestic uranium production over the next 25 years will be required. This entails long leadtimes, major capital expenditures, and in the relatively near term, large exploration effort and ore-body development. The long time, perhaps 10 years, required for the development of a new mine-mill complex, together with the existence of competing investment opportunities, may require the creation of a relatively low-risk investment climate through loan guarantees, accelerated depreciation regulations, and assured uranium markets. Market prices have increased dramatically during the 1973-75 period from $7 per pound of U_3O_H to about $30, and there is no reason to expect an early end to the seller's market.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Uranium Resources	16.8	41.3	41,3	31,3

COMPARATIVE SUMMARY

This program is projected to expand rapidly as is appropriate for such a critical subject. The bulk of the increase is in actual field surveys. The present phase consists of an aerial survey. The second phase, a hydrogeochemical and stream-sediment survey, is just getting underway. The next phase starting late FY 76 will be the first actual drilling. The program for identification of reserves appears to be adequately funded to meet a reasonable schedule. Recognition is given to the need for liaison with the private sector. No studies are mentioned of the impacts of dependence on foreign uranium.

QUESTIONS

1. What is ERDA's program for obtaining uranium resource information from the private sector for its data base?
2. How does ERDA evaluate the impacts of dependence on foreign sources of uranium, exportation of domestic uranium, and participation of foreign interests in domestic resource development.

14. Uranium Enrichment

ISSUE

Expansion of uranium enrichment capacity is required to meet domestic requirements and foreign commitments for LWR and HTGR fuel.

SUMMARY

Enriched uranium fuel is needed in light-water reactors (LWR) and high-temperature gas-cooled reactors (HTGR). The existing ERDA diffusion plants are being upgraded and expanded, but their capacity will be exceeded within a decade if presently contemplated nuclear powerplant construction occurs. ERDA policy calls for development of new production facilities by the private sector, but the financial risks may be too great without some form of Federal economic assurance. Among the risks involved in the financing of new plants is the possibility that new technology, such as the gas centrifuge or laser separation, might render a new diffusion plant obsolete. A related management question concerns the proposal to allow the U-235 content of the enrichment plant by-products material ("tails") to increase, thereby producing increased enriched uranium output at the expense of greater natural uranium input.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
OPERATING COSTS				
Uranium Production	636.7	822.3	818.3	803.3
Process Development	48.4	75.5	72.5	62,7
Other U-235	8.7	16.3	16.3	16.4
TOTAL	693,8	914.1	907.1	882.4
Advanced (laser)	29.5	50$1	46.1	36.8
Enrichment Revenues	—591 .5	—539. 1	—539.1	—539. 1
TOTAL OPERATING COSTS	131.8	425,1	414.1	380.1

SUMMARY TABLE – Continued

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Construction				
Uranium Production	—	521.8	521.8	521.8
Process Development	—	100.0	100.0	100.0
Advanced		15.0	0	0
TOTAL CONSTRUCTION		636.8	621.8	621,8
Capital				
Uranium Production		17.2	17.2	17.2
Advanced	—	7.0	7.0	7,0
TOTAL CAPITAL		24.2	24.2	24.2
GRAND TOTAL	131.8	1,086.1	1,060.1	1,026.1

COMPARATIVE SUMMARY

ERDA recognizes the need for expansion of the Nation's enrichment capacity. Legislation has been introduced in Congress that would allow transfer of the technology to the private sector. Alternative plans for expansion are being prepared by ERDA. The centrifuge technology is nearing the commercialization stage, and ERDA is negotiating with the private sector. The laser enrichment process is still in the laboratory phase, but an orderly process of development has been proposed. There is no mention of the implications for nuclear weapons proliferation.

QUESTION

1. What are the implications for nuclear weapons proliferation in the advanced enrichment technologies?

15. Fuel Recycle

ISSUE

Fission fuel recycling capability is needed for the orderly development of nuclear power.

SUMMARY

Spent nuclear fuel assemblies still contain much valuable fuel material. The discharged fuel can be reprocessed to recover the usable fuel material, which can then be recycled through a reactor. There are four basic reasons for recycling the fuel: (a) the recycled fuel reduces the demand for new uranium that would have to be mined and refined; (b) recycling, desirable for LWR'S, is an economic necessity for HTGR's, LMFBR's, and other advanced reactor designs; (c) lower power-generating costs should result; (d) the chemical processing which is part of recycling is also an integral part of some of the more promising waste disposal schemes.

Recycling is, however, beset by several problems. First, a reprocessing, a refabrication, and a radioactive waste disposal industry must be constructed and operated. Second, safeguards and transportation must be developed to protect the material adequately. Third, the economic advantage of recycling in LWR's is small at best although the spent fuel still contains material that can produce a large amount of energy.

