EEG-24

POTENTIAL PROBLEMS FROM SHIPMENT OF HIGH-CURIE CONTENT CONTACT-HANDLED TRANSURANIC (CH-TRU) WASTE TO WIPP

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FOREWORD

The purpose of the Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the potential radiation exposure to people from the proposed Federal radioactive Waste Isolation Pilot Plant (WIPP) near Carlsbad, in order to protect the public health and safety and ensure that there is minimal environmental degradation. The EEG is part of the Environmental Improvement Division, a component of the New Mexico Health and Environment Department -- the agency charged with the primary responsibility for protecting the health of the citizens of New Mexico.

The Group is neither a proponent nor an opponent of WIPP.

Analyses are conducted of available data concerning the proposed site, the design of the repository, its planned operation, and its long-term stability. These analyses include assessments of reports issued by the U.S. Department of Energy (DOE) and its contractors, other Federal agencies and organizations, as they relate to the potential health, safety and environmental impacts from WIPP.

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SUMMARY

There are approximately 1000 drums of contact-handled transuranic (CH-TRU) wastes containing more than 100 Ci/drum of Plutonium-238 that are stored at the Savannah River Plant (SRP) and at the Los Alamos National Laboratory (LANL). As much as one-half of these high-curie content containers may contain waste in a combustible form. To date, no plans have been announced to process these wastes prior to shipment to the WIPP.

Studies performed at DOE laboratories have shown that large quantities of gases are generated in stored drums containing greater than 100 curies of Plutonium-238. Concentrations of hydrogen gas in the void space of the drums are often found to be high enough to be explosive. The calculated explosive energy for a truck shipment consisting of 36 drums with 6% hydrogen (lower explosive limit) would be equivalent to about 0.7 pounds of trinitroglycerol. None of the analyses in the DOE WIPP Final Environmental Impact Statement (FEIS), Safety Analysis Report (SAR), and Preliminary Transportation Analysis (PTA) have considered the possibility that the generation of hydrogen gas by radiolysis may create an explosive or flammable hazard that could increase the frequency and severity of accidental releases of radionuclides during transportation or handling.

These high Plutonium-238 concentration containers would also increase the estimated doses received by individuals and populations from transportation, WIPP site operations, and human intrusion scenarios even if the possibility of gas-enhanced releases is ignored. The WIPP Project Office has evaluated this effect on WIPP site operations and is suggesting a maximum limit of 140 Plutonium-239 equivalent curies (P-Ci) per drum so that postulated accidental off-site doses will not be larger than those listed in the FEIS. No actions have been suggested by DOE to maintain the transportation, occupational, and human intrusion doses that would result from accidents involving high-curie content drums to those listed in the FEIS.

Additionally, the TRUPACT container, which is being designed for the transportation of Contact-Handled Transuranic (CH-TRU) wastes to WIPP, does not appear to meet the Nuclear Regulatory Commission (NRC) regulations requiring double

containment for the transportation of plutonium in quantities greater than 20 Ci. A 20 alpha Ci/shipment limit would require approximately 200,000 shipments for the 4 million curies of alpha emitters slated for WIPP.

The WIPP Project Office has not brought the gas generation problem or the adequacy of the TRUPACT shipping container to the attention of the Environmental Evaluation Group (EEG) either in reports, letters, or verbal communications.

I. INTRODUCTION

A. Final Environmental Impact Statement Analysis

The April 1979 Draft Environmental Impact Statement (DEIS) (Ref.1) for WIPP provided estimates of doses to people from the transportation of radioactive waste to WIPP for the expected radiation exposure for each of the waste generating facilities scheduled to ship wastes to WIPP. When the Final Environmental Impact Statement (FEIS) on WIPP (Ref. 2) was published in October 1980 the only estimates included were based on waste coming from Idaho National Engineering Laboratory (INEL) and the Rocky Flats Plant (RFP) and all the calculated doses from other facilities were deleted. Transportation accident calculations were included in both reports using typical RFP waste concentrations.

B. Post FEIS Analysis

An October 1982 DOE report (Ref. 3) on radioactive wastes indicated that the radionuclide composition and concentrations of TRU wastes vary considerably between the several generating facilities and are greatly different than the "typical" waste used in the October 1980 Final EIS and the various revisions to the Safety Analysis Report (SAR)(Ref. 4). EEG used the 1982 data to calculate the average composition and concentrations for waste coming from each of the facilities including the Savannah River Plant (SRP). These values were transmitted on November 10, 1982 to DOE (Ref. 5) with the observation that the revised inventory could significantly change the calculated quantities of nuclides released and doses incurred in most transportation, operation, and human intrusion scenarios. The following statement was also made by EEG in this letter:

> "EEG is hereby requesting that DOE: (1) modify the SAR values to be consistent with present data and plans; and (2) begin to keep us fully and currently informed about all changes and contemplated changes involving wastes that may be brought to WIPP. Information needed includes shipment schedules from each lab, total radionuclide concentrations, and percent composition of the more important radionuclides.

