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Development and Implementation of Attractiveness Level E Criteria and the Plutonium Disposition Methodology

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by

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ABSTRACT

Historically, the Department of Energy used the Economic Discard Limits (EDLs), those Special Nuclear material (SNM) concentrations in residue matrices below which production of new SNM was more economic than SNM recovery, as a basis for discard decisions. In 1994, a joint team from DOE Defense Programs (DP) and Environmental Management (EM) determined that the EDLs were no longer a valid discriminator and directed that SNM disposition consider instead 12 specific criteria, foremost of which are waste minimization, environmental impacts, safety, proliferation concerns, and cost. In response, the Los Alamos National Laboratory developed a technical basis for determining SNM-bearing materials unattractive for proliferation purposes and a quantitative method for predicting materials disposition consequences as a basis for decision-making called the Plutonium Disposition Methodology.

Introduction

A mechanism for discriminating between low-grade special nuclear material- (SNM) bearing materials (residue and scrap) requiring SNM recovery (separation) and materials of *di minimis* SNM concentrations appropriate for discard as waste is an imperative for operational nuclear facilities, for several reasons.[1] From an operational perspective, such a benchmark is necessary because an operational facility must discard low-grade materials or quickly become glutted and have to shut down for lack of storage space. From a legal perspective, there must be a dividing line between low-grade materials governed as SNM by the Atomic Energy Act and discardable waste subject to the Solid Waste Disposal Act (SWDA), and potentially the Resource Conservation and Recovery Act (RCRA). And from the perspective of national security and international agreements, the point where proliferation and terrorist/sabotage risks are sufficiently reduced must be identified to allow termination of safeguards and discard to a waste management regime and eventual geologic isolation. For nuclear facilities under the purview of the Department of Energy (DOE) Albuquerque Operations Office (ALO), these three necessities converge in the Plutonium Disposition Methodology (PDM).

Background

Historically, the DOE used the economic discard limits (EDLs), those SNM concentrations in residue matrices below which production of new SNM was more economical than SNM recovery, as a basis for discard decisions.[1] However, in 1994 a joint team from DOE Defense Programs (DP) and Environmental Management (EM) determined that the EDL was no longer a valid discriminator because plutonium production had been terminated. DP then canceled the EDL methodology and directed that SNM disposition follow these 12 criteria: worker safety, minimizing environmental impact, waste minimization, proliferation potential, costs, disposal technical criteria, risk assessment, interim storage, implementation time/feasibility, technical risk, regulatory concerns, and stakeholder interest.[2] In 1995, the ALO issued the PDM as guidance for all facilities under its direction for developing detailed implementing procedures for the 12 DP/EM criteria.[3]

Because the Los Alamos National Laboratory (LANL) has the nation's only full-scale operational plutonium facility (TA-55) and because the Laboratory's national security mission of stockpile

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[1] Special Nuclear Material, as defined in Section 51 of the Atomic Energy Act of 1954, Public Law 83-703, as amended. SNM currently includes Pu-238 through Pu-242 and uranium enriched with U-233 or U-235.

maintenance required a disposition mechanism, the Nuclear Materials Technology Division took the lead in developing a quantitative implementing methodology.

Concurrent with these evolutions in the direction of SNM disposition, certain watershed events were occurring in the arena of international and domestic safeguards. In 1990, the International Atomic Energy Agency (IAEA) issued recommendations for safeguards termination criteria.[2][4, 5] Safeguards termination in the domestic sense means removal of low-grade materials from the strict regime of accountability and protection required for SNM [6] and transfer to the controls and protection required for radioactive waste management.[7] The controls applied to radioactive waste are required to meet international agreements on radioactive material protection [8], but are less rigorous than those required for SNM. Because it was apparent that EDLs did not explicitly consider safeguards concerns, the DOE Office of Safeguards and Security (NN-51) issued an across-the-board policy for safeguards termination (0.1 weight percent [wt•%] SNM for all matrices).[9] The constraints of this very conservative guidance to disposition of legacy residue inventories were recognized by the Laboratory in 1993.[10] Pursuant to ongoing developments in the measured discards arena, NN-51 subsequently issued two draft criteria in an effort to develop a graded scale for safeguards termination related to the attractiveness of materials for proliferation purposes.[11]

LANL recognized early-on that a ceiling beneath which proliferation concerns (1 of the 12 DP/EM criteria) were minimized was essential to allow quantitative disposition of SNM-bearing materials. In response to the NN-51 drafts, LANL plutonium chemists developed a technical rationale for termination of safeguards equating attractiveness for proliferation purposes to degree of difficulty of SNM recovery.[12]

With some minor modifications, NN-51 adopted the LANL recommendations and issued them as expanded Attractiveness Level E policy in 1996.[13] Under this policy, safeguards may be terminated on Attractiveness Level E materials having SNM weight percent concentrations below ceilings established for groups of materials of similar recoverability characteristics, provided they are discarded to a waste management regime requiring physical protection equivalent to that mandated by international agreements. In other words, the Attractiveness Level E criteria are ceilings below which discard decisions can be made in consideration of the other applicable PDM criteria.

