

II (3)

PDR

advance copies J. R. Kelly

PR 50

44 FR 61372

HEARING BOARD REPORT
on the
DEPARTMENT OF ENERGY
DRAFT ENVIRONMENTAL IMPACT STATEMENT
entitled
"MANAGEMENT OF COMMERCIALY GENERATED RADIOACTIVE WASTE"
(DOE/EIS-0046-D)

February 1980

0/1
V102

9812090189 800220
PDR PR
50 44FR61372 PDR

000018

HEARING BOARD REPORT
ON THE DEPARTMENT OF ENERGY
DRAFT ENVIRONMENTAL IMPACT STATEMENT

entitled

"MANAGEMENT OF COMMERCIALY GENERATED RADIOACTIVE WASTE"
(DOE/EIS-0046-D)

CONTENTS

	Page
I. BACKGROUND: THE HEARING BOARD AND PROCEDURES	1
II. RECOMMENDATIONS	5
A. PURPOSE OF THE STATEMENT	5
B. SCOPE	6
1. Relationship of the Statement to Other Nuclear Activities	6
2. Treatment of Alternatives	7
3. Sequence of Comparative Environmental Analyses by Stages, Beginning with Spent Fuel	9
4. Testing and Experimental Programs	9
5. Humanistic Concerns and Consequences	10
6. Other Nuclear Power Projections	12
C. STATEMENT PRESENTATION	12
1. Length	12
2. Summary	13
3. Conclusions and Recommendations	13
4. Editorial and Terminological	14
D. SPECIFIC SUBJECTS	15
1. Risk-Benefit Analysis	15
2. Reprocessing	17
3. Schedules and Timing	17
4. Costs	18
5. Types and Characteristics of Host Rock	19
E. PUBLIC NOTIFICATION PROCEDURES	21
F. MISCELLANEOUS ITEMS REQUIRING REVIEW	23
III. CONCLUSIONS	25
IV. BACKGROUND REFERENCES: REPORTS PROVIDED TO THE BOARD BY THE U.S. DEPARTMENT OF ENERGY	26

HEARING BOARD REPORT
on the
DEPARTMENT OF ENERGY
DRAFT ENVIRONMENTAL IMPACT STATEMENT
entitled

"MANAGEMENT OF COMMERCIALY GENERATED RADIOACTIVE WASTE"
(DOE/EIS-0046-D)

I. BACKGROUND: THE HEARING BOARD AND PROCEDURES

The Board's main responsibilities were to conduct a series of public hearings to give interested persons, organizations, and governmental agencies an opportunity to comment on the Department of Energy Draft Environmental Impact Statement of April 1979, "Management of Commercially Generated Radioactive Waste", (called the "Statement" in this Report), and to prepare a report to the Department identifying the significant issues that should be addressed in preparing a final statement.

The Department of Energy selected the members of the Hearing Board with the intention of obtaining the public's views through an outside, impartial, diverse group with substantive knowledge and experience about energy and the environment. Professor George T. Frampton, Sr., Professor of Law and formerly a Vice-Chancellor of the University of Illinois, chaired the Board. Other members were Dr. Hubert L. Barnes, Professor of Geochemistry and Director of the Ore Deposits Research Institute of the Pennsylvania State University; Dr. Melvin W. Carter, Professor of Nuclear Engineering and Director of the Center for Radiological Protection at the Georgia Institute of Technology; Dr. Dorothy K. Newman, socio-economist and author of studies about the

energy consumer and other citizen concerns for the U. S. Department of Labor, for the National Urban League as former research director, and for Carnegie Corporation of New York as Director of the Project on Race and Social Policy; and Dr. Clifford V. Smith, Professor of Environmental Engineering and Vice President, Oregon State University, and former Director of the Office of Nuclear Materials, Safety, and Safeguards of the Nuclear Regulatory Commission.

The Board conducted hearings in five major cities: Washington, D. C. (June 26-27, 1979); Chicago, Illinois (August 8-9, 1979); Atlanta, Georgia (September 25-26, 1979); Dallas, Texas (October 2-3, 1979); and San Francisco, California (October 8-9, 1979). Notice of public availability of the Statement appeared in the "Federal Register" of April 20, 1979. Later notices in the "Federal Register" (June 1, July 3, and July 18, 1979) provided hearing dates and places, invited written comments, and gave other information about public participation. These issues of the "Federal Register" are cited in the Background References at the end of this report.

The regional offices of the Department of Energy advertised the subject of the hearing and its time and location in news media of each region before the first day of each hearing. The Department also made extensive mailings to various public interest groups and organizations in an effort to elicit their views.