Current and detailed information concerning waste forms, plans for processing, and waste acceptance criteria certification and compliance procedures are all part of the same problem. We must know these details in order to provide an adequate independent technical review of the project."

DOE responded to the November 10, 1982 letter by developing Pu-239 Equivalent TRU Activity Limits for the WIPP Containers and presented a proposed methodology and rationale for determining the limit at a February 15, 1983 meeting with EEG. The limit chosen by DOE at that time was 169 P-Ci (Pu-239 Equivalent Curies) per 55-gallon drum on the basis that the dose to an off-site individual from the limiting accident would be no greater than calculated in the FEIS. Transportation accident scenario doses, long-term releases from the repository, and possible problems with radiolytic gas generation at higher container loadings were not considered by DOE in the analysis. EEG has not received any updated or more detailed data on radionuclide content, waste forms, etc.

The EEG agreed with the method and limit of the P-Ci activity for operational accidents at the WIPP facility but made the following additional comment on March 17, 1983 (Ref. 6): "it also seems consistent to set equivalent curie limits on specific groups of containers (e.g. on the hoist and in transportation shipments) and to consider all types of radiation exposure (operational, transportation, and long-term)."

Although, DOE has not specifically answered this March 18, 1983 letter, their April 13, 1983 Preliminary Transportation Analysis (PTA)(Ref. 7) addressed some of the concerns.

The Preliminary Transportation Analysis report used an average of the new inventory rather than facility specific inventories. This average was 303 P-Ci per TRUPACT, a value 10.7 times that used in the FEIS (42 average loaded drums with 0.68 P-Ci per drum). The Preliminary Transportation Analysis report did not specifically discuss radiation doses to the maximum individual from transportation accidents but the doses vs. square meters curves in Appendices J and L indicate that severity category 6 or greater accidents (which have an estimated probability of occurence during the repository lifetime of about 0.006) would lead to doses 10-100 times those presented in the FEIS.

After an exchange of comments on the PTA (Ref. 8, 9, 10) between DOE and EEG the following issues remain on those topics addressed in the PTA:

(1) The PTA provided no new data or analysis relative to the shipment of RH-TRU or Experimental HLW to WIPP since the October 1980 calculations in the FEIS, although the origin is known as well as the routes to be taken.

(2) The analysis does not use the latest inventory for each Plant and fails to address the fact that the average Savannah River Plant waste containers contain 4 times the number of P-Ci assumed in the analysis.

(3) The increase in maximum individual accident doses by an order-of-magnitude or more compared to the FEIS has not been fully addressed.

II. POSSIBLE PROBLEM AREAS

The above discussion mentions some of the outstanding concerns the EEG has about the overall transportation issue. There are also other concerns that have not been raised by DOE or EEG in our previous transportation evaluations. Because a number of issues are involved, EEG decided to address them in this single document rather than continue to attempt to deal with them by commenting on various reports. The main topics are listed below and will be dealt with in more depth in subsequent chapters.

A. High-curie content of CH-TRU containers. There are two issues in this category:

(a) The possibility that radiolytic hydrogen gas generation in high-curie content containers may present an explosive hazard in transporting and handling these containers. The WIPP Project Office has never informed us that there is a potential gas generation problem in any WIPP Project Office correspondence or reports. However, review of several DOE contractor reports (Ref. 11, 12, 13, 14, 17) indicates that some investigators at DOE laboratories have recognized this potential problem for four years and suggests that the explosive nature of the gas in the wastes deserves a comprehensive evaluation;

(b) The effect of higher curie quantities in drums on operation, transportation, and human intrusion dose calculations.

B. Updated RH-TRU and Experimental HLW Data and Analyses. No new data or evaluations have been provided to the State since the FEIS was issued in October 1980. DOE stated in the PTA (Ref. 7) that there is not sufficient new information to warrant a reevaluation at this time. EEG believes a great deal of information currently exists (models, routes, waste generator source) and merits analysis now. This report will only address CH-TRU waste problems and will not address the remote-handled transuranic (RH-TRU) or experimental high-level waste (HLW) issues.

C. Adequacy of TRUPACT Containers for Shipment. There is some question whether the current plans for transporting 55-gallon drums or boxes in the TRUPACT meets the requirements of a Type B package that would be permitted by the U. S. Nuclear Regulatory Commission and the Department of Transportation to transport more than 20 curies of plutonium per TRUPACT (Ref. 15, 16).