Implications of Safeguards Termination

The old EDLs for recoverable residues leveraged the cost of plutonium recovery against the cost of production of new plutonium (but excluded waste management costs from consideration). Those economics frequently produced a limit that allowed discard of the bulk of residuals (heel) from first-pass recovery processing, including the somewhat richer heels resulting from recovery process upsets.

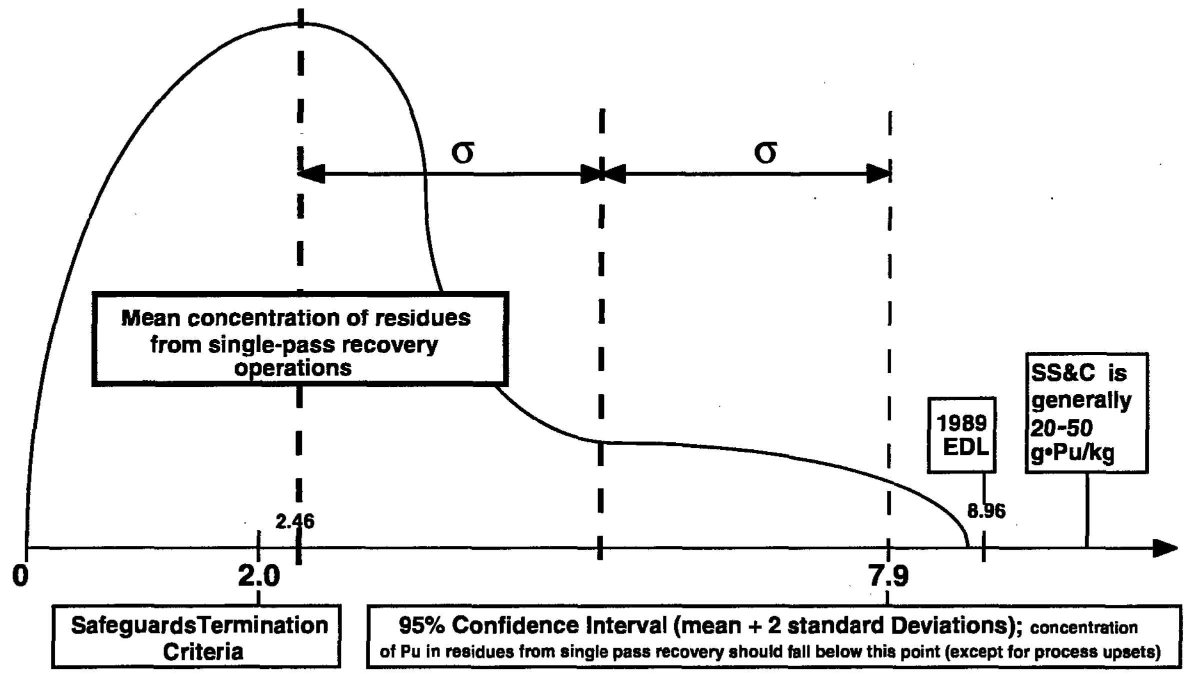
The ceilings for termination of safeguards on recoverable residue matrices under NN-51's Attractiveness Level E criteria (criteria which must be satisfied as part of a discard decision in accordance with DOE/ALO direction through the PDM) were established to approximate mean concentrations of plutonium in heel from single contact recovery. The objective was to establish a plutonium concentration benchmark where residues could be considered unattractive for recovery for proliferation or radiological sabotage purposes. Because plutonium recovery from heel at or below this benchmark has diminishing returns,[3] the mean concentration in heel from first-pass recovery is

[2] The IAEA recommendations, and policy published subsequently [5], have to date applied primarily to nonweapons states; IAEA safeguards will be applied to select inventories of DOE excess fissile materials under several U.S. offerings that are being consolidated as part of the Trilateral Agreement.