A total of 142 witnesses testified before the Board. In addition, the Board reviewed more than 200 written comments, some of them extensive. These were submitted instead or in extension of oral testimony. Most of the presentations were by individuals expressing their personal views. Many respondents had technical, scientific or medical expertise. Many represented concerned citizens' groups, state or local governments, nuclear research and service organizations, power companies, and trade associations. Several Federal agencies submitted extensive written reviews. Transcripts of the hearings are available for public inspection at certain local and regional offices of the Department of Energy and at its Headquarters in Washington, D. C.

The Board members attended a briefing in June 1979 by the Department of Energy Division of Waste Isolation and by Pacific Northwest Laboratories of the Battelle Memorial Institute, which prepared the draft statement for the Department of Energy. In further preparation, Board members read the Statement (Volume 1) "Management of Commercially Generated Radioactive Waste" (about 700 pages) and its supporting "Appendices" (Volume 2), about 650 pages. Further backup volumes to the draft statement were submitted later for the Board's review. These include five volumes on "Technology for Commercial Radioactive Waste Management" (DOE/ET-0028) and three volumes on "Environmental Aspects of Commercial Radioactive Waste Management" (DOE/ET-0029). The ten volumes total more than 5,000 pages.

Associated documents that came to the Board's attention were "Nontechnical Issues in Waste Management: Ethical, Institutional, and Political Concerns" (PNL-2400) and "Safety Indices and Their Application to Nuclear Waste Management Safety Assessment" (PNL-2727). The Board also reviewed other documents relevant to the draft environmental impact statement, including the "Report to the President by the Interagency Review Group on Nuclear Waste Management" (March 1979, TID-29442). Dr. Smith, a member of this Hearing Board, served on the Interagency Review Group.

Other reports submitted to the Board members for their information were the report by the Comptroller General of the United States on "The Nation's Nuclear Waste--Proposals for Organization and Siting" (June 21, 1979, EMD-79-77), the two-volume "Draft Environmental Impact Statement, Waste Isolation Pilot Plant" (April 1979, DOE/EIS-0026-D), and the Waste Isolation Pilot Plant Hearing Board report of November 6, 1979, on its series of public hearings. Other environmental impact statements came to the Board's attention because they illuminated parts of the waste management problem. These are about power reactor spent fuel, including the storage of foreign power reactor spent fuel, and the program plan for defense waste management. These and other documents (cited in the Background References at the end of this report) are within the scope of the Department of Energy's total "Nuclear Waste Management Program" (April 1979, DOE/ET-0094). Particularly important for assessing the place of the environmental impact statement about the management of commercially generated nuclear waste is the "Commercial Waste Management Multi-Year Program Plan" (August 1979).

II. RECOMMENDATIONS

The Board observes that the Department and its contractors have prepared a statement of substantial depth and breadth, made efforts at its wide distribution, and solicited public participation in deliberations about the Statement. However, on the basis of the public testimony and briefings, and supplementary documents, the Board identifies the following issues for development or modification in the final generic environmental impact statement.

A. PURPOSE OF THE STATEMENT

The Board recommends that the Department of Energy define the purpose of the Statement more clearly at the outset to avoid the obvious confusion reflected in the oral testimony and written comments.

The purpose of the "Draft Environmental Impact Statement" is unclear at the outset and requires clarification. The Foreword states: "This Generic Environmental Impact Statement (GEIS) is intended to provide environmental input" for the "decision" "of selecting an appropriate programmatic strategy leading to the permanent isolation of commercial radioactive wastes in a fashion that provides reasonable assurance of safe, permanent isolation of the material." The term "generic" (and its effect on the entire document) is not defined or explained, but it becomes part of the acronym, "GEIS", adopted by the Department of Energy.

Further, this sole statement of purpose confused some people by covering, but failing to distinguish between, two important purposes of an environmental impact statement. One purpose is to demonstrate that the environmental consequences of a proposed federal action have been considered by identifying and describing them and comparing them with the consequences of alternative courses of action. The other purpose is to subject that demonstration to public review and comment, thus affording broad participation in a decision before action is taken. While the statement of purpose of the document does not, on its face, cover the second purpose, use of the word "input", and the process of distributing the documents and holding hearings, are evidence of the Department of Energy's intention to encompass both purposes.

B. SCOPE

1. RELATIONSHIP OF THE STATEMENT TO OTHER NUCLEAR ACTIVITIES.

The Statement should reveal early how its limited scope relates to other waste management operations and to the processes of nuclear technology here and abroad.

