~~DOE/AL/TRU-8001~~

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TRANSURANIC (TRU) WASTE MANAGEMENT PROGRAM

U.S. Department of Energy Acceptance of Commercial Transuranic Waste

February 1980

(REVISED)

Rockwell International

ENERGY SYSTEMS GROUP
ROCKY FLATS PLANT

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U. S. DEPARTMENT OF ENERGY

ACCEPTANCE OF COMMERCIAL TRANSURANIC WASTE

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TRU Waste Management Program

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ABSTRACT

Contaminated transuranic wastes generated as a result of non-defense activities have been disposed of by shallow land burial at a commercially operated (NECO) facility located on the Hanford federal reservation, which is licensed by the State of Washington and by the NRC. About 15,000 ft^3 of commercial TRU waste have been generated each year, but generation for the next three years could triple due to decontamination and decomissioning scheduled to start in 1980. Disposal at other commercial burial sites has been precluded due to sites closing or prohibitions on acceptance of transuranic wastes.

The State of Washington recently modified the NECO-Hanford operating license, effective February 29, 1980, to provide that radioactive wastes contaminated with transuranics in excess of 10 nCi/g will not be accepted for disposal. Consistent with the state policy, the NRC amended the NECO special nuclear material license so that Pu in excess of 10n Ci/g can not be accepted after February 29, 1980. As a result, NRC requested DOE to examine the feasibility of accepting these wastes at a DOE operated site. It is clear that NRC's concerns are packaging, and burial vs. retrievable storage of TRU.

TRU wastes accepted by the DOE would be placed in retrievable storage in accordance with DOE policy which requires retrievable storage of transuranic wastes pending final disposition in a geologic repository. DOE transuranic wastes are stored at six major DOE sites; INEL, Hanford, LASL, NTS, ORNL and SRP. A specific site for receiving commercial TRU waste has not yet been selected. Shipments to DOE-Hanford would cause the least disruption to past practices, since for the last 4 years only the NECO-Hanford licensed burial ground has accepted such wastes. Commercial TRU wastes would be subject to waste form and packaging criteria established by the DOE.

The waste generators would be expected to incur all applicable costs for DOE to take ownership of the waste, and provide storage, processing, and repository disposal. The 1980 charge to generators for DOE acceptance of commercial TRU waste is \$ 147 per cubic foot.

FOREWORD

At present, DOE has no responsibility for the management of commercial or institutional TRU wastes. The purpose of this study is to provide background information and recommendations to formulate contingency plans in the event DOE assumes greater responsibility for commercial TRU wastes generated after February 1980. The report does not address important institutional and other non-technical considerations which will influence the DOE policy decision regarding interim management of these wastes. The report does not commit DOE to any course of action. The waste acceptance criteria and charge schedule given in this study are preliminary and subject to change.

I. INTRODUCTION

1.1 Background

Although there have been previous commercial burial sites in operation (i.e., Sheffield, IL, Maxey Flats, KY, and West Valley, NY), commercial low-level waste is currently being received at only three state licensed burial sites.

SITE	AGREEMENT STATE
NECO - Hanford	Washington
NECO - Beatty	Nevada
Chem. Nuclear - Barnwell	South Carolina

Since the early 70's Nevada and South Carolina have prohibited the acceptance of waste containing greater than 10 nCi/gm of activity from TRU contamination. NECO-Hanford has been the only commercial site in the U. S. which would accept TRU contaminated waste above this limit. There is no generic restriction on shallow land burial of TRU waste, and it has been routinely buried at the NECO site in the Hanford Reservation.

In 1970, the AEC initiated a policy directing retrievable storage of TRU waste containing concentrations greater than 10 nCi/gm pending the availability of a facility for ultimate disposition. In September 1974, a Federal Register notice (Volume 39, No. 178,) stated: "..., the Commission (AEC) believes that in the future, storage and disposal of such (TRU) waste at Government-owned facilities should replace disposal in licensed commercial burial grounds." No final action was taken on this question at that time. There have been several attempts by burial site operators to obtain a governmental commitment to an upper charge in the event of having to process the waste and place it in a repository. The lack of an upper limit of liability precludes establishment of a commercially viable charge schedule and of commercial interim storage sites.

In November 1979, the State of Washington modified the NECO operating license to prohibit the acceptance of TRU waste at the NECO-Richland site. Provision 26 of the modified state license includes: "......the licensee shall not receive waste containing transuranic elements. However, waste containing less than 10 nanocuries total transuranic nuclides per gram of waste is acceptable provided transuranic nuclides are evenly distributed within a homogeneous waste form. This license condition does not authorize receipt or burial of components or equipment contaminated with transuranic nuclides."

In December 20, 1979, (Federal Register, Vol.44, No. 246) the Nuclear Regulatory Commission (NRC) requested DOE "to finalize and implement its plans for routine acceptance of commercial TRU waste for retrievable storage. The generation rate of TRU being cosidered for possible DOE disposal is estimated to be 57,000 cubic feet per year for the next three years, compared with a current generation rate of TRU waste by DOE of 140,000 cubic feet per year. After the next three years the non-DOE generation rate drops to 2,700 cubic feet per year. Total remaining capacity for TRU storage at DOE storage sites exceeds twenty million cubic feet.

1.2 Scope of the Study

The purpose of the study is to recommend a course of action in the event DOE decides to implement storage and eventual disposal of commercial transuranic waste. The study includes (1) sources of TRU waste and identification of DOE sites with TRU waste in retrievable storage, (2) legal considerations involved in DOE acceptance of the waste, and (3) financial considerations and possible charge schedules.

This study was prepared by the Transuranic Waste Management Program which has been decentralized by the Office of Nuclear Waste Management to the Albuquerque Operations Office, and with Rockwell International as lead contractor.