III. HIGH-CURIE CONTENT CH-TRU CONTAINERS

A. Radiolytic Gas Generation

The CH-TRU defense waste in retrievable storage at SRP that is scheduled to be disposed at WIPP (Ref. 3) includes substantial quantities of Pu-238, an alpha emitter with an 86.4 year half-life. Pu-238 has a specific activity of 17.5 Ci/g and is 285 times more radioactive than Pu-239 with 6.13 x 10^{-2} Ci/g.

Radiolysis by alpha emitters of organic wastes breaks down the chemical bonds and produces H_2, O_2, and CH_4. Studies have indicated that hydrogen gas concentrations can increase to potentially explosive levels within a few weeks if 100 curies or more of alpha emitters are stored in a 55 gallon drum (Ref. 17).

The lower explosive limit has been defined as either 5 mol% H_2 or 4 mol% H_2 in air (Ref. 17) or 6 mol% H_2 (Ref. 12). Even though waste storage drums usually do not contain gas-tight seals and pressurize little or not at all, their void space will still contain elevated concentrations of H_2. Although, this leakage is probably the main reason why H_2 gas problems have not occurred during storage (Ref. 17), it would increase the H_2 concentration inside the perfectly gas tight TRUPACT transporting the drums to WIPP. The hydrogen gas buildup in drums or TRUPACTS could potentially cause accidents or could increase the quantity of radionuclides released during handling and transportation accidents. Also, the radiolysis process has been observed to generate considerable quantities of powder when it occurs in a cellulosic matrix. One study indicated that 10% of the cellulosics, containing 50% of the radioactivity, was reduced to powder in a drum (Ref. 12). The FEIS transportation accident scenarios assumed 10% powder with 10% of the radioactivity in the average drum after all combustibles had burned.

Quantity of waste. Approximately one thousand drums presently stored at SRP and LANL contain over 100 Ci of Plutonium-238. The following table shows a break-down of wastes stored at SRP. Note that a considerable fraction of these wastes originated at either Mound Laboratory or LANL. At the end of 1979 there were 560 30-gallon drums stored in concrete casks in covered trenches at LANL containing over 100,000 Ci of Pu-238 (Ref. 19).

Large amounts of Pu-238 are expected to be generated in the future and shipped to WIPP. Current projections are that over 3.4 million curies out of the 4.0 million curies of TRU radionuclides expected to come to WIPP will be Pu-238 (Ref. 3). Most of this Pu-238 will be from heat source wastes and unless special precautions are taken there will be additional thousands of drums filled with over 100 Ci of Pu-238.

Pu-238 Wastes Stored at Savannah River Plant [a]

Curies of	Number of Drums		
Pu-238	SRP Wastes	LANL Wastes[b]	Mound Wastes
0-86	657	36	
86-172	36	15	[c]
172-258	24	9	
258-344	14	7	
344-430	9	12	
430-516	4	13	
516-602	3	14	
602-688	-	12	
Total Drums	747	118	440
Total Curies	-	49,600	128,000

[a] Source is Appendix B of Reference 22.

[b] 30-gallon drums

[c] Distribution not given. Average for the 55-gallon drums is 290 Ci. There are also 125,000 Ci of Mound Wastes stored in boxes, cans, and tanks at SRP in some cases at >0.5 Ci/ℓ concentrations.

Length of time for a drum to reach explosive concentrations. Using a G value of 1.9 molecule of gas/100 ev ionizing alpha energy absorbed (Ref. 17) and assuming H_2 is 50% of the total gas evolved (Ref. 17), one curie of Pu-238 with a 5.5 Mev/disintegration will produce 0.044 liters H_2/week.

For a 208ℓ drum with a 50% void space, the percentage of the void space filled with hydrogen produced by the radiolysis of 85 Ci Pu-238 each week will be (0.044)(85)(100)/100 = 3.7% H_2/week.

As the following graph shows, a concentration of 6% H_2 could be realized within two weeks if there is no leakage from the drum seals. Data from SRP and LANL indicate that leakage would be expected to occur. According to Zerwekh (Ref. 12), mixtures of 6% or more are explosive. The following calculation indicates the extent. If all 36 drums in a TRUPACT truck shipment had 6% H_2, it would be equivalent to approximately 0.7 pounds of trinitroglycerol. Blasting operations of rock use approximately one pound of this explosive per cubic yard of rock.

<u>Explosive equivalent of hydrogen in one TRUPACT from SRP.</u>

Assumptions.

6 liters of hydrogen gas at STP per drum
36 drums per shipment
Heat of combustion of Trinitroglycerol is 368.4 kcal/gm mole
Heat of formation of hydrogen is 52.09 Kcal/gm mole
Molecular weight of Trinitroglycerol is 227

Calculation.