The central point is whether ERDA's budget is adequate to develop the necessary recycling capability or whether adequate incentives can be provided to industry to provide this capacity.

BUDGET SUMMARY

SUMMARY TABLE
(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 OMB Request
Support of Nuclear Fuel Cycle	35.5	160.5	160.5	56.7
Commercial LWR Reprocessing R&D (Budget Outlay)	7.5	(Not Available)		23.5
LMFBR Reprocessing R&D (Budget Outlay)	4.0	(Not Available)		6.8
HTGR Reprocessing R&D	14.6	(Not Available)		15,5
Supporting Services	5.0	(Not Available)		6.0

COMPARATIVE SUMMARY

The large budget increase proposed for LWR reprocessing R, D&D indicates that ERDA is actively pursuing its goal of closing the LWR fuel cycle. The ERDA program states that investigations of certain aspects of the technology, advanced design concepts, operability and maintainability of facilities, and environmental effects will be undertaken so as to minimize the time required for commercial deployment of reprocessing complexes. It is also indicated that if barriers to commercial deployment arise, ERDA will formulate programs to deal with the impediments. In summary it appears that ERDA is responding to the technological deficiencies in LWR reprocessing capabilities while continuing R, D&D on advanced cycle reprocessing in an orderly fashion.

Public acceptance of reprocessing, however, particularly plutonium recycle, may require the resolution of social problems such as the effect on those exposed to an accidental release of plutonium or the impact of an adequate safeguards system. The resources devoted to HTGR reprocessing are harder to justify. ERDA does not anticipate commercial plants starting out until 1990 if at all. Hence, this part of the program seems excessive compared to the HTGR development program.

QUESTIONS

1. How does the retrievable storage of spent fuel elements in geological formations compare with closing the fuel cycle?
2. What must be the price of uranium and plutonium to justify reprocessing including the cost of all expected health, safety, and environmental controls (e.g., krypton-85 capture) required for eventual licensing?
3. What studies are planned on questions of social acceptability in relation to fuel recycle?

16. Public Understanding

ISSUE

Public understanding of the energy problem, and especially of the nuclear option, receives minor emphasis in the ERDA Program.

SUMMARY

The energy problem is complex, and increased efforts must be directed toward better public information programs. Within the past several years, public anxiety, confusion, and doubts have increased, and the energy problem is widely perceived as a "contrived situation, " More effort must be directed toward better understanding of energy options so that well-informed energy decisions can be made by the public. One of ERDA's tasks is to create and encourage ", . , the development of general information to the public on all energy conservation technologies and energy sources. . ." In addition, the ERDA Administrator, in conjunction with the FEA Administrator, is directed to disseminate such information through the use of mass communications, (Section 103.7 of Public Law 93-577.]

BUDGET SUMMARY

Budget provision for Public Understanding is made in the Public Awareness portion of the Program Support Section. The requests are given below.

SUMMARY TABLE
(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 OMB Request
Program Support Public Awareness	2.6	7.1	6.0	3$0

COMPARATIVE SUMMARY

The ERDA budget request for FY 77 indicates that increased efforts were planned to communicate with larger segments of the population through organizations representing cross sections of the public. The increased effort planned in communicating through educational institutions could have provided information to many more people than have been reached by the more specialized past activities. The proposed ERDA activities appear to be responsive to the need for widespread energy information dissemination. The substantial reduction by OMB (50 percent) will negate ERDA's planned FY 77 improvement.

QUESTION

1. How will the effectiveness of the public awareness programs be judged?

17. Controlled Fusion

ISSUE

Great care must be exercised to ensure that the ERDA-controlled fusion program does not expand at a rate so fast that proper attention is not given to the different physics problems of controlled fusion and that development of new concepts is not prematurely abandoned.

SUMMARY

The advantages of successful fusion power are great; fusion research needs should receive high priority, but success is not yet assured by any future date. For example, it appears necessary to scale present experiments up to larger machines in order to maintain an effective program. While these next generation devices are being conservatively designed, they are still experimental. In addition, even though the science may scale to larger sizes, technological, engineering and economic considerations may or may not permit exploitation of a given concept for practical fusion power,

This uncertainty has two practical consequences. First, since no clear or complete path to fusion power now exists for any fusion concept, and since fusion is one of the few major long-term energy options, no fusion scheme should presently be abandoned unless it can be shown fairly convincingly to be unproductive. Second, in order to establish proper priorities in the face of this uncertainty, a more or less continual assessment of fusion concepts and prospects must be maintained; otherwise the program may evolve into either uncritical support of unfeasible concepts or unwarranted and premature concentration on a single concept.