II. DATA

2.1 Sources of TRU Waste

The generation of non-DOE TRU waste is currently undergoing a change in both the quantities and nature of the wastes, as compared to the last few years. Non-DOE TRU wastes have been principally generated from fabrication of MOX fuels and R&D associated with such fuel fabrication, and from examination of irradiated fuels. The current policy of deferment of fuel reprocessing has brought most of this work to a halt in the commercial sector, and firms with fuel fabrication facilities are now decommissioning them or plan to do so in the near future. These decommissioning activities will generate large quantities of TRU waste in the next three years. After the decommissioning is complete, the non-DOE TRU waste generation rate is expected to fall to very low levels.

Table I summarizes the source of plutonium (other than Pu-238) contaminated waste that have been shipped to NECO-Hanford. The source of information in this section has been from contacts with the NRC, the Nuclear Material Information System (NMIS), and direct contacts with the generators. The NMIS tracks the movement and ownership of Pu. Significant quantities of contaminated waste shipped to NECO were generated by DOE or DOE contractors (75% in 1976, 31% in 1977, 25% in 1978, and 69% in 1979 up to 5/24/79). Small quantities of waste are generated through contract with other federal agencies that do not have disposal facilities. In addition, small quantities of TRU waste are produced from the commercial manufacture of radioactive power sources (estimated at less than 200 ft^3/yr). An example of these is the Nuclear Battery Corporation which purchases heat source grade plutonium (principal isotope is 238 Pu) from DOE for the production of pacemakers, and is required to dispose of any scrap as well as the power sources, each of which contain about 2.75 Ci.

The currently generated plutonium waste results essentially from decontamination and decommissioning, fuel fabrication, and irradiated fuel studies. A summary of projected DOE and commercial waste generation is given in Table II. Projections by commercial generator are given in Table III. Most of the wastes are generated as dry solids and include an assortment of categories such as combustibles, obsolete equipment, glassware, and other trash, along with large numbers of decommissioned glove boxes. Some solutions are generated which are either absorbed on an absorbent such as clay or are solidified in concrete prior to being shipped. (More organizations seem to use absorbents than use concrete.)

Process residues generated as a result of irradiated fuel studies include wastes that after packaging, must be transported in shielded casks. These wastes are generated by B&W (Lynchburg), Battelle (Columbus), and General Electric, and would be expected to be less than 5% of the volume of waste shipped in the future. The remainder of the waste is contact handled.

The following section describes the recent history and current status of the major non-DOE generators. Projections for future generation are summarized in Table III. It should be noted that except for accountability, it is not possible to distinguish commercial from government waste when both types of work have been performed in the same cells.

TABLE I

GRAMS OF PLUTONIUM SENT TO NECO-HANFORD

Waste Shipper	1979	1978	1977	1976
AGNS, Barnwell, SC	11(J)	20(J)	--	--
B&W, Lynchburg, VA	52(J)	270(J)	35(J)	--
B&W, Leechburg, VA	10(G)	27(G)	--	7074(B)
	--	--	414(J)	945(J)
Battelle, Columbus, OH	29(G)	22(G)	--	--
	98(H)	18(H)	--	--
	--	268(J)	--	--
Battelle, PNL, WA	--	--	113(J)	21(J)
	--	--	10(G)	--
General Atomic Co., CA	--	--	--	*
GE, Vallecitos, CA	48(J)	2268(J)	810(J)	117(J)
	659(G)	1006(G)	469(G)	65(G)
LFE Environmental, CA	--	*	*	--
The Lovelace Foundation, NM	--	--	*	*
Kerr-McGee, Cimarron, OK	--	77(J)	49(J)	474(J)
NFS, Erwin, TN	--	594(J)	--	76(J)
US Army Material Command	--	--	--	1(B)
Westinghouse, Cheswick, PA	154(J)	148(J)	120(J)	856(J)
	49(G)	152(G)	222(G)	273(G)
TOTAL	1110	4870	2242	12330
(B) DOE-Owned Lease Agreement	--	--	--	8873
(G) DOE-Owned Prod. & Research	747	1207	701	968
(H) Owned by Other US Agencies	98	18	--	--
(J) Privately Owned (Domestic)	265	3645	1541	2489

*Less than 1 gram

TABLE II

COMMERCIAL AND DOE TRU WASTE GENERATION

	ft^3 Per Year 1977	1978	1979	Average for 1980 - 1982	1983 & Beyond
DOE Normal Generation	143,000	207,000	111,000	215,000	
DOE D&D Generated	*	*	*	35,000	
Commercial Normal Generation	approx. 15,000			13,000	2,700
Commercial D&D Generated	*	*	*	44,000**	0

*D&D generated for 1977-1979 included in normal generation

** Determination of ownership of some D&D waste remains to be made and may change this estimate (e.g. see B&W-Parks Township, page 7).

Small quantities of waste generated by AGNS appear to have been the result of DOE contracts. AGNS expects to continue to generate less than 100 ft^3 a year under DOE contracts.

B&W-Apollo has been engaged in fuel fabrication work associated with FFTF and other government contract work. The FFTF work is now complete and their future waste generation is uncertain. Their best estimates are shown in Table III, but only the 1980 numbers are firm. One possible option at this site is decommissioning of the plutonium handling facilities which could generate fairly large waste amounts in the 1981 to 83 time frame. The waste projections from this site appear to be the most uncertain of any given in this report.

B&W Lynchburg has been engaged in numerous government (FFTF fuel pins) and commercial (spent fuel) activities in the recent past. They have recently decommissioned a glove box (used in work for FFTF fuel pins) line and packaged the glove boxes in large (6' x 6' x 14') steel boxes in compliance with NRC requirements. They are now holding this material on site but cannot be expected to do so indefinitely. This site also does considerable work on examination of irradiated fuels from existing B&W reactors, and they intend to continue this work for some time. About 80 cu. ft./yr. of this waste will have external radiation levels >25 R/hr and will likely require special packaging and handling if received at a DOE storage site.