Number of moles of hydrogen in one TRUPACT from SRP

(6 x 36)/22.4 = 9.7 moles of hydrogen

Energy relased in combustion of 9.7 moles of hydrogen

9.7 x 52.09 = 505 Kcal = 505,000 cal

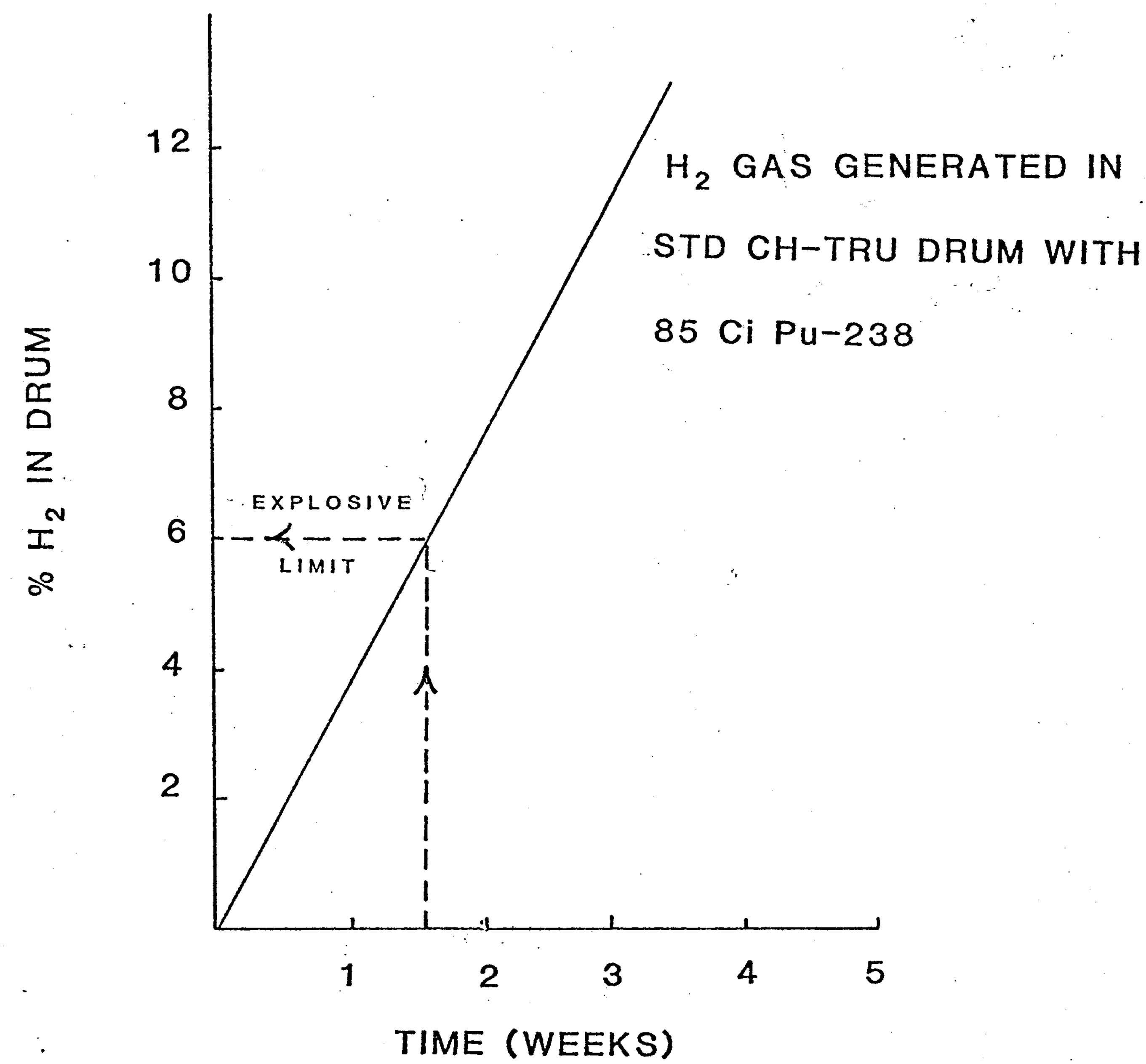
Combustion energy per gram of Trinitroglycerol

368,400/227 = 1621 cal/gm

Equivalence of hydrogen in one TRUPACT from SRP

505,000/1621 = 311 gm = 0.7 lbs.

Energy released in combustion of 9.7 moles of hydrogen equals combustion of 0.7 lbs. of Trinitroglycerol.