[3] Recovery efficiency is reduced for secondary and tertiary dissolution efforts in all matrices, and most of the recoverable plutonium is normally extracted on the initial pass. For example, if ash is recovered at a typical first-pass efficiency of 85%, and second- pass efficiency is only about 55%, and third-pass efficiency is reduced to 30%, only about 10% of the initial actinide loading can be extracted from such materials in the secondary and tertiary passes, as compared with 85% in the initial recovery effort: {[(1-0.85)]0.55] + [(1- 0.85)0.45].30 = 0.103}.

considered an appropriate quantitative ceiling for unattractive material. To put the practical application of this rationale in perspective, the Attractiveness Level E criteria for plutonium-bearing incinerator ash is 2.0 wt•%. At ≤2.0 wt•%, a proliferator would have to divert and process 968–4500 kg•ash to obtain a goal quantity of plutonium (bounding estimates).[4] When packaged at the maximum allowable drum loading for disposal at the Waste Isolation Pilot Plant (WIPP) of about 167 g•Pu per drum (167 g•Pu + 2 x 10% assay error = 200 g•Pu/drum), this equates to 116–540 drums of transuranic (TRU) waste. Unobserved diversion/processing on this scale is clearly unrealistic, and therefore such material would be unattractive for proliferation or sabotage purposes.

It is worthy of note that for recoverable residues, the Attractiveness Level E ceiling may differ significantly from the EDL. Where recovery processes were highly automated and operated in a production-like sequence, the EDL was generally lower than the mean plutonium concentration in single-pass recovery heel; where batch recovery was the norm, the EDL was generally higher than the mean for single-pass recovery heel. The typical relationship of plutonium distribution in heel from single-pass recovery, EDL, and Attractiveness Level E criteria for a batch process is depicted below for sand, slag, and crucible (SS&C) residues.



Distribution of Pu (g•Pu/kg) in Residues (Heel) from Single-pass Recovery of SS&C

In the U.S. termination of domestic safeguards has subtle, but very important, legal implications. Under the mandate of the Atomic Energy Act, SNM must be protected against diversion to unauthorized purposes (i.e., safeguarded). Only when it is determined sufficiently unattractive for proliferation purposes can it be discarded to a waste management regimen. Consequently, safeguards termination criteria represent a ceiling below which discard decisions can be made in consideration of the other 11 criteria established by DP/EM, as previously mentioned.