B&W - Parks Township has also been engaged in fuel fabrication work associated with the FFTF. Decommissioning waste from this site could be roughly 50,000 ft^3 over the next few years. This waste is not included in Tables II or III since determination of DOE or commercial ownership of this waste based on the contract for the work is still pending.

Battelle-Columbus has produced TRU waste as a result of DOE and NRC contracts and also privately funded work on fuel supplied by utilities. The Government work has generated contact handled wastes from their plutonium laboratory and remotely handled wastes from irradiated fuel studies. In 1980 they will decontaminate their plutonium laboratory. When decontamination is complete, they anticipate generating only hot cell wastes from irradiated fuel studies, with approximately 75% of that waste coming from government contract work. The hot cell wastes will require special packaging and remote handling. In addition, Battelle is holding about 10 grams of heat source grade Pu for disposal. Battelle-PNL holds less than 200 grams of Pu in samples and standards.

Exxon-Nuclear currently has an inactive plutonium fuels fabrication laboratory which they intend to decommission in 1980. No additional waste generation is anticipated from this site. They have about 70kg of MOX fuel in powder and pellets which they would like to "donate" to the government.

General Electric-Vallecitos has generated large quantities of TRU waste in recent years and disposed of the waste at the NECO-Richland site. Most of the waste was generated from DOE contract work but some waste from private work was included and was not separable. They are in the process of decommissioning their plutonium facilities and will generate large amounts of waste in 1980 and 1981 that are the result of DOE work. In addition they will generate wastes from irradiated fuel studies for the private sector for an indefinite period of time. A portion of these wastes have high surface radiation levels and will likely require special packaging and handling to be acceptable at DOE storage sites.

Kerr-McGee-Cimmaron has fabricated fuel pins for the FFTF and ZPPR Programs and has disposed of that waste at the NECO-Richland site. They are currently decommissioning those fabrication facilities and will generate large quantities of TRU waste over the next three years. They

TABLE III

PROJECTED GENERATION OF COMMERCIAL TRU WASTE

(in cubic feet)

	WASTE FROM GOVERNMENT WORK				WASTE FROM PRIVATE WORK				D&D WASTES[1]			
	1980	1981	1982	1983	1980	1981	1982	1983	1980	1981	1982	1983
B&W - Apollo	7070	13360[2]	13360[2]	-	500	2090[2]	2090[2]	2090	-	-	-	-
B&W - Lynchburg	7600	-	-	-	260	155	155	155	7600	-	-	-
Battelle Columbus	790	240	240	220	260	80	80	80	570	-	-	-
Exxon-Nuclear	-	-	-	-	1900	-	-	-	1900	-	-	-
GE-Vallecitos	8000	8500	-	-	228	132	132	132	8000	8500	-	-
Kerr-McGee	8000	1200	10000	-	-	-	-	-	8000	12000	10000	-
Monsanto Research Corp	-	-	-	-	575	1400	200	200	-	1200	-	-
Nuclear Fuel Services	6800	17850	21250	-	1200	3150	3750	-	8000	21000	2500	-
Rockwell Int-Canoga Pk	300	-	-	-	-	-	-	-	-	-	-	-
Westinghouse - Cheswick	-	-	-	-	9000	10000	2000	-	9000	10000	2000	-
Other[2]	-	-	-	-	400	400	400	200	-	200	200	-
TOTAL	38560	41150	44850	220	14323	17407	8807	2857	43070	52900	14700	-

[1] Includes wastes from previous two categories resulting from existing and planned D&D operations.

[2] Significant uncertainty exists in these estimates at this time.

report that 10 Kg of plutonium, confirmed by gamma assay, is present in the glove box lines, after cleaning with hot nitric acid. No further waste is expected after completion of the decommissioning.

Monsanto Research Corp.-Dayton is producing TRU waste from manufacture of radiation sources. The isotopes involved are 241Am, 238Pu, and 252Cf. Monsanto is currently holding all waste from these operations on site and had planned shipments to NECO-Richland this year. They expect to generate TRU wastes on a continuing basis for the foreseeable future. They also plan a decommissioning task in 1981 as shown in Table III. None of the waste is generated under direct DOE contracts.

Nuclear Fuel Services - Erwin has generated and sent to NECO-Richland TRU wastes from fuel fabrication operations for DOE and private firms. These facilities are currently shut down and contain about 390 grams of Pu. At NRC direction they have established a plan for decommissioning these facilities which calls for large quantities of waste to be generated over the next three years. They estimate that 80% of these wastes are a result of work under DOE contracts. After the decommissioning is complete, no additional waste is expected.

Rockwell International-Canoga Park has on hand 300 cu. ft. of TRU wastes from a recently completed DOE contract on fuel decladding. No additional TRU waste is projected at this time. A DOE decision to decommission the plutonium facilities there could generate up to 100,000 cu. ft. of waste but would be done under contract to the Office of Surplus Facilities and would be considered to be DOE waste.

Westinghouse-Cheswick has sent large quantities of TRU waste to NECO-Richland in the past several years generated as a result of plutonium fuels development work done for DOE and commercial interests. They currently plan to decommission these facilities and will generate significant quantities of TRU waste in the next three years.