H2 GAS GENERATED IN
STD CH-TRU DRUM WITH
85 Ci Pu-238
% H2 IN DRUM
12
10
8
6
4
2
EXPLOSIVE
LIMIT
1
2
3
4
5
TIME (WEEKS)

Length of time for a TRUPACT to reach explosive concentrations. Another estimate that could be made is the time it would take the entire void space of a TRUPACT to develop a 5 % by volume concentration of H_2. The time required depends on the number of curies in the TRUPACT, the G(gas) factor for H_2 and total gas, the void space in drums and in the TRUPACT volume, and the initial H_2 concerntration in the drums. The following tabulation assumes that the drums are vented, sealed and stored for 1-4 weeks before loading in the TRUPACT. The drums are assumed to diffuse gas through their seals so as to maintain one atmsophere of internal pressure. Other assumptions are a G(gas) factor of 2.0 total, and 1.0 for H_2; 70% void space in drums; 13.5 m^3 of TRUPACT void space outside of drums; 140 Ci of alpha radiation per drum; and 36 drums per TRUPACT.

Drum Storage Time-days	H_2 Conc. in Drums, vol %	Final H_2 Conc. in TRUPACT, Vol %	Time in TRUPACT before becoming potentially explosive (days)
7	4.2	5.0	25.0
14	8.0	5.0	18.9
21	11.5	5.0	13.3
28	14.8	5.0	7.9

These assumptions for time of storage after venting and time in the TRUPACT are not unreasonable. Without a special effort it is reasonable to believe that drums would be stored for two to three weeks after venting and before shipping. Time in the TRUPACT could easily run 12-15 days when allowance is made for weekends and several days of outside storage at the WIPP site.

B. Effect on Radionuclide Release in Accidents

A higher curie content in waste containers than assumed in the FEIS has the potential to significantly increase the calculated amounts of radionuclides released in the various transportation, operation, and human intrusion release scenarios presented in the FEIS.

DOE recognized that high-curie content drums would increase the maximum dose that could occur to an off-site individual in the limiting operational

operational accident at the WIPP facility itself. They responded to this by the following actions:

(a) setting a maximum Pu-239 equivalent curie (P-Ci) limit for 55-gallon drums and other containers.
(b) indicating an intent to require that underground waste hauling vehicles have a maximum possible velocity of 20 mph and puncture resistant fuel tanks so that the underground fire accident (which was limiting in the FEIS analysis) could be considered incredible.

The hoist drop accident becomes limiting if the underground fire can be considered as incredible. EEG accepted this change in the limiting accident with the stipulation that speed limited and puncture resistant vehicles would be required underground. Also, on March 18, 1983 EEG agreed with the (169 P-Ci) limit (Ref. 6).

In the same response (Ref. 6), EEG also expressed the opinion that it was equally appropriate to set equivalent curie limits for the hoist, for transportation shipments, and for human intrusion situations. Since DOE has not responded to any of these other considerations they are discussed in more detail below.

Equivalent Curie Limitation on Hoist. DOE stated at a February 15, 1983 meeting with EEG that an equivalent curie limit on the hoist would be needed to insure that the hoist drop accident would not lead to greater doses than the limiting FEIS accident. However, there is no indication that they have set such a limit. The need for a limit is more than theoretical, as indicated by the following discussion.

A maximum limit of 468 P-Ci on the hoist will insure that the hoist drop accident release will not exceed the release assumed in the limiting accident in the FEIS (Ref. 6). This limit is unlikely to be met by random probability, especially for wastes from the Savannah River Plant and Los Alamos National Laboratory.

The average of all CH-TRU at SRP is now estimated to be about 31.7 curies per 55-gallon drum (Ref. 5). The average of the Pu-238 wastes, which comprise about 37% the total at SRP, is reported to be 60 P-Ci/drum (Ref.

11). Present plans are to load 48 drums on the hoist during regular operation. Thus, an average hoist load of SRP wastes would be 1530 Ci (overall) and 2880 Ci (Pu-238 waste only) which is 3.3 and 6.2 times the 468 Ci limit. Maximum loads could be as much as 6720 P-Ci, if all drums were at the maximum limit of 140 P-Ci.

Wastes from LANL average about 8.0 P-Ci per 55-gallon drum (Ref. 3). Thus a 48 drum load on the hoist would contain 385 P-Ci. If the hoist had only one maximally loaded drum and 47 average ones it would exceed the limit by 11%.

Wastes from the other laboratories have average concentrations much lower than SRP and LANL and would be expected to be under the 468 P-Ci hoist limit most of the time. However, without more information on the distribution of waste concentrations in individual packages it's not possible to estimate the frequency with which this equivalent curie limit might be exceeded.