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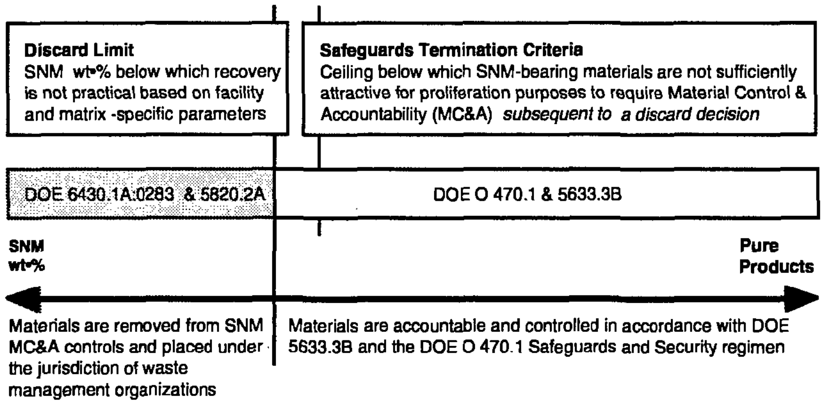
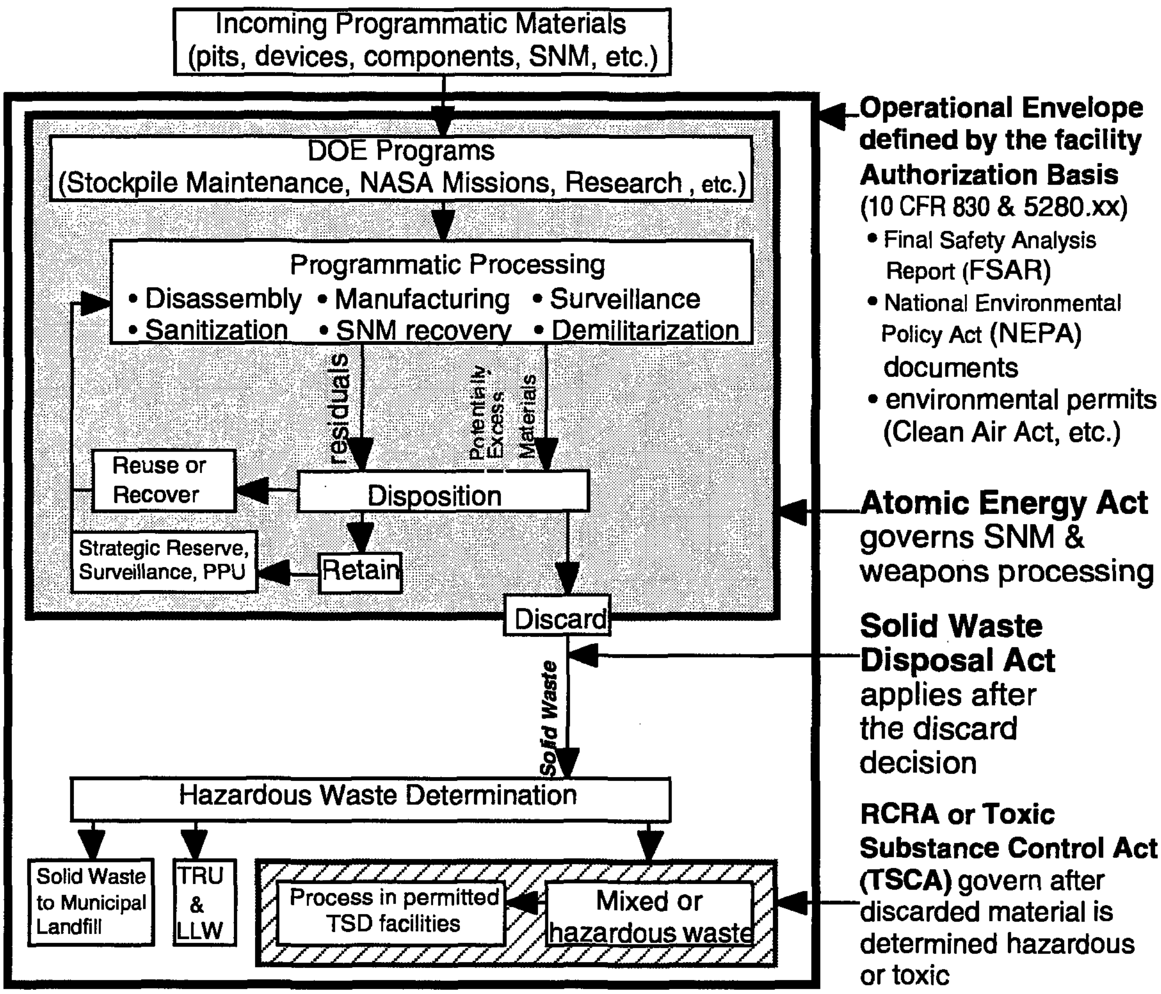
[4] The first estimate above assumes all ash <2.0 wt•% Pu is refractory heel: [(9 kg•Pu) = (4500 kg•ash) (0.02 kg•Pu/kg•ash)(0.10 recovery efficiency)]. The second estimate assumes virgin ash and heel distributed as in the Rocky Flats inventory (30% <2.0 wt•% and 70% >2.0 wt•%) and that recovery efficiency for the heel is reduced to 30%: (9 kg•Pu) = {[0.30(0.02 kg•Pu/kg•ash)(0.7X kg•ash] + [0.85(0.02 kg•Pu/kg•ash)(0.3X kg•ash]}; X = 968 kg•ash. Note that the 2.0 wt•% ceiling applies to high-fired incinerator ash; NN-51 has not yet issued criteria for low-fired ash.[16]



Consequently, as long as material is considered attractive for proliferation purposes, it cannot be discarded and is regulated by the Atomic Energy Act. Once such materials are determined discardable, they meet the definition of solid waste and become subject to applicable environmental laws such as SWDA and, potentially, RCRA.



It is worthy of note at this juncture that significant differences in the objective and rationale exist between the NN-51 Attractiveness Level E criteria and the DOE Material Disposition (MD) Program's "spent fuel standard." The Attractiveness Level E criteria apply to materials containing only *di minimis* concentrations of SNM, while the spent fuel standard applies to "direct use" material.[5] The objective of Attractiveness Level E criteria is to insure that waste is unattractive for proliferation or terrorist (sabotage) purposes and the hypothetical (conceptual) threats are terrorist or subnational groups. The objective of the spent fuel standard is to insure that excess weapons parts and plutonium metal/oxide are as unattractive as worldwide inventories of spent nuclear fuel and the conceptual threat is the host nation (In other words, the objective is to render the materials irreversible in terms of weapons use by the U.S. government). The end result of the Attractiveness Level E criteria is about 0.17 kg•Pu per 208 L drum (requiring diversion of a minimum of 54 drums, assuming 100% recovery efficiency, to accumulate a goal quantity). The end result under the spent fuel standard is a canister containing as much as 55 kg•Pu (6 goal quantities).[6]