2.2 DOE Site Inventory

The major DOE storage sites considered in this study are:

Oak Ridge National Laboratory (ORNL), TN
Los Alamos National Scientific Laboratory (LANSL), NM
Savannah River Plant (SRP), SC
Nevada Test Site (NTS), NV
Hanford Site, WA
Idaho National Engineering Laboratory (INEL), ID

TABLE IV

INVENTORY AND CAPACITY OF TRU STORAGE AT DOE SITES

SITE	INVENTORY (Cubic ft)	Est 5 yr STORAGE RATE (Cubic ft/yr)	REMAINING CAPACITY (Cubic ft)
Oak Ridge National Laboratory	4,000	2,500	42,500
Los Alamos Scientific Laboratory	124,000	19,400	500,000
Savannah River Plant	85,000	5,300	225,000
Nevada Test Site	8,000	900	approx 10^7
Hanford Site	283,000	50,000	Over 10^7
Idaho National Engineering Laboratory	1,410,000	100,000	9,500,000

These sites are the major facilities in the United States that store DOE-generated TRU waste for eventual retrieval and disposal. Several DOE sites have burial grounds for low-level waste, but DOE policy (since 1970) does not permit burial or disposal of TRU contaminated waste.

The DOE generation of TRU waste by defense programs in 1979 was over 110,000 ft^3, and is expected to exceed 200,000 ft^3 by 1985. DOE generation may increase substantially in the event of fuel recycling, or a commercial breeder reactor program. Depending on the actual decontamination schedule, commercial generation is expected to increase from about 15,000 ft^3/yr in 1979 to an average of 57,000 ft^3/yr for each of the next 3 years. Decontamination of a single reactor, however, may generate several thousand cubic feet of TRU waste. With respect to the Three Mile Island (TMI) reactor accident, essentially none of the waste, other than the core, is suspected of TRU contamination. Even the resins after filtering core coolant are expected to have substantially less than 10 nCi/gm of TRU contamination.

Table IV indicates estimated capacity for retrievable storage of TRU waste at each of the sites considered. Existing capacity in DOE sites exceed 50 times the current annual generation rate of combined DOE and non-DOE wastes.

2.3 Acceptance Criteria

Packaging criteria to be established would be essentially the same as for DOE waste. The following general criteria would have to be met by each waste generator prior to acceptance by DOE. Final criteria would be formally established and issued by the receiving site:

a. The following are prohibited: free liquids, pyrophoric materials smaller than 0.25 in. cube, liquid metals, acids, elemental alkaline metals, and explosives.

b. Liquids must be mixed with absorbants so that liquids will not flow if container is broken.

c. Combustible waste must be packaged separately, and labeled with a bright green 4-in. triangle on all sides.

d. Surface contamination must be less than 2,200 d/m/100 cm^2 beta - gamma and less than 220 d/m/100 cm^2 - alpha. Radiation at surface: less than 200 mR/hr.

e. Packaging must minimize gas buildup. In hydrogenous materials alpha activity must be restricted to 4×10^5 nCi/gm waste.

f. Thermal decay must not exceed 10 watts per package.

g. Each package must be serialized and marked to maintain identity for at least 20 years.

h.

Acceptable Package	Maximum Gross Weight	Fissionable Material Maximum Content
DOT 17C 55-Gallon Drum	800 lb/drum	200 g/drum
DOT 6M Packaging	640 lb/drum	500 g/drum
DOT 7A Steel Box	3,200 lb/box	60 g ^{233}U or 100 g ^{235}U
DOT 7A Fiberglassed Box	10,000 lb/box	5 g/ft^3 of waste volumetric average and 350 g/box maximum
DOT 17H 30-gallon Drum	200 lb/box	100 g/drum

2.4 Effect of Redefinition of TRU Waste

Currently EPA and NRC are considering defining TRU waste to include materials and equipment contaminated with transuranics in amounts up to 100nCi/gm as to not require geologic repository disposal. Waste with contamination levels between 10 and 100 nCi/gm could be managed by alternate methods, such as intermediate depth burial. It has not been possible to get an accurate estimate of how much of the projected commercial TRU waste would fall in the 10 to 100 nCi/gm range, but it is thought to be less than 20%. Attempting to segregate the wastes at the 100 nCi/gm level by the generators would be generally unsuccessful as few have the capability to monitor this range accurately. A change in current DOE policy requiring retrievable storage of TRU waste exceeding 10nCi/gm would be required prior to implementing alternative disposal options. If DOE receives commercial TRU waste should be handled exactly as with DOE generated waste.

III. LEGAL CONSIDERATIONS

DOE's authority to enter into contracts to accept TRU waste for storage and disposal is limited. In the following cases DOE has authority to enter into such contracts.

a. Where the TRU waste is generated by a DOE contractor in carrying out a DOE contract. In this situation DOE's authority to enter into the original contract would be broad enough to authorize DOE actions which are a necessary or incidental adjunct to that contract. In this case DOE charges, if any, for accepting the TRU waste for storage and disposal would be established as part of the procurement action under which the original contract was awarded.

b. Where the TRU waste is generated by a non-DOE Government contractor carrying out a U. S. Government contract. In this case DOE, utilizing authority under the Economy Act, could accept the TRU waste at the request of the agency which awarded the contract. The contracting Government agency would have to treat disposal of TRU waste as necessary and incidental to its contract and would have to determine that commercial sources for the service are not available or that it would be advantageous to utilize DOE service. In accordance with the Economy Act, DOE would recover its costs of providing the service from the requesting Government agency. One additional problem with the Economy Act is that such authority would not be available if DOE, in order to provide the services, were required to invest in new facilities or provide additional staff.

c. Where storage or disposal of TRU waste is necessary to insure the continued conduct of research and development in nuclear related fields. In Section 31 of the Atomic Energy Act of 1954, as amended, Congress directed DOE "to exercise its powers in such a manner as to insure the continued conduct of research and development and training activities..." in broad fields set forth in that section. To this end DOE is authorized and directed to make arrangements (including contracts, agreements, and loans) for the conduct of research and development activities. In this case, DOE as a minimum, would be required to determine that failure to accept TRU waste from research and development activities would threaten the continued conduct of the research and development. Charges for the DOE-supplied storage and disposal service would be established as part of the contracting activity.

d. Finally, NRC, utilizing the authority of Section 161b of the Atomic Energy Act of 1954, as amended, has authority to order that the TRU waste be delivered to the Federal Government. Since DOE is the only agency which has the ability to receive and handle such material, such an order could be argued to provide to DOE the necessary authority. In this case NRC would establish the charges under the authority of 31 USC 483 a. Except for small quantities of material, this approach would appear to be undesirable because of the uncertain division of responsibility between NRC and DOE.