Since SRP and LANL wastes are estimated to be 11.9% and 7.7% of wastes by volume coming to WIPP (Ref. 3), it appears that a 468 P-Ci limit on the hoist would be violated 5 to 15% of the time by random probability unless positive management controls are taken.

It is concluded that the FEIS dose estimates for the limiting operational accident will be exceeded unless a limit is enforced on the equivalent curies that can be placed on the hoist.

Transportation Accidents. If the transportation accident scenario assumptions used in the FEIS are applied to transportation shipments in which the equivalent curie contents are one or two orders of magnitude greater than assumed in the FEIS, then it is apparent that the individual and population doses presented in the FEIS will be increased by a like amount. The Preliminary Transportation Analysis (Ref. 7), although it used slightly different release rates and atmospheric diffusion methodology, did report individual doses 10-100 times greater than in the FEIS (see discussion in Chapter I).

Scenario dose calculations could give even higher numbers than in the PTA, because the Preliminary Transportation Analysis assumed a TRUPACT load of 303 P-Ci. A load of average SRP Pu-238 drums (2880 P-Ci) would contain 9.5 times this amount.

The probabilities of accidents and their severities developed in the PTA are based on route specific (when available) and national transportation accident rates. The assumptions are also made that the wastes are in a relatively stable form and transported in a container system that meets Type B requirements. However, items discussed elsewhere in this report concerning possibly explosive gas generation and subsequent formation of powders in cellulosic waste (Ref. 12) and adequacy of the TRUPACT for large quantity shipments cast doubt upon whether these assumptions are valid. These deficiencies, if they actually exist, would be expected to increase the probability and, perhaps, the quantity of releases from transporation accidents.

The one to two order-of-magnitude increase in calculated radiation doses, compared to the FEIS, raises the question of whether a supplement to the FEIS would be appropriate.

<u>Human Intrusion Scenarios.</u> In EEG's March 18, 1983 letter to DOE (Ref. 6) the following statement was made about human intrusion:

> "The scenarios that estimate doses from drilling through a stack of drums or boxes (FEIS, EEG-15, and Scenario I in TME 3151) all assume a maximal loaded container is encountered. Thus, a raising of the limit would increase the dose. However, decay before intrusion would significantly offset this 10-fold increase since the increases in loading (compared to the FEIS) are primarily due to Pu-238 and Am-241. The TME 3151 Scenario I assumptions applied to a maximal-loaded and 2 average-loaded LANL drums (with typical radionuclide distribution) would bring to the surface about one-fifth of the nuclides permitted by the proposed EPA (40 CFR 191) standard for a reasonably foreseeable release. However, this calculation is sensitive to the assumed radionuclide distribution; a drum containing 200 gm of Pu-239 and 82 Ci of

Am-241 would exceed the proposed standard at 100 years after closing. We believe the maximum Am-241activity (including ingrowth from Pu-241) should be limited to 80 Ci per drum to insure that a borehole through the repository would not result in excess radionuclide quantities being brought to the surface. Also, a loading plan would be necessary in the repository for separating high concentration containers to insure that a single borehole could not strike 2 or 3 high concentration containers."

High Am-241 content containers apparently exist. Appendix M of the PTA (Ref. 7) mentions that at Hanford the waste product resulting from reworking 8-10 year old weapons grade plutonium could have an americium to plutonium weight ratio as high as 10 to 1. This is a radioactivity ratio of about 425 to 1. Also, the equivalent curie calculation considers Am-241 to be only one-third as toxic as the plutonium radioisotopes and a 140 P-Ci limit would allow 420 Ci of Am-241 in a 55 gallon drum.

A recalculation slightly changes the amount of Am-241 that could be in a stack of 3 drums and not exceed the permissible quantity that can be brought to the surface under the proposed EPA High Level and Transuranic Waste Standard (40 CFR 191). The permissible quantity (based on an assumed inventory at time of closing of 3.6×10^6 Ci of alpha emitting TRU) is 77 Ci Am-241 at the time of drilling. Since Am-241 will ingrow from Pu-241 decay the limitation on curies of Am-241 that will be present at the earliest feasible time for inadvertent human intrusion is the appropriate limitation. EEG believes the appropriate minimum time is 100 years after repository closing, hence our request in the Executive Summary of EEG-23 (Ref. 20) for 100 years of post-closure administrative control. If there are no controls over placing of high-curie content drums in the repository, the Am-241 activity should be limited at 100 years after closing to 25 Ci/55-gallon drum.