NN-51 Attractiveness Level E Criteria vs. MD Performance Objectives			
Parameter	**NN-51 Criteria**	**MD Program[7]**	
Starting material	Low-grade plutonium-bearing materials	Direct-use metal and oxide	
Weight percent plutonium in final form	Range <0.1–<5.0[8]	10–13	
Inventory	Discrete EM legacy inventories[9] and DP operational discards	50 MT excess weapons materials	
Safeguards termination Rationale	Degree of difficulty of recovery	Spent fuel standard (radiation barrier required until geologic isolation)	
Storage duration	Repository emplacement starts May '98	30 years	
Storage security	Physical protection	Stored weapons standard[10]	
Threat	Terrorist or subnational group	Terrorist/subnational group and host nation	
Final form objective	Transuranic waste (unattractive for proliferation purposes)	Irreversibility in terms of weapons use	
Repository	WIPP	MRS until disposal at Yucca Mt.[11]	
Repository safeguards	None	International monitoring	
Diversion Logistics	Glass/cement TRU waste drum	Can[12]	Can-in-canister
kg•Pu/item	0.17	2.56	51.2
kg•net/item	248	28	2200
kg•net/SQ[13]	11 900	87	344
Items/SQ	48	3.1	6.4 SQs per canister

[5] *Direct use* materials are those that can be directly applied to weapons manufacture without chemical extraction/purification. Basically, this means SNM metal, oxide, compounds, and solutions.

[6] A *goal quantity* is the minimum theoretical objective for proliferation purposes.

[7] Analysis based on design parameters described in "Proliferation Vulnerability Red Team Report," Sandia National Laboratory, 1996.

[8] Safeguards termination ceilings on a sliding scale from 0.1–2.0 wt•% for contaminated (non-immobilized) materials and 5 wt•% for microencapsulated materials (cement, glass, ceramic, etc.)

[9] <1 metric ton (MT) for any individual matrix.

[10] Safeguarded Secured Vault storage (Stored Weapons Standard) required until Spent Fuel Standard applied; reduced safeguards regimen similar to 10 CFR 73 after Spent Fuel Standard is implemented; international monitoring of all phases including geologic isolation.

[11] Monitored Retrievable Storage (MRS).

[12] Mass quantities and threat scenarios for can-in-canister derived from Proliferation Vulnerability Red Team Report.

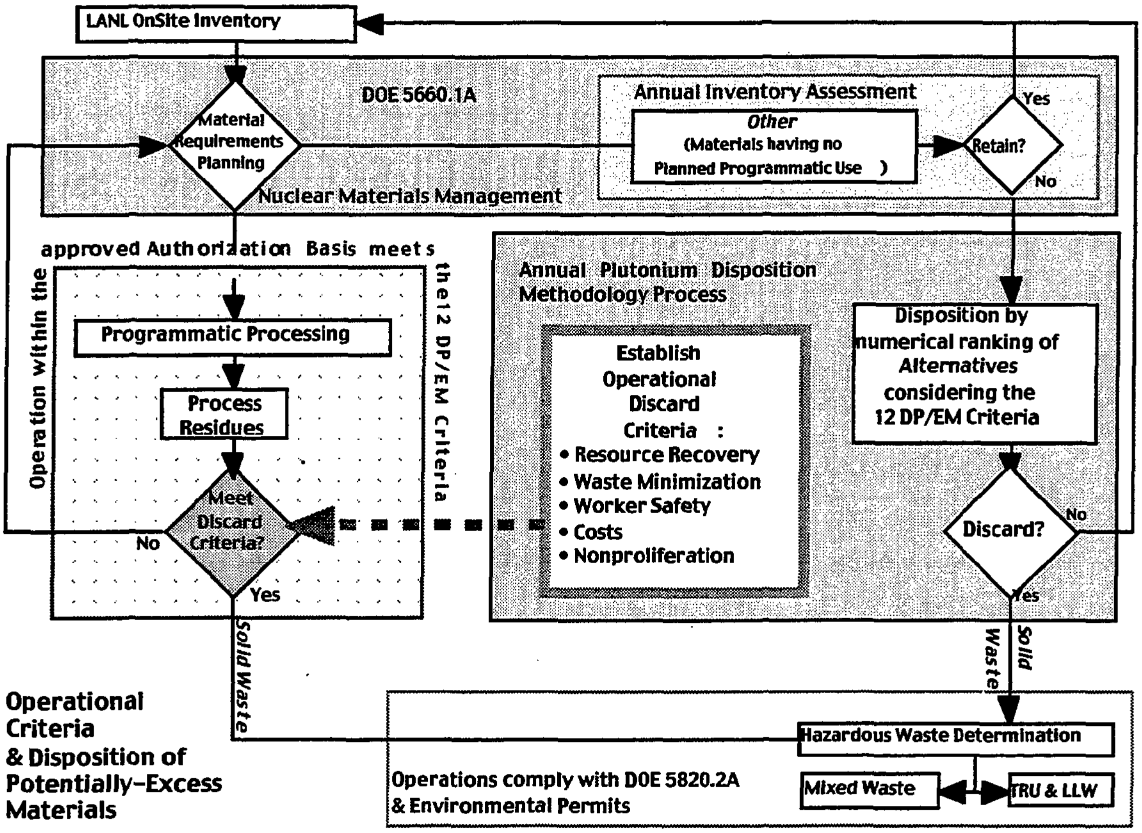
[13] 8 kg•Pu significant quantity (SQ) per IAEA policies.