In cases not covered by the above (e.g., TRU waste generated by a commercial nuclear power reactor where NRC has not exercised section 161b authority) DOE does not have authority to enter into contracts to accept TRU waste for storage and disposal. Legislation granting such authority is needed if large quantities of TRU waste are to be stored and disposed of by DOE. However, DOE would be able to make space available for interim storage of limited quantities of TRU waste on a cost reimbursable basis. Such arrangements could be made if DOE could find that the interim storage would be compatible with the primary mission of the storage site, no additional DOE facilities were required, and the storage would not require utilization of additional DOE manpower or budget resources.

Most of the non-DOE TRU waste generation projected for the next three years may not be covered by cases a, b, or c. Only small quantities are the result of non-DOE Government contracts, so case b has little applicability. Most of the waste, approximately 75%, will result from decommissioning of inactive facilities, limiting the basis to apply case c to these wastes. DOE work was conducted in most of these facilities but the contracts are complete in almost all cases, eliminating case a. Case d, NRC applying Section 161b, could provide the necessary authority, but actual implementation appears to be administratively complex and difficult, including NRC authority to establish the charge schedules. The most positive approach for DOE to gain the necessary authority is to seek specific legislation. Such authority would be consistent with the authority granted to DOE to accept other waste requiring long term isolation, i.e. high level waste and spent fuel, and with the proposed authority for ownership of low level waste burial sites operated by the states.

IV. FINANCIAL AND OTHER CONSIDERATIONS

4.1 Required DOE and NRC Actions

Required NRC actions are discussed in Section III, Legal Considerations, but essentially consist of a formal request under Section 161b of the Atomic Energy Act to DOE to accept the non-defense TRU waste being shipped to NECO-Richland with a determination that no other facility is available, and stating that such acceptance by DOE would not require an EIS nor require licensing by the NRC.

Before actual receipt of waste can occur, the following must be accomplished by DOE:

a. Funds must be appropriated for construction of a new storage pad.

b. DOE transmit acceptance criteria, and charge schedules. Generators must agree to comply with acceptance criteria and charge schedules.

c. Coordination with affected state governments, and with the House Science and Technology Committee.

d. An Environmental Assessment should be prepared with EV participation.

Pad construction is expected to take 2 months. Preparation and transmittal of final charges and criteria will take 2 weeks, while subsequent contract negotiations will likely require about 2 months. Discussions with affected states should be done at the earliest convenience and not take over 2 weeks. Thus DOE could start receiving waste 3 months after a DOE commitment to accept the waste. The schedule could be extended by a significant amount if state governments are not cooperative or if generators challenge the cost schedule. The schedule could be shortened by a month by concerted DOE action, but this option should not be exercised unless an emergency arises.

4.2 Summary of Charge for Commercial TRU Waste Acceptance

The appendix describes the assumptions, methodology and reference case calculation to determine the charge schedule for DOE acceptance of commercial transuranic waste. The preliminary charge schedule is based on current estimates for retrievable storage, retrieval, processing, transportation and disposal in a geologic repository. Table V gives the charge schedule for 1980 - 1995 in terms of contact handled (>90% of the volume) waste. Waste requiring remote handling during storage and retrieval will require a 5% surcharge.

TABLE V

CHARGE SCHEDULE

Year	Charge ($\$/ft^3$)
1980	147
1981	156
1982	166
1983	177
1984	188
1985	200
1986	213
1987	226
1988	241
1989	256
1990	272
1991	290
1992	308
1993	328
1994	349
1995	372

APPENDIX

CHARGE FOR COMMERCIAL TRU WASTE ACCEPTANCE

The following section gives the methodology used to determine the charge for DOE acceptance of commercial TRU waste. A preliminary charge based on current estimates to retrievably store, retrieve, process, transport and dispose of DOE transuranic waste is developed. Although cost estimates are based on current available conceptual designs, this study does not make any recommendations as to facilities or repositories to be used.

A.1 General Assumptions Used in Preparing Charge Estimates

1) There is no requirement for licensing to allow DOE to accept commercial waste. However, disposal of retrievably stored TRU waste is assumed to require an NRC licensed repository.

2) There will be a one-time charge covering the full cost of Government-provided services over a reasonable time. The charge schedule will be that in effect at the time of commitment. The charge schedule and/or methodology will be revised periodically to take known changes into account (e.g., firm construction costs); however, no adjustment will be made for TRU wastes already delivered and accepted.

3) Waste transferred must be delivered to a government-approved storage site at user expense. Entire payment for disposal will be made at the time of transfer.

4) All liability and ownership by the commercial generator with respect to transferred waste will cease at the time of transfer and payment, provided all acceptance criteria are met.

5) For waste to meet NRC repository license criteria processing is required.

6) Processing of waste prior to the availibility of a repository or delay in processing the commercial portion of stored TRU waste is at government convenience and does not influence the charge.

Full cost recovery has been interpreted to mean that the present value of revenues received during a reasonable period of time should equal the present value of costs applicable to the same period. That is,

Discounted Cost = Discounted Revenue

There is some latitude in the application of this methodology as long as care is taken to conserve the total system balance between discounted cost and discounted revenues. The following conventions and considerations are used in this analysis.