Gas Generation in the Repository. The DOE has recognized that gas generation from CH-TRU wastes disposed of in WIPP could be a potential post-emplacement problem in the repository. DOE has concluded that an annual gas generation rate of <10 moles/m^3 in the repository disposal rooms would be acceptable and placed a requirement in the Waste Acceptance Criteria (Ref. 21) that limits the concentration of organic material to less than 220 kg/m^3 in 55-gallon drums (46 kg/55-gallon drum) and 100 kg/m^3 in boxes. This analysis, which assumed an average alpha-emitting radioactivity content of only 0.62 Ci/drum, concluded that gas generation from radiolysis was negligible compared to that from organics decomposition.

For high-curie content containers the radiolytic gas generation rate can be substantial. For example, an average concentration of 49 alpha curies per drum would generate 10 moles/m^3 per year if the G(gas) factor (molecules gas/100 ev of deposited energy) was 1.0.

The same drums could be substantial gas generators from both mechanisms since many organic matrices generate much gas by radiolysis. Therefore, it is appropriate to add the gas generation rate that results from organic decomposition to that from radiolysis in a waste storge room.

The appropriate expression for the limiting average concentration of alpha curies and kilograms of organics in all the 55-gallon drums in a repository disposal room would be:

$$C_{average} = \frac{\text{Ci/drum} \times \text{G(gas)}}{(49)} + \frac{\text{kg/drum organics}}{46} \leq 1.0.$$

Gas generation in the repository is yet another situation where problems could arise if high-curie content containers are brought to WIPP without a positive mechanism for mixing them with containers of much lower radionuclide concentration.

IV. ADEQUACY OF TRUPACT CONTAINERS FOR SHIPMENT OF CH-TRU WASTE

The WIPP FEIS indicates that about 6 million cubic feet of CH-TRU waste will be shipped to WIPP in TRUPACT containers holding 42 drums each. A later DOE publication limits the TRUPACT to 36 drums (Ref. 7).

The authorizing legislation for WIPP (PL 96-164) stated that the defense transuranic waste scheduled for emplacement is exempted from regulation by the NRC. Nonetheless, the DOE FEIS stated "The transportation of radioactive waste to the WIPP will comply with the regulations of the U. S. Department of Transportation (DOT) and the corresponding regulations of the U. S. Nuclear Regulatory Commission (NRC)"(Chapter 6, Ref. 2). Additionally, the DOE's internal order for the packaging of fissile material (Ref. 18) states that when offered to the carrier, each shipment of radioactive material shall be in compliance with applicable DOT and NRC regulations, specifically Code of Federal Regulations, Title 10, Part 71.31 through 71.42.

Although DOE has voluntarily agreed to meet the NRC and DOT transportation requirements for these shipments, the design of the TRUPACT may preclude compliance with the double containment provisions of the NRC. If the TRUPACT does not meet the double containment provisions, shipments of Transport Group I Type B materials would be limited to 20 curies of plutonium per shipment, a value considerably less than the average of 143 curies/shipment of fissionable material cited in the FEIS (3.4 curies/drum and 42 drums). The number of shipments to WIPP could increase substantially if the 4 million curies of alpha nuclides were limited to 20 Ci/shipment. To transport the 6 million cubic feet may require more than 200,000 shipments.

The DOE Waste Acceptance Criteria for CH-TRU waste to be shipped to WIPP (Ref. 21) has the following restriction:

> "Explosives and compressed gases. TRU waste shall contain no explosives or compressed gases as defined by 49 CFR 173 Subpart C and G."

Subpart C applies only to materials that are intended to be explosive. The TRU wastes are not intended as explosives. Subpart G applies only to compressed gases whose pressure exceeds 40 psia. The pressure in the drums is not likely to be greater than 2.6 times the atmospheric pressure. Explosive mixtures of hydrogen, oxygen and methane can occur in these drums at pressures considerably less than 40 psia. As a result, it is questionable whether subparts C and G of 49 CFR 173 provide assurance that explosive gases will not be sent to WIPP. The DOE certification compliance requirements (Ref. 21) also do not satisfactorily address this problem of gas formation from high-curie content drums.

The Code of Federal Regulations Title 10 Part 71.42 contains the following NRC regulation:

> "Plutonium in excess of twenty (20) curies per package shall be packaged in a separate inner container placed within outer packaging that meets the requirement of Subpart C for packaging of material in normal form. The separate inner container shall not release plutonium when the entire package is subjected to the normal and accident test conditions specified in Appendices A and B. Solid plutonium in the following forms is exempt from the requirements of this paragraph:
> (1) Reactor fuel elements
> (2) Metal or metal alloy; or
> (3) Other plutonium bearing solids that the Commission determines should be exempt from the requirements of this section."