BUDGET SUMMARY

The budget requests for the controlled fusion program are summarized as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Confinement Systems	68.2	95.5	85.4	80.3
Development & Technology		(see Issue 18)		
Research	26.2	49,6	43.5	30.7
Reactor Projects	2.2	9.3	9.3	10.8
Total (Magnetic Fusion)	131,6	242.7	218.4	168.0

The budget request to the Congress is 25 percent greater than FY 76. The request appears to commit ERDA even more closely to the tokamak concept and may not allow adequate funding of other devices such as the mirror machine and theta pinch. Indeed, the budget may put pressure on the entire program (including the tokamak) and stretch out the timetable for ERDA to achieve a successful fusion reactor.

COMPARATIVE SUMMARY

The ERDA program document contains a fusion program description which acknowledges the points raised in the issue. The emphasis that will be placed on efforts to implement ERDA's concern on these matters is not clear, however. The financial requirements associated with the start of the large tokamak fusion test reactor project, combined with an increase in the operating budget 31 percent less than the division requested, are already putting pressure on other possibly viable concepts and supporting research. The statement made in the program document to the effect that eventual, practical fusion power can be confidently predicted because of sufficient understanding of the basic physics of magnetic fusion may not be valid, Practical fusion power also depends on technology and engineering advances which are much less well understood.

In this context, there are crucial questions that concern the direction and pace of the fusion program. The principal one is the urgency that the fusion effort is to be given among the various approaches to solving the energy problem. With a given funding level there are a certain set of priorities in the program which evolve over time depending on successes. If the level is increased more attention can be given to difficult engineering problems, which are presently given a lower priority. This could reduce the time needed to successfully implement controlled fusion as a power source. The level at which fusion is funded will depend on the priority it is given among all supply options. It is important to carefully assess the potential of fusion, in terms of economics, environmental impact, material consumption, and the degree to which the program can be accelerated, so that the most effective funding level can be established.

QUESTIONS

1. Are there budget constraints which limit efforts to assess new and on-going fusion efforts to minimize the possibility of pursuing unproductive fusion concepts (i. e., unlikely to develop into a commercial reactor)?

2. Are the mirror and/or theta pinch confinement systems likely to be pursued at a rate slower than desirable as a result of the need to support the TFTR project coupled with the reduction of the division's budget requests before being sent to Congress?

3. Are there programs underway to determine the maximum rate at which fusion can be implemented as a function of various funding levels?

18. Technologies for Fusion

ISSUE

New technologies, which will be critical to fusion's successful development through the 1980's, requires a long time to develop and will require rapidly increasing effort with time.

SUMMARY

Many critical technological problems relate to more than one fusion concept. Some typical critical areas where much work needs to be done are:

(a) Materials and material combinations resistant to high energy neutron bombardment from the fusion reaction.

(b) Economical storage of large amounts of electrical energy to operate pulsed fusion devices.

(c) Very large superconducting magnetic systems needed for all but laser fusion schemes.

(d) Diffusion of tritium fuel into and out of reactor materials.

BUDGET SUMMARY

The budget requests relevant to this issue are principally as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Development & Technology	31.7	88.3	80.2	46.2

That this portion of the fusion program has grown at a greater rate than the rest of the fusion subprograms reflects the growing importance attached to this aspect of the fusion effort. It should be noted, however, that this subprogram received the largest percentage cut in the Division and ERDA requests of any of the subprograms within the fusion program.

COMPARATIVE SUMMARY

ERDA has responded favorably to this issue through the substantial increase in the budget request. Most of the points raised in the issue have been addressed in the ERDA Program document. There remain specific areas of concern:

1. There appears to be insufficient emphasis on the development of plasma engineering (plasma shaping, pumping, refueling, etc.).
2. The problem of diffusion and recovery of tritium from massive fusion reactor systems may not be receiving adequate attention. It is essential that this problem be resolved early in any reactor development program.
3. There seem to be inadequate systems studies and technology assessment, leading both to (a) early recognition of any promising new fusion confinement geometries, and (b) timely recognition of which fusion concepts have higher or lower probability of being extrapolated to eventual fusion reactors.

The fact that efforts in these areas appear to be lacking seems to be primarily due to budget limitations. It is precisely these kinds of problems that would receive more attention with higher budget levels for the fusion program as indicated in the Issue 17 comparative analysis. There is no doubt that these problems need to be solved before successful implementation of controlled fusion. They have been given a lower priority than problems of confinement and heating and therefore are receiving less emphasis at present, The principal issue that needs to be resolved is whether the potential contribution of fusion can be realized at a significantly earlier date than now envisaged, if the fusion program were to be given a greater sense of urgency, The resolution of this issue will determine the pace at which these important technology programs should be pursued.

QUESTIONS

1. How does ERDA set priorities among the various technology items given the size of the budget requests?

2. What would limit the rate at which these technological problems could be solved if budget requests were not a constraining factor (assuming that it presently is)?