Application of the Plutonium Disposition Methodology
The PDM is intended to be implemented in conjunction with ongoing inventory assessments and programmatic planning. One obvious application is to disposition materials that are subject to the Defense Nuclear Facilities Safety board (DNFSB) Recommendation 94-1 such that stabilization campaigns are designed to minimize waste, personnel exposure to ionizing radiation, and overall costs.

DOE Order 5660.1A [14] requires an annual assessment of SNM inventories and forecast of intended future use. This is a complicated process at an operable facility with numerous and varied missions, particularly because plutonium is not static where recovery, production, and fabrication are occurring simultaneously, and in a world where DP, EM, and MD plutonium cannot intermix or change ownership. Essentially, each gram of SNM must be classified by project and as to whether it is dedicated to Strategic Reserve, treaty obligation set asides, programmatic use, planned programmatic use, or excess to programmatic needs. Material that is potential excess to programmatic needs is the inventory subject to the PDM.

Consequently, the PDM is used to select processing end states for materials that were historically accumulated until inventory quantities reached volumes that provided for economic recovery campaigns (economic in relation to production of new plutonium per the old EDL rationale). DOE's direction is that the PDM be implemented annually to insure that residues are not allowed to languish in inventory as historically occurred at some weapons facilities. It should not be surprising, considering the suitability of the analysis mechanism, that the Laboratory has applied the PDM to facilitate processing of legacy residues as scheduled under DNFSB Recommendation 94-1. TA-55 is the only facility in the DOE Complex that has successfully met DNFSB Recommendation 94-1 schedules and objectives; several metric tons of residues have been processed and converted to plutonium oxide packaged for long-term storage in the last two years. With the development of the PDM, the Laboratory has been able to accomplish this while simultaneously insuring that the approach minimizes waste, personnel exposure, and costs.

A secondary function of the PDM is to establish discard limits for residues arising through ongoing programmatic processing such that these materials are "automatically" dispositioned in a way that minimizes proliferation risks, waste, personnel exposure, and costs. Thus far, discard limits have been established for graphite, SS&C, and hydroxide cake.[15] The evaluations supporting these discard limits, as well as a recent evaluation of low-fired incinerator ash [16], all validate the NN-51 Attractiveness Level E criteria. Consequently, the Laboratory is considering simply establishing the Attractiveness Level E criteria across-the-board as discard limits until limits for individual residue matrices can be refined using the PDM evaluation technique. It is important to understand that this function (discard limit development) of the PDM is very important to facilities managing SNM inventories because facilities must be able to discard waste in order to remain operable. The overall inventory evaluation strategy is depicted below.