The title of the Statement does not limit the discussion to the sole problem of finding a strategy for permanent and safe isolation of commercially generated radioactive wastes. The broad term "management" was included in the title "Management of Commercially Generated Radioactive Waste", and the term "high-level" was excluded. Many witnesses and readers, therefore, expected to find information about the total system, all wastes, and explicitly, various techniques for disposal and their environmental impacts.

Not even those in the scientific community and in federal or state agencies, and few among the general public, knew about the Department of Energy's comprehensive waste management plan and schedule, the numerous radioactive waste management environmental impact statements already written or in progress, and the extent of experimental work under way. It is no wonder that countless hours at the hearings were spent on issues that were not pertinent to the isolation of commercially generated high-level waste. If the Statement at the outset had informed readers in a general way, as introduction, about the total management system, considerable confusion would have been avoided. For example, readers need an early explanation of the difference between low-level and high-level wastes and how and where they are handled and stored, the programs for handling defense wastes and their relationship to commercial waste management, experimental work under way in all spheres, issues surrounding waste arriving from abroad, what happens to nuclear waste generated by medical and research activities, what happens to non-nuclear waste from commercial nuclear facilities, and what happens upon the decommissioning of a nuclear facility. After such an exposition the focus of the Statement about commercially generated high-level radioactive waste would be in context, as would the concern--frequently expressed--that testing or experimental work on nuclear waste was insufficient or lacking.

2. TREATMENT OF ALTERNATIVES

Only the most viable alternative strategies should be assessed in detail. Less viable alternatives should be ranked for feasibility, and the fullness of their treatment should be commensurate with that ranking.

The Statement identifies ten alternative strategies for waste isolation. Two---chemical resynthesis and transmutation---are not techniques for waste isolation, but are methods of waste treatment. They are not, therefore, alternative courses of action. Furthermore, even if transmutation were a method of waste treatment, it is not technologically or economically feasible in the foreseeable future (twenty years) and thus could have been treated less comprehensively on that basis alone.

Of the remaining eight options, only those with some reasonable prospect of relatively short-term economic and technical feasibility should require fully detailed analysis. Less detailed treatment of other disposal options, while not ignoring any positive findings of current research, should indicate the critical factors that reduce feasibility in this century. None of the alternatives is entirely without merit, especially in changed economic or political circumstances. At present, however, near-term feasibility is a vital consideration but is in doubt for certain options. Examples are: for space disposal, risk and costs; for ice sheet disposal, international jurisdictional and treaty obstacles; for seabed disposal, current legal restrictions, (e.g. the Marine Sanctuary Act of 1972), and transportation risk; for island disposal, geologic instability and transportation risk; for deep hole disposal, costs; for rock melting, potential release of volatiles; and for well injection, seismic risk. Furthermore, nonretrievability is an additional concern to all the above except island disposal.

3. SEQUENCE OF COMPARATIVE ENVIRONMENTAL ANALYSES BY STAGES,
BEGINNING WITH SPENT FUEL

The entire chain of environmental consequences of managing commercially generated high-level wastes should be treated consistently and compared for each viable alternative course of action, beginning with spent fuel at the reactor.

The Statement does not provide information at each appropriate stage of the entire spent fuel cycle about environmental consequences, beginning with on-site storage and going through chemical treatment, encapsulation, handling, transportation, site selection, testing, emplacement, and storage.

4. TESTING AND EXPERIMENTAL PROGRAMS

Since the feasibility of proposed options must be verified by appropriate experiments, the Statement should disclose more fully and explain the nature and extent of the testing and experimentation now under way and planned.

Experimental work already under way in this country and abroad, including the extent of U.S.-international cooperation, should be more adequately treated in the final Statement. In addition to the work in Sweden mentioned in the Statement, experiments are also under way in India, West Germany, France, Great Britain, Canada, Japan, and the Soviet Union, among others.

A common misconception is that holes drilled into a potential repository would destroy its integrity permanently. Therefore, discussion is necessary of how such holes are effectively sealed by cementing or grouting and how permeability tests by injecting water at high pressure are used to assess the final repository conditions.

Abandoned mines, which provide a wide variety of rock types as possible repository hosts, with presumably limited environmental consequences, have been suggested by the U. S. Bureau of Mines for testing, and are used for that purpose in Sweden and West Germany. Information about the present use or consideration of such mines should be provided.

5. HUMANISTIC CONCERNS AND CONSEQUENCES

Ecological, social, psycho-social, political, and economic consequences should be given more prominence and receive more professional attention.

The significance of social concerns and their political influence is apparent in the testimony of witnesses ranging from the pro-nuclear to the anti-nuclear. Witnesses emphasized, and the Board concurs, that the degree to which human concerns are taken into account could result in the success or failure of any waste management plan.