While the application of this provision to CH-TRU waste is not clear, the preamble to NRC's recent revision to 10 CFR Part 71 (48 FR 35600 et.seq.) includes the following: "The Commission considers it most important that solid form plutonium be doubly contained and that both barriers in the packaging maintain their integrity under normal and accident test condition." Thus, the above regulation suggests that a Type B container within a Type B container would be required for plutonium shipments greater than 20 curies. While the actual testing of the TRUPACT has yet to be performed, the ability of the waste containing drums or boxes (Type A containers) not to open inside the TRUPACT following Type B testing may be difficult to demonstrate. With reference to the three exemptions, NRC stated: "Since the double containment provision compensates for the fact that the plutonium may not be in a "nonrespirable form," solid forms of plutonium that are essentially nonrespirable should be exempted from the double containment requirements." Fuel elements and metals or metal alloys are considered in a nonrespirable form and hence they are exempted. However, exemption (3) may not apply for the CH-TRU waste since one percent by weight of the waste is allowed to be in respirable form (particle size less than 10 microns).

There is also some question on the compliance of the WIPP waste shipments with the NRC and DOT thermal limits for fissile material. The DOE Waste Acceptance Criteria, the DOE FEIS or internal order for the packaging of fissile materials does not establish a thermal limit. The DOT in 49 CFR Part 173.396 (i)(2), Fissile Radioactive Material, provides that for Spec. 6M metal packaging (a container used at INEL according to the FEIS) the radioactive thermal decay energy output shall not exceed 10 watts. Because of this limitation, the Spec. 6M metal packaging is limited to a content of 0.020 kilograms of Pu-238 (348 curies).

Although DOE has not addressed this important problem with EEG, it appears that there are five possible solutions to comply with the NRC and DOT regulations: a) redesign the TRUPACT to assure double containment; b) limit shipments to 20 Ci plutonium; c) NRC could issue new regulations for CH-TRU waste which do not require double containment; or d) DOE could process the waste to remove the high concentrations of Plutonium 238 in many of the packages or to insure that the material is in non-respirable form; e) grant themselves a variance when they self-certify compliance with the NRC and DOT regulations.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

CH-TRU	Contact-handled Transuranic
DOE	U. S. Department of Energy
FEIS	Final Environmental Impact Statement on WIPP
INEL	Idaho National Engineering Laboratory, Idaho Falls, ID
LANL	Los Alamos National Laboratory, Los Alamos, NM
NRC	U. S. Nulcear Regulatory Commission
P-Ci	Plutonium-239 Equivalent curies
PTA	DOE Preliminary Transportation Analyses Report
RFP	Rocky Flats Plant, Golden, CO
RH	Remote-handled
SAND	Sandia National Laboratory, Albuquerque, NM
SAR	Safety Assessment Report
SRP	Savannah River Plant, Aiken, SC
TRU	Transuranic waste
WIPP	Waste Isolation Pilot Plant near Carlsbad, NM

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The following page, explaining the method of calculating the Pu-239 equivalent TRU activity, was reproduced from the Preliminary Transportation Analysis (Reference 7).

APPENDIX A

Pu-239 EQUIVALENT TRU ACTIVITY

The maximum Pu-239 equivalent TRU activity limit (AM) for 55-gallon drums is 140 P-Ci.

The Pu-239 equivalent correction factor is based on the maximum permissible concentration (mpc) from 10CFR20,[25] Appendix B, Table 1, Column 1 for limiting form.

The activity (AM) can be characterized by:

$$AM = \sum_{i=1}^{K} \frac{A_i}{CF_i}$$

where there are K TRU isotopes, A_i is the maximum activity of isotope i, and CF_i is an mpc correction factor for isotope i obtained by multiplying the mpc specified above by 5×10^{11} ml/μCi to normalize the factor relative to Pu-239.

The correction factors used in these analyses are:

Isotope	Correction Factor (CF_i)
U-233	250
Pu-238	1
Pu-239	1
Pu-240	1
Pu-241	45
Pu-242	1
Am-241	3
Am-243	3
Cm-244	4.5
Cf-252	3

Values of the maximum permissible concentration (mpc) are currently under review by the Nuclear Regulatory Commission (NRC) in their revision of 10CFR20[25]. It is recognized that the correction factors (CF) listed are not consistent with the dose conversion factors used in the analysis. It is expected that the CF values for U-233, Am-241, Am-243, Cm-244, and Cf-252 may be reduced when 10CFR20 is revised, and the value for Pu-241 may increase. However, the impact of the activity assumed to be present in this analysis will remain unchanged by the revision, but the allowed contents of a container may increase or decrease for various isotopes. To allow a preliminary assessment of these potential changes, Table A-1 provides a summary of CF values based on other data sets. The data sets include the dose conversion factors used in this analysis[26], which it is considered will produce correction factors similar to the mpc's expected in the NRC's revision of 10CFR20.