1) Planning Period - The reasonable period of time over which costs and revenues are included must be selected. There are no "rules" for determining the appropriate period. In general, the period should be long enough to lessen the effects of any unusual perturbations in estimated cost or transfers, but short enough that the estimates are reliable. A campaign period of 24 years (1980 through 2002) was selected. Construction of the processing facility and repository take place in 1990 - 1992. Processing and disposal of retrievably stored waste occurs in 1993 - 2002.

2) Cost Data - Projections must be made of the cost of future facilities and activities. All capital and operating costs and revenues are expressed in constant 1980 dollars. Operating costs are given as unit costs (dollars per cubic foot of waste).

3) Charge Schedule - The charge (which is expressed in dollars per cubic foot of waste stored) is composed of two parts. The first part, the charge for retrievable storage, covers the cost of storage. This charge remains constant at the 1980 level except for adjustments for inflation each year. The second part of the charge is revenue received at the time of waste transfer against the future cost of retrieval, processing, transportation and disposal. This charge will increase by the discount rate each year since payment for these costs by the generators is one year less in advance. In addition this part of the charge will also be adjusted for inflation each year. The charge schedule is the compilation of total charge by year over the period of waste acceptance.

4) Discount Rate - To insure that the predicted amount of capital is available to cover government cost to retrieve, process and dispose of the commercial waste (assumed to begin in 1993, the cost of the services expressed in 1980 dollars should be discounted by an amount equal to the interest rate less the inflation rate. That is, the part of the expected interest rate due to inflation should be removed. To be consistent with the development of the preliminary estimate of spent-fuel storage and disposal charges (reference 5) a discount rate of 6.5% per year is used.

5) Discounted Costs - The following definition is used for discounted costs.

Discounted Costs = Present Value of [Initial System Value + Cash Expenditures - Ending System Value]

The initial system value refers to any unrecovered costs incurred prior to the selected campaign period. The cash expenditures are those associated with managing the waste received during the period, even if they are to be incurred after the end of the period. The ending system value adjusts the costs allocated to the period by taking credit for the remaining value of capital facilities at the end of the period.

A.2 Reference Case Assumptions for Facilities and Services

The specific assumptions related to facilities and services that were made for the reference case were grouped into five categories or cost centers. They are:

1. Retrievable storage
2. Retrieval
3. Processing
4. Processed waste transport
5. Disposal

The assumptions related to each cost center are described below. All costs are given in 1980 dollars. The referenced reports served as the principle sources of cost data. These costs were based on the latest DOE program information. Facility costs were based on preliminary facility designs and include a 25 to 35% engineering contingency. Storage and processing of the waste is assumed to occur at a typical DOE site, and repository disposal is assumed to occur 1500 miles away.

1) Retrievable storage

Waste received from commercial generators will be placed in retrievable storage according to current criteria and practices used at DOE facilities. Retrievable storage costs are primarily dependent on the emplacement, operation, and maintenance costs over the time waste is received and placed in storage. Ten-twenty year retrievable storage costs are $4/ft^3 based on current practices.

2) Retrieval

Two estimates for the retrieval of stored waste are given in references 2 and 3. The estimate for retrieval of stored waste at both INEL and SRP is $17/ft^3 even though the characteristics and form of the waste is different at the two sites. $17/ft^3 is taken as the retrieval cost of stored waste at all DOE sites.

3) Processing

The estimated amount of government generated retrievably stored TRU waste at the DOE processing site in 1993 is 1,380,000 cubic feet with an annual new generation rate of 75,000 cubic feet (projected from reference 1). With the 225,000 cubic feet of commercial TRU waste, the processing facility will be required to process a total of 2,355,000 cubic feet of waste in 10 years (the assumed processing campaign length). This size facility is essentially identical to a conceptual design estimated by INEL (221,000 ft^3/year, reference 2). Estimated costs for that facility are $409 million in capital cost. Operating and maintanence costs are $24.9 million per year or $112/ft^3. No credit is given for possible increases in efficiency due to centralization of processing facilities or increased utilization due to processing of buried waste. However the processing facility is assumed to have a 20 year life and credit is given for half the capital value remaining in the facility at the end of the campaign period. The assumed effective volume reduction from processing is 3 to 1.

4) Transportation of processed waste

The transportation cost element represents the shipping charges to transport processed transuranic waste by rail. A shipping rate of 9¢/ton shipped/mile is used for the transportation cost in this study. This rate is the approximate cost of unprocessed waste shipments in 1980. A preliminary design for a processed waste container developed by the Transportation Technology Center at Sandia Laboratories is a solid steel vessel designed to carry six cylinders of processed material. The expected ratio of container weight to load weight is 1 to 1. For this analysis a rail-only container with loaded weight of 30 tons is assumed. With an expected density of 175 lb/ft^3 this container would hold 170 cubic feet of processed waste.

If the waste is shipped 1500 miles on 30 ton rail cars, the transportation cost is $31.5 per cubic foot shipped.

5) Repository

The estimated total inventory of DOE retrievably stored TRU waste in 1993 is 4,990,000 cubic feet (projected from reference 1). The estimated generation rate at that time is 205,000 ft^3/year. Over the assumed 10 year processing period a total of 7,265,000 cubic feet of retrievably stored waste will be processed. With an assumed effective volume reduction ratio of 3 to 1, 2,420,000 ft^3 or 242,000 ft^3/year of processed waste will require disposal. A recent Stearns-Roger Engineering Company conceptual design for a combined TRU and high level waste repository in a domed salt formation(reference 4) has a TRU waste disposal rate of 200,000 cubic feet per year for a 20 year period. The fraction of the total capital cost of the conceptual design required for TRU waste is $227 million. Operating and maintanence cost for TRU disposal are 14.3 million/year or $71.5 per cubic foot stored. Since the assumed stored waste work-off period is 10 years, credit is given for half the capital value remaining in the facility at the end of the campaign period.