The Statement, however, deals inadequately with the humanistic effects of each stage in the process of each alternative management system, especially with those stages before waste reaches a final site. The Statement deals with social and economic consequences of constructing and operating a storage facility more fully, but even in this instance the treatment is sketchy. For instance, insufficient attention is given to the interaction with waste management operations of alternative employment and unemployment projections nationally and regionally, of migration streams, and of easily demonstrable demographic changes, to mention a few conditions considered too summarily or not at all. Neglected for each option are occupational opportunities, training requirements, and hazards involved in handling, shipping, encapsulating, and inserting and re-covering wastes.

Even in addressing issues surrounding only site selection and operation, detail is lacking on how participation by State and local governments and the public takes place in the experimental or final site selection. The Statement is sketchy on environmental surveillance, monitoring, and managing each kind of site. The problems to be encountered in clean-up in the event of decommissioning or serious accident, as well as possible evacuation, require more detailed analysis taking into account comparative environmental effects before and after the event, for each option, with emphasis on behavioral and biological science approaches.

In summary, humanistic considerations and consequences require much more sophisticated development and more social imagination.

6. OTHER NUCLEAR POWER PROJECTIONS

The Statement should take account of the environmental effects of managing waste generated by other projections of nuclear power production.

Additional projections beyond those now considered and which require attention are (a) that all commercially generated nuclear power production would cease in 1980; and (b) that nuclear power production by present facilities or those currently licensed would be permitted only until their normal decommissioning dates.

C. STATEMENT PRESENTATION

1. LENGTH

The Statement is unnecessarily wordy and voluminous. It should be reorganized and cut drastically by judicious rewriting and editing, with the aim of reducing the basic volume to less than 300 pages.

Much of the Statement treats methods in inordinate detail, thus obscuring the findings and the central ideas that went into models. It relies

heavily on jargon, acronyms, convoluted sentences and bulky tables and figures, much of which could be dispensed with by distillation into simple English. Many parts of the Statement are redundant, confusing, and sometimes conflicting. Reorganization could follow in part the guidelines for environmental impact statements of the Council on Environmental Quality.

2. SUMMARY

After revising the Statement, a short, clear, concise, accurate and readable summary should be prepared that is comprehensive and reflects the findings of the Statement as a whole. An even shorter summary should also be prepared aimed at fuller comprehension by the general public.

Many who testified or wrote comments had read only the Statement Summary from Volume 1. It appeared to the Board that few read Volume 1 and fewer Volume 2. Almost none had seen the other eight volumes. It is important that a short summary carry the essential message clearly.

3. CONCLUSIONS AND RECOMMENDATIONS

Conclusions or recommendations should be recognizable as such, without equivocation or hedging.

The conclusions and recommendations should be presented in a positive and straightforward manner, thus assisting the reader in determining what is important, what is known, the degree of that knowledge, and the major thrusts of the Statement.

4. EDITORIAL AND TERMINOLOGICAL

The Board recommends:

- Minimizing the use of acronyms and defining them when first used and in the glossary.
- A simple page-numbering system without competing section numbers.
- A clear, well-organized table of contents.
- A comprehensive index.
- A complete glossary with readable definitions.
- Identifying the key persons involved in preparing the Statement.
- Distinguishing clearly between "containment" and "isolation."
- Not using the title "Conventional Geologic Disposal" to denote a disposal not yet "conventional". More accurate would be "Disposal in Mined Repositories".
- Using "Well Injection" instead of "Reverse Well Disposal"
- Not calling spent fuel "waste", since spent fuel has intrinsic energy value.
- Changing the phrase "Geologic Emplacement Following Chemical Synthesis" to "Waste Solidification".
- Distinguishing between individual radiation dose equivalents and accumulative dose to populations. An amount of man-rem per individual, for example, is a contradiction in terms.

D. SPECIFIC SUBJECTS

1. RISK-BENEFIT ANALYSIS

The Statement should acknowledge and define the special problems of undertaking risk-benefit analysis in this unusual area, pursue the analysis in an orderly fashion, and recognize and include nontechnical values, by integrating political and social concerns with technical consideration.

Frequent criticisms and misperceptions communicated to the Board involved the analysis of risk. Many thought risks unduly minimized; many thought the opposite. Such a range of views results from fragmentation of the analysis of risk in the Statement, an overly simplistic technical approach, and lack of sufficient accommodation to nontechnical considerations.