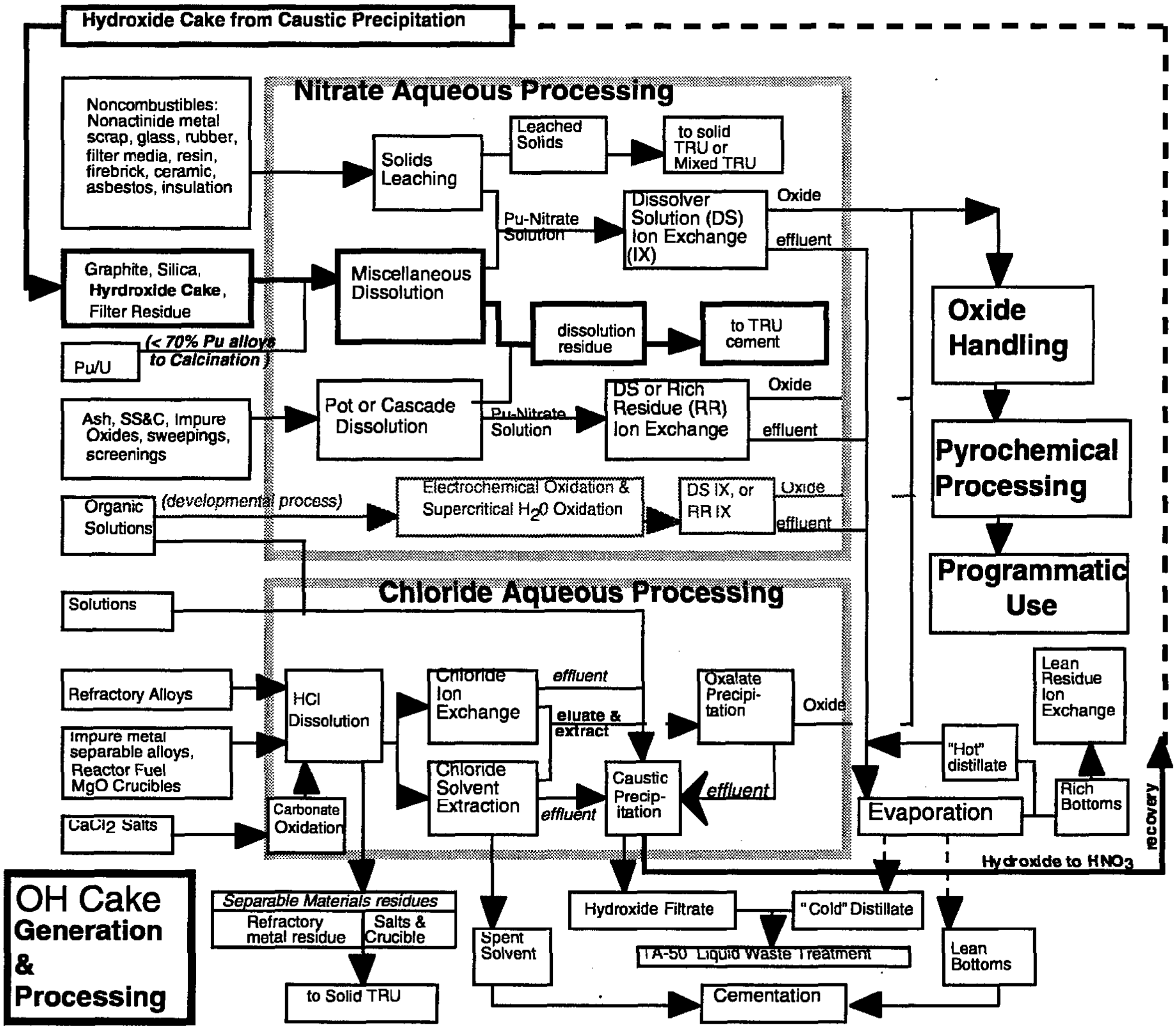


Operational Criteria & Disposition of Potentially-Excess Materials

Implementation of the Plutonium Disposition Methodology

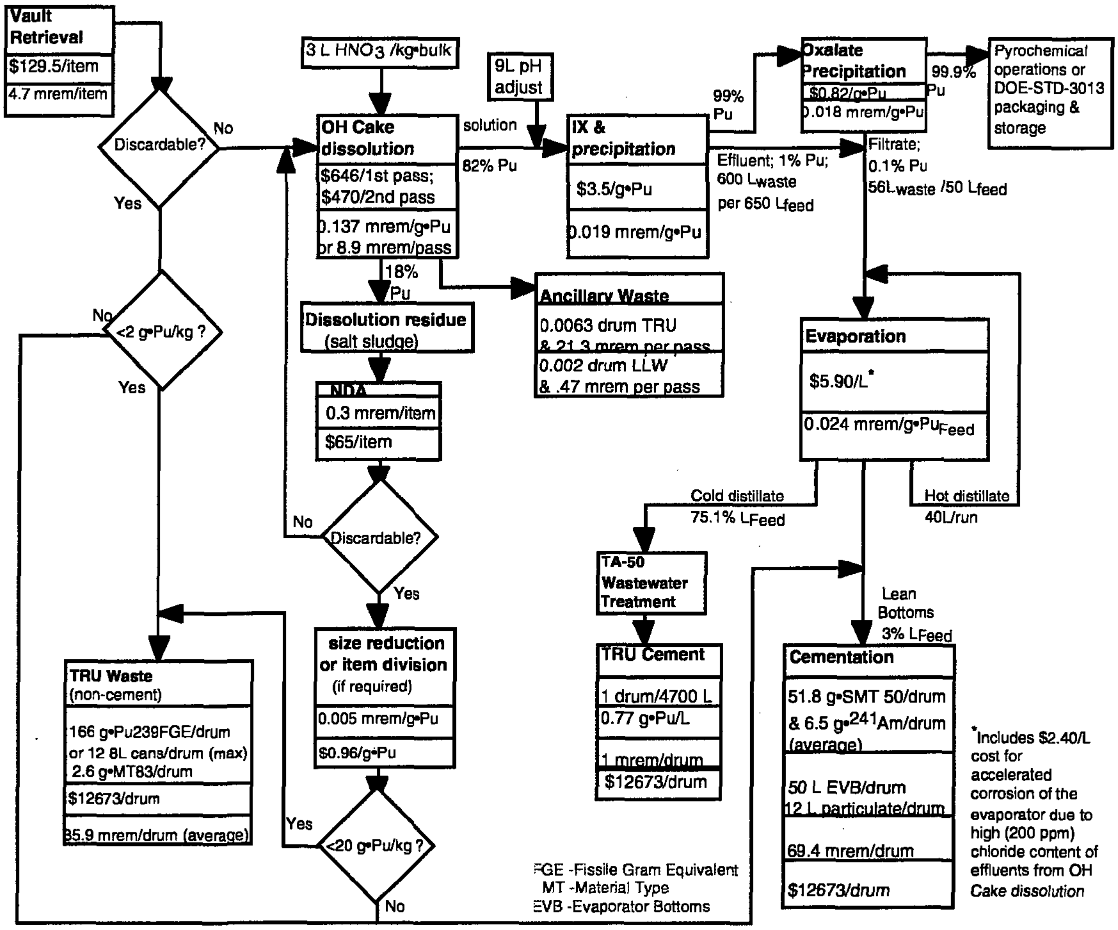
With the safeguards termination ceiling established, the Laboratory turned to the business of satisfying the remaining 11 disposition criteria. For an operable facility maintaining valid nuclear safety and environmental authorization bases, it becomes clear that the PDM criteria affected by disposition decisions are those that are direct consequences of the amount of processing required to implement a disposition decision: waste generation rates, personnel exposure, amount of SNM recovered for programmatic purposes,[14] and costs. These consequences can be quantitatively predicted by careful analysis of facility processing, especially in a facility like TA-55 where plutonium processing for all residue matrices is very well understood. A conceptual model of the TA-55 aqueous chloride and nitrate recovery process is depicted below, with particular emphasis on the generation and processing of hydroxide cake residues.

[14] Plutonium use in national security missions, National Aeronautic and Space Administration (NASA) missions, or MD Program mixed oxide (MOX) fuel or can-in-canister applications are all considered "programmatic purposes."



To complement historical knowledge of processing efficiencies, the Nuclear Materials Technology Division also performed a comprehensive health physics study of all plutonium recovery and waste management processes and developed corresponding dose models that were validated using empirical data such as personnel dose records and radiation field measurements.[17] Extensive Laboratory studies of waste processing costs were also factored into PDM analyses.
This cumulative information allows the Nuclear Materials Technology Division to predict the consequences of proposed dispositions for residue inventories as a function of required throughput. Furthermore, this ability also allows TA-55 to analyze inventories considering salient factors such as selection of ideal discard limits below the Attractiveness Level E criteria, distribution of plutonium and americium (or other higher specific activity isotopes) within residue inventories, and immobilization of leaner materials as an alternative to SNM recovery (Attractiveness Level E criteria are higher for immobilized matrices than for unconditioned materials) to identify disposition options that concurrently minimize waste, exposure, and costs while expediting processing.

The following process flow sheet was developed to facilitate the quantitative modeling of disposition alternatives for legacy inventories of hydroxide cake residues.



Hydroxide Cake Processing Parameters

Once recovery and waste management process operations are so quantified in terms of waste generation rates, personnel exposure, and costs, it is possible to examine alternatives for disposition considering other salient inventory characteristics. The inventory can be analyzed in terms of plutonium distribution to determine where the bulk of the plutonium residues is and how options such as "high-grading" (focusing on recovery of the richest residues) influence processing consequences. And, options such as blending richer and leaner residue to achieve overall concentrations below Attractiveness Level E criteria, can easily be evaluated.