A.3 Calculation of Charge Elements - Reference Case

The charge methodology is based on the principle that the Government should be reimbursed over a reasonable period of time for all costs relevant to the services provided. This has been interpreted to mean that the present value of all applicable revenues must equal the present value of all relevant costs, or,

Discounted Costs = Discounted Revenues

All costs and revenues are expressed in constant 1980 dollars. Costs are recognized at the beginning of the year incurred. Revenues are recognized at the end of the year that waste is received at the Government designated storage site. Because capital costs apply to both Government generated waste and DOE accepted commercial waste, only the fraction of capital cost which applies to commercial TRU is used in the calculation of charges. For the reference case in this analysis a campaign through the year 2002 is taken as a reasonable period of time. The discount rate is constant throughout the period.

Discounted costs are determined by first projecting annual cash expenditures for capital and operating costs for each cost center, then discounting them to the present year at the accepted rate. This is expressed by the formula,

$$C_i = \sum_{t=1}^{t=n} \frac{C_{it}}{(1+r)^{t-1}}$$

where C_i = sum of discounted costs for cost center i, *
C_{it} = cash expenditure in year t for cost center i,
r = discount rate
t = year (t = 1 represents present year)
n = last year of campaign

Total discounted cost is found by summing the discounted annual costs by cost center. Any unrecovered costs incurred prior to the campaign period (referred to elsewhere in the report as initial system value) are included as costs in the first year. The cash expenditures are those for managing the program during the period and include costs associated with managing all the waste received during the period, even if those costs are incurred after the end of the period. Any costs incurred during the period which are associated with the remaining value of capital facilities at the end of the period are accumulated as an ending system value and credited against the cost in the year following the end of the campaign.

In a similar manner discounted revenue is given by the formula:

$$R_i = \sum_{t=1}^{t=n} \frac{R_{it}}{(1+r)^t}$$

where R_i = sum of discounted revenues for revenue center i,
R_{it} = cash income in year t for revenue center i.

Because payments are received only at the time of waste transfer all revenues occur within the campaign period.

The total charge for the present year (expressed in $ per cubic foot of waste transferred) is the sum of the five center components for year 1.

$$P = \sum_{i=1}^{i=5} P_i ,$$

where P = total charge for the present year
P_1 = storage component of charge for the present year
P_2 = retrieval component for the present year
P_3 = processing component for the present year
P_4 = transportation component for the present year
P_5 = disposal component for the present year

*Cost centers are: (1) Retrievable storage; (2) Retrieval; (3) Processing; (4) Transportation; (5) Disposal

As stated earlier in this report, the charge for storage is constant from year to year while the charges for the other cost centers will increase by the discount rate each year. The charge schedule is the compilation of total charge by year over the period of waste acceptance.

The charge component for each cost center is calculated by setting the discounted costs equal to the discounted revenues for each cost center; which is expressed by the following equation:

$$\sum_{t=1}^{t=n} \frac{C_{it}}{(1+r)^{t-1}} = \sum_{t=1}^{t=n} \frac{R_{it}}{(1+r)^{t}}$$

The calculation for each cost center follows. In addition to the notations defined thus far, the following notations are common to each calculation.

c_i = unit operating and maintenance cost for cost center i,
V_{At} = volume of waste accepted for storage or processing in year t,
V_{St}, V_{Rt}, V_{Pt}, V_{Tt}, V_{Dt} = volume of waste stored, retrieved, processed, transported, or disposed in year t,
$V_{A\ total}$ = total volume of waste accepted for storage or processing in the campaign period,
$V_{S\ total}$, $V_{R\ total}$, $V_{P\ total}$, $V_{T\ total}$, $V_{D\ total}$ = total volume of waste stored, retrieved, processed, transported, or disposed,
C_{Pt}, C_{Dt} = fraction of capital expenditure for processing or disposal in year t which applies to commercial TRU
$C_{P\ total}$, $C_{D\ total}$ = fraction of total capital expenditure for processing or disposal which applies to commercial TRU.

1) Charge for Retrievable Storage in the present year

Cash expenditures are given by:

$$C_{it} = c_1 V_{St}$$

Revenues are given by:

$$R_{it} = P_1 V_{St}$$

Setting discounted costs equal to discounted revenues results in the following equation:

$$c_1 \sum_{t=1}^{t=n} \frac{V_{St}}{(1+r)^{t-1}} = P_1 \sum_{t=1}^{t=n} \frac{V_{St}}{(1+r)^{t}}$$

$$P_1 = c_1(1+r)$$
$$P_1 = \$4/ft^3$$

2) <u>Charge in present year for Waste Retrieval</u>
Cash expenditures are given by:

$$C_{it} = c_2 V_{Rt}$$

Revenues are given by:

$$R_{it} = P_2(1+r)^{t-1} V_{St}$$

therefore;

$$c_2 \sum_{t=1}^{t=n} \frac{V_{Rt}}{(1+r)^{t-1}} = P_2 \sum_{t=1}^{t=n} \frac{(1+r)^{t-1} V_{St}}{(1+r)^t}$$

or;

$$P_2 \frac{V_{S\ total}}{(1+r)} = \frac{c_2}{10} (V_{S\ total}) \sum_{t=14}^{t=23} \frac{1}{(1+r)^t}$$

Since $V_{Rt} = 1/10 \times V_S$ total assuming a 10-year processing campaign.

This results in:

P_2 = [illegible]$/ft^3$.