Traditional assessment of environmental consequences attempts to analyze hazards and risks quantitatively in relation to benefits. The limitations and difficulties of such quantification in this area, however, require special caution and consideration which do not appear to have been brought to bear in preparing the Statement. A wider range of risks should be assessed, including some ordinary, realistic situations as well as some least expected. Some worst case accidents used for analysis (the meteorite, for example) are too extreme.

Several views of comparative risk need airing and reconciliation. One view suggests that risks from commercially generated radioactive waste and its management activities are additive (cumulative) so that comparison with other risks masks a true danger. This view requires consideration.

At the other extreme, but necessary, is more complete comparison of radiation exposure from high-level radioactive waste with risk from other conditions or materials. It should include more information about the waste exposure with that from the original ore, natural background at varying elevations, and with other minerals or poisons (as with pesticides, nitrates from fertilizers, sulphur dioxide from flue gases, and the like). At this level of analysis, comparative dosage rates and a definitive basis for evaluation are critical.

In another dimension is the desirability of comparing the risks from the radioactive waste management system with the risks from other waste-generating systems, such as coal, metal mining, or logging, for examples.

Assessment of total risk for each alternative waste-isolation option is necessary and is lacking. More imaginative concepts or analogies are required when specific data are not available. In the case of marine transport for island disposal, automobile shipment could be used as an analogy for marine transport of cask-sized units. Comparison would then be possible with continental disposal, for which transport is over land near sizeable populations, whether by rail or by truck.

2. REPROCESSING

The final Statement should summarize in one place the comparative waste management implications both of continuing and of discontinuing the present moratorium on reprocessing.

The consequences of the present moratorium against reprocessing of spent fuel elements are not explicitly summarized. A change in this reprocessing policy, viewed by many as inevitable, would make portions of the Statement obsolete. The costs and benefits, risks, and time associated with planned retrievability should be included in the Statement.

The high-level wastes associated with possible breeder reactors should also be described in comparison with those from other sources.

3. SCHEDULES AND TIMING

The Statement should make consistent and clear the estimated time during or at which certain events will occur.

How long will spent fuel be stored before disposal? How long does it take for radioactive waste to become a "nominal" risk? There should be a consistent use of half-lives or time intervals (not a variation among 500, 600, 1,000 and 10,000 years, for example) when evaluating hazards from radioactivity.

The Statement does not clarify the time frame in which a failure or inability to implement a "permanent" solution to the waste isolation problem will begin to alter the environmental consequences of the present "temporary" isolation by on-site storage. The uncertainty on this matter left witnesses free to speculate that a long-continued resort to on-site storage would have effects ranging from none in the next few years to a foreseeable exhaustion of on-site facilities and a consequent shutdown of nuclear power production.

4. COSTS

The cost analysis in the Statement should be more comprehensive, and should relate to the whole system of each alternative so as to provide a basis for cost comparisons.

Costs should be more fully analyzed to take into account the entire system for every viable isolation alternative. They should include administration, research and development, interim storage, encasement and the cost of encasement materials, vehicles, transport, training, labor, negotiations leading to site selection, risks and risk insurance, land, construction, final emplacement, institutional surveillance, and emergency preparedness.

Since current costs in developing and producing a feasible waste isolation program could be perceived as a nuclear power subsidy, comparative analysis with other regulated systems and large-scale enterprises could be made as, for example, railroads, airlines, and automobiles.

Costs are affected by the availability of materials here and abroad. In the array of materials proposed as canisters, for example, there may be problems of cost and access to necessary quantities of such metals as titanium, zirconium, gold, platinum, nickel and others.

5. TYPES AND CHARACTERISTICS OF HOST ROCK

The final statement should be modified to reflect that an objective evaluation has been made for all potential host rocks.

More present information about one alternative over another does not necessarily translate into a clear-cut technological advantage nor support a preference for, or emphasis on, any one rock type. The present Statement, moreover, reflects an emphasis on salt which may not be supported even by all the facts currently available.

Types

The advantages and disadvantages of all host rocks as repositories, including salt, should be compiled and compared objectively.

Factors that might be considered in evaluating salt include: thermal conductance, fluid migration toward warm canisters, high acidity when hot, high plasticity, low sorptive capacity, susceptibility to radiation damage, permeability evidenced by breccia pipes, and environmental problems associated with surface storage or disposal of salt.

A fifth rock type, tuff, should be added to the other four--granite, basalt, shale and salt--as a possible candidate host rock for repositories. If anhydrite is included, its large volume change on hydration should be considered.

Mobility

The mobility of wastes in various rock types deserves greater emphasis in the Statement. Should a canister be breached, the viability of the host rock as a backup barrier directly depends on this mobility. Solubility under reducing conditions is likely to be dominant in limiting the long-term migration of components from a breached canister.

Sorption

Since the sorption characteristics and reactivity of host rocks to radioactive solutes are among the most important properties of the

multiple barrier concept, they should be more clearly developed. In this connection, shales could be superior to other proposed rock types provided that there is not large-scale lateral migration of ground water through the shale.

Permeability

Large-scale permeability is of concern for all rock types. Thus, Table 3.1.1 should be revised to show only bulk properties. Shale across bedding is much less permeable than typical broken basalt flows or ash beds.

E. PUBLIC NOTIFICATION PROCEDURES

When the U. S. Department of Energy holds further hearings, it should consider major modifications in the public notification procedures used for these hearings.

Although the Board recognizes that substantial effort was made to circulate the Statement and obtain public comment on it, the Board nevertheless recommends critical review of the Department's entire notification and mailing procedures. Its mailing lists should reach a more diversified group. Advertising, if used at all, should be more effectively designed and placed. Copies of impact statements should be available farther in advance of hearing dates.

While the hearings on the Statement were under way, the Board was surprised to learn from witnesses that hearings were taking place at a nearby location on the environmental impact statement on the Waste Isolation Pilot Plant (WIPP), a proposed facility which would be used to test some of the uncertainties related to this Statement. Both the timing and the locations of those hearings competed for the attention of interested persons.

There seems also to be lack of consistency and consideration in time given for thoughtful public reaction to the Statement as compared with its preparation. For example, evolution of the Statement has taken several years during which a number of related waste management program documents have been prepared, received, and in one case, withdrawn. In contrast to the time taken in those processes, the limited period--days or weeks--given to interested persons to prepare comments in writing or orally on this massive technical document has imposed an unnecessary condition of undue haste on public participation.

These procedural deficiencies offset the earnestness with which many individuals in the Department of Energy sought wider public participation and designed a hearing process for doing so. The deficiencies also created the unfortunate impression at times that effective public participation is not regarded as a serious part of revising the Statement or of decision-making in the nuclear waste management program.

F. MISCELLANEOUS ITEMS REQUIRING REVIEW

1. Maps.

Maps of the United States showing the distribution of salt deposits and granites omit areas of their respective rock types and should either be deleted or more carefully compiled. Because several types of metamorphic rocks could behave toward waste in a similar manner to granites, perhaps they might also be identified on the map of granites. The map should clarify whether it refers only to granites or also to granodiorites and similar rocks, since granites are rarely homogeneous in composition. The map of basalts also omits many areas of basalt in the west and the Appalachians, for example.

2. Chemical Resynthesis.

The indication in the Statement that chemical resynthesis is for the purpose of achieving equilibrium with the host rock needs revision.. The foreign compounds of the waste cannot be in true equilibrium with the host rocks in the thermodynamic sense. Actually, the goal of resynthesis is to achieve minimum kinetic mobility of waste components in the host.

3. Retrievalability from Wells.

After well injection, widespread dispersal of the waste fluid down the hydrologic gradient occurs, so that no significant fraction of the fluid is likely to be recovered by pumping. Furthermore, the reaction of other components of the host rock to neutralize any acid flush would thwart efforts to leach radioactive solutes lost by reaction with the host rock.

4. Erosion Rates.

For most of the United States, erosion rates are only a few centimeters per thousand years, so that, contrary to the discussion of erosion rates in the Statement, erosion is no threat to mined or similarly deep repositories.

5. Geothermal Gradients.

The effect of geothermal gradients on the emplacement depth of waste canisters should be addressed because of the effects on heat loss from canisters and on rock plasticity.

6. Canister Rupturing.

Canister integrity can be affected by circumstances other than chemical corrosion or tectonic events. Some of such circumstances are puncturing and mechanical stress caused by differential compaction of the host rock on the canister overpacking.

7. Risk from Rock Falls.

The statement that "accidents that threaten human life are rarely caused by failure of the rock itself" does not square with the fact that rock falls, not rock bursts, are the typical causes of mining fatalities. These falls occur generally at joints or faults that have caused local weaknesses in the host rock.

III. CONCLUSIONS

Subject to the above recommendations, suggestions, and comments, the Hearing Board concludes that:

1. The Statement seriously and impressively analyzes the environmental impacts of proposed actions for solving the problem of disposing of commercially generated high-level radioactive waste.
2. The Statement has served effectively as a vehicle for public comment and for indicating and generating changes that should be made in the final statement.
3. The Statement supports the conclusion, in principle, that commercially generated high-level radioactive waste can be disposed of by one or more alternative strategies with minimal and acceptable environmental consequences, and that the present preferred disposal option is a deep, mined geologic repository.