3) <u>Charge in present year for Waste Processing</u>
In a manner similar to the previous calculations:

$$C_{it} = c_3 V_{Pt} + C_{Pt} \text{ and,}$$
$$R_{it} = P_3(1+r)^{t-1} V_{At}$$

therefore;

$$\sum_{t=1}^{t=n} \frac{c_3 V_{Pt} + C_{Pt}}{(1+r)^{t-1}} = P_3 \sum_{t=1}^{t=n} \frac{(1+r)^{t-1} V_{At}}{(1+r)^t}$$

Since $V_{Pt} = 1/10 \times V_{A\ total}$ during the processing campaign, this results in:

$$P_3 = \$112/ft^3,$$

when credit is given for the remaining capital value of the processing facility at the end of the campaign period (assumed to be 1/2 the capital cost).

4) Charge in present year for Waste Transportation.
For transportation:

$$C_{it} = c_4 V_{Tt} \text{ and,}$$

$$R_{it} = P_4 (1+r)^{t-1} V_{At}$$

therefore;

$$c_4 \sum_{t=1}^{t=n} \frac{V_{Tt}}{(1+r)^{t-1}} = P_4 \sum_{t=1}^{t=n} \frac{(1+r)^{t-1} V_{At}}{(1+r)^t}$$

Since $V_{Tt} = 1/3 \times 1/10 \times V_{A\ total}$ during processing, assuming an effective volume reduction of 3 to 1:

$$P_4 = \$4/ft^3$$

5) Charge in present year for Waste Disposal.
For disposal:

$$C_{it} = c_5 V_{Dt} + C_{Dt} \text{ and,}$$

$$R_{it} = P_5 (1+r)^{t-1} V_{At}$$

therefore;

$$\sum_{t=1}^{t=n} \frac{c_5 V_{Dt} + C_{Dt}}{(1+r)^{t-1}} = P_5 \sum_{t=1}^{t=n} \frac{(1+r)^{t-1} V_{At}}{(1+r)^t}$$

Since $V_{Dt} = 1/3 \times 1/10 \times V_{A\ total}$ during processing:

$$P_5 = \$21/ft^3,$$

when credit is given for the remaining capital value of the repository at the end of the campaign period (assumed to be 1/2 the capital cost).

A.4 Calculation of the Charge Schedule - Reference Case.

Table II shows the charge cost elements and total charge for each year from 1980 to 1995. These charges will be adjusted for inflation at the time of waste transfer. Table III gives the material and cash flows for the reference case used in this study.

TABLE II

CHARGE SCHEDULE

YEAR	CHARGE ($/ft³) P_1	$P_2 + P_3 + P_4 + P_5$	TOTAL
1980	4	143	147
1981	4	152	156
1982	4	162	166
1983	4	173	177
1984	4	184	188
1985	4	196	200
1986	4	209	213
1987	4	222	226
1988	4	237	241
1989	4	252	256
1990	4	268	272
1991	4	286	290
1992	4	304	308
1993*	4	324	328
1994*	4	345	349
1995*	4	368	372

*Extrapolations beyond assumed construction period of processing facility and repository to be used if construction is delayed.

TABLE III

REFERENCE CASE MATERIAL AND CASH FLOWS

	Material (ft^3)		Costs (million $)						
	Accepted	Processed	Storage	Retrieval	Processing[1]	Transportation	Disposal[1]	Total	Revenues
1980	57,000	---	0.23	---	---	---	---	0.23	8.38
1981	57,000	---	0.23	---	---	---	---	0.23	8.89
1982	57,000	---	0.23	---	---	---	---	0.23	9.46
1983	2,700	---	0.01	---	---	---	---	0.01	0.48
1984	2,700	---	0.01	---	---	---	---	0.01	0.51
1985	2,700	---	0.01	---	---	---	---	0.01	0.54
1986	2,700	---	0.01	---	---	---	---	0.01	0.57
1987	2,700	---	0.01	---	---	---	---	0.01	0.61
1988	2,700	---	0.01	---	---	---	---	0.01	0.65
1989	2,700	---	0.01	---	---	---	---	0.01	0.69
1990	2,700	---	0.01	---	13.03	---	2.34	15.38	0.73
1991	2,700	---	0.01	---	13.03	---	2.34	15.38	0.78
1992	2,700	---	0.01	---	13.03	---	2.34	15.38	0.83
1993	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	0.89
1994	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	0.94
1995	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.00
1996	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.07
1997	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.14
1998	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.21
1999	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.29
2000	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.37
2001	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.46
2002	2,700	22,500	---	0.38	2.52	.24	0.54	3.68	1.56
2003	---	---	---	---	-19.54	---	-3.51	-23.05	---
TOTAL	225,000	225,000	0.79	3.80	44.75	2.40	8.91	60.68	45.05
Discounted to 1980			0.7	1.3	23.5	0.8	4.5	30.8	30.8

[1] Capital cost is fraction which applies to commercial TRU only.

A.5 References

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

2. DOE (U.S. Department of Energy), 1979. Environmental and Other Evaluations of Alternatives for Long-Term Management of Stored INEL Transuranic Waste, DOE/ET-0081 (Revised), Washington, D.C.

3. DOE (U.S. Department of Energy), 1979. Alternatives for Long-Term Management of Defense Transuranic Waste at the Savannah River Plant, DOE/SR-WM-79-1, Washington, D.C.

4. DOE (U.S. Department of Energy), 1979. National Waste Terminal Storage Repositories 1 and 2 - Cost Estimate Reconciliation Study, Columbus Program Office, Columbus, Ohio.

5. DOE (U.S. Department of Energy), 1978. Preliminary Estimates of the Charge for Spent-Fuel Storage and Disposal Services, DOE/ET-0055, Washington, D.C.