The Board is concerned that the longer the delay in implementing an appropriate strategy to solve the problem of high-level radioactive waste disposal, the greater the erosion of political, scientific, and public support essential for such a strategy.

IV. BACKGROUND REFERENCES: REPORTS PROVIDED TO THE BOARD BY THE U.S.
DEPARTMENT OF ENERGY

Battelle, Nontechnical Issues in Waste Management: Ethical, Institutional, and Political Concerns. Seattle, WA, Battelle, May 1978. 106 pp.
PNL-2400. UC-70.

Ad Hoc Population Dose Assessment Group, Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station. (A preliminary assessment for the period March 28 through April 7, 1979). Washington, D.C., U.S. Government Printing Office, May 10, 1979.

Analytic Sciences Corporation, A Status Report on Risk Assessment for Nuclear Waste Disposal. Palo Alto, CA, Electric Power Research Institute, October 1979. EPRI NP-1197. Interim Report.

Council on Environmental Quality. National Environmental Policy Act: Implementation of Procedural Provisions; Final Regulations. Washington, D.C., Federal Register, Vol. 43, No. 230, Wednesday, November 29, 1978, Part VI.

Federal Register. Vol. 44, No. 11 Friday June 15, 1979. pp. 34466-68.
Nuclear Regulatory Commission 10 CFR Part 73 Physical Protection of Irradiated Reactor Fuel in Transit. Interim final rule.

Federal Register. Vol. 44, No. 78, Friday, April 20, 1979, pp. 23569-70;
Vol. 44, No. 107, Friday, June 1, 1979, pp. 31699-31700;
Vol. 44, No. 129, Tuesday, July 3, 1979, pp. 38994-95;
Vol. 44, No. 139, Wednesday, July 18, 1979, pp. 41953-54. (About "Management of Commercially Generated Nuclear Wastes", Draft Generic Environmental Impact Statement)

Federal Register, Vol. 44, No. 208, Thursday, October 25, 1979, pp. 61372-61375. Nuclear Regulatory Commission, 10 CFR Parts 50 and 51. Storage and Disposal of Nuclear Waste. Notice of Proposed Rulemaking.

Interagency Review Group. Report to the President by the Interagency Review Group on Nuclear Waste Management. Washington, D.C., U. S. Department of Energy, March 1979. TID-29442.

President's Commission on the Accident at Three Mile Island. The Accident at Three Mile Island: The Need for Change: The Legacy of TMI. Washington, D.C., The Commission, October 1979, 79 pp. and Supplemental Views by Members of President's Commission on the Accident at Three Mile Island. October 25, 1979. 17 pp.

Public Law 91-190. 91st Congress, S. 1075. January 1, 1970. National Environmental Policy Act of 1969.

Rockwell Hanford Operatins, Basalt Waste Isolation Program Plan.
Richland, WA, Rockwell Hanford Operations, May 15, 1979.
RHO-CD-132 REV 3.

Science Applications Inc., Status Report on the EPRI Fuel Cycle Accident Risk Assessment. Palo Alto, CA, Electric Power Research Institute, July 1979. EPRI NP-1128. Interim Report.

United States Atomic Energy Commission. Operational Accidents and Radiation Exposure Experience. 1943-1975. Washington, D.C. U. S. Atomic Energy Commission, Fall 1975. 150 pp. WASH 1152.

U. S. Department of Energy, Commercial Waste Management: Multi-Year Program Plan. FY 1980. Washington, D.C. U. S. Department of Energy, August 1979. 60 pp.

, Defense Waste Management: Multi-Year Program Plan.
FY 1980. Washington, D.C. U. S. Department of Energy, July 1979.
Draft. 58 pp.

, Draft Environmental Impact Statement. Charge for Spent Fuel Storage. Washington, D.C., U. S. Department of Energy, December 1978. DOE/EIS-0041-D.

, Draft Environmental Impact Statement. Management of Commercially Generated Radioactive Waste. Washington, D.C., U. S. Department of Energy, April 1979. Vol. 1 and Vols. Appendices, DOE/EIS-0040-D.

, Draft Environmental Impact Statement, Management of Commercially Generated Radioactive Waste. Summary. Washington, D.C. U. S. Department of Energy, April 1979. 36 pp. DOE/EIS-0046-D. Summary.

, Draft Environmental Impact Statement, Storage of Foreign Spent Power Reactor Fuel. Washington, D.C., U. S. Department of Energy. December 1978. DOE/EIS-0046-D.

, Draft Environmental Impact Statement Storage, of U. S. Spent Power Reactor Fuels. Washington, D.C., U. S. Department of Energy. August 1978. DOE/EIS-0015-D.

, Draft Environmental Impact Statement Supplement, Storage of U. S. Spent Power Reactor Fuel. Washington, D.C., U. S. Department of Energy, December 1978. DOE/EIS-0015-DS Supplement.

_____, Draft Environmental Impact Statement, Waste Isolation Pilot Plant. Washington, D.C. U. S. Department of Energy, April 1979. Volume 1 and Volume 2 (Appendices). DOE/EIS-0026-D.

_____, Environmental Aspects of Commercial Radioactive Waste Management. Washington, D.C., U. S. Department of Energy. May 1979. Volumes 1, 2, 3. DOE/ET-0029.

_____, Office of Nuclear Waste Isolation. National Waste Terminal Storage Program: Office of Nuclear Waste Isolation Technical Program Plan. Vol. 1, Technical Overview. Washington, D.C., U. S. Department of Energy, February 16, 1979. ONWI-19.

_____, Nevada Nuclear Waste Storage Investigations: FY 1979 Project Plan. Las Vegas, NV, U. S. Department of Energy, Nevada Operations Office, March 1979. NVO-196-9.

_____, Nuclear Waste Management. Washington, D.C., U. S. Department of Energy, Office of Communications, July 1979, 4 pp.

_____, Nuclear Waste Management Program: Summary Document. FY 1980. Washington, D.C., U. S. Department of Energy, April 1979. DOE/ET-0094.

_____, Nuclear Waste Management Public Policy. Washington, D.C., U. S. Department of Energy, October 1979. (Draft #6. By K. Schmitz).

_____, Public Hearing Record on the Public Hearing Held by DOE on "Management of Commercially Generated Radioactive Waste", DOE/EIS-0046-D, Held in Atlanta, Georgia, on September 25-26, 1979. Washington, D.C., U. S. Department of Energy, November 1979. Volumes 1, 2, 3.

_____, Public Hearing Record on the Public Hearing Held by DOE on "Management of Commercially Generated Radioactive Waste", DOE/EIS-0046-D Held in Chicago, Illinois, on August 8-9, 1979. Washington, D.C., U. S. Department of Energy, August 1979. Volumes 1 and 2.

_____, Public Hearing Record on the Public Hearing Held by DOE on "Management of Commercially Generated Radioactive Waste", DOE/EIS-0046-D Held in Dallas, Texas, on October 2-3, 1979. Washington, D.C., U. S. Department of Energy, November 1979. Volumes 1, 2, 3, 4.

_____, Public Hearing Record on the Public Hearing Held by DOE on "Management of Commercially Generated Radioactive Waste", DOE/EIS-0046-D, Held in San Francisco, October 8-9, 1979. Washington, D.C., U. S. Department of Energy, November 1979.

_____, Public Hearing Record on the Public Hearing Held by DOE on "Management of Commercially Generated Radioactive Waste", DOE/EIS-0046-D, Held in Washington, D.C., June 26-27, 1979. Washington, D.C., U. S. Department of Energy, July 1979.

_____, Hearing Board. Report of the Panel Identifying Significant Issues on the Draft Environmental Impact Statement on the Waste Isolation Pilot Plant DOE/EIS-0026-D. Washington, D.C., U. S. Department of Energy, November 6, 1979. 18 pp.

_____, Spent Fuel Storage Programs: Multi-Year Program Plan. FY 1980. Washington, D.C., U. S. Department of Energy, Draft, May 1979, 29 pp.

_____, Technology for Commercial Radioactive Waste Management. Washington, D.C., U. S. Department of Energy, May 1979. Volumes 1, 2, 3, 4, 5. DOE/ET-0028.

- U. S. Environmental Protection Agency. Proposed Environmental Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes. (Invitation to Comment. Limited Distribution.) Washington, D.C., U. S. Environmental Protection Agency, October 9, 1979. Working Draft No. 7, Documents 1779A-Disc 0059A and Document 1815A-Disc 0059C.
- U. S. General Accounting Office. Report by the Comptroller General of the United States. The National Nuclear Waste--Proposals for Organization and Siting. Washington, D.C., U. S. General Accounting Office, June 21, 1979, 19 pp.
- U. S. Department of Energy and U. S. Geological Survey. Earth Science Technical Plan for Mined Geologic Disposal of Radioactive Waste. Washington, D.C., U. S. Department of Energy and U. S. Geologic Survey, January 1979. Draft. 151 pp. TID-29018.
- Voss, J.W., Safety Indices and Their Application to Nuclear Waste Management Safety Assessment. Richland, WA, Battelle, April 1979. DNL-2727. VC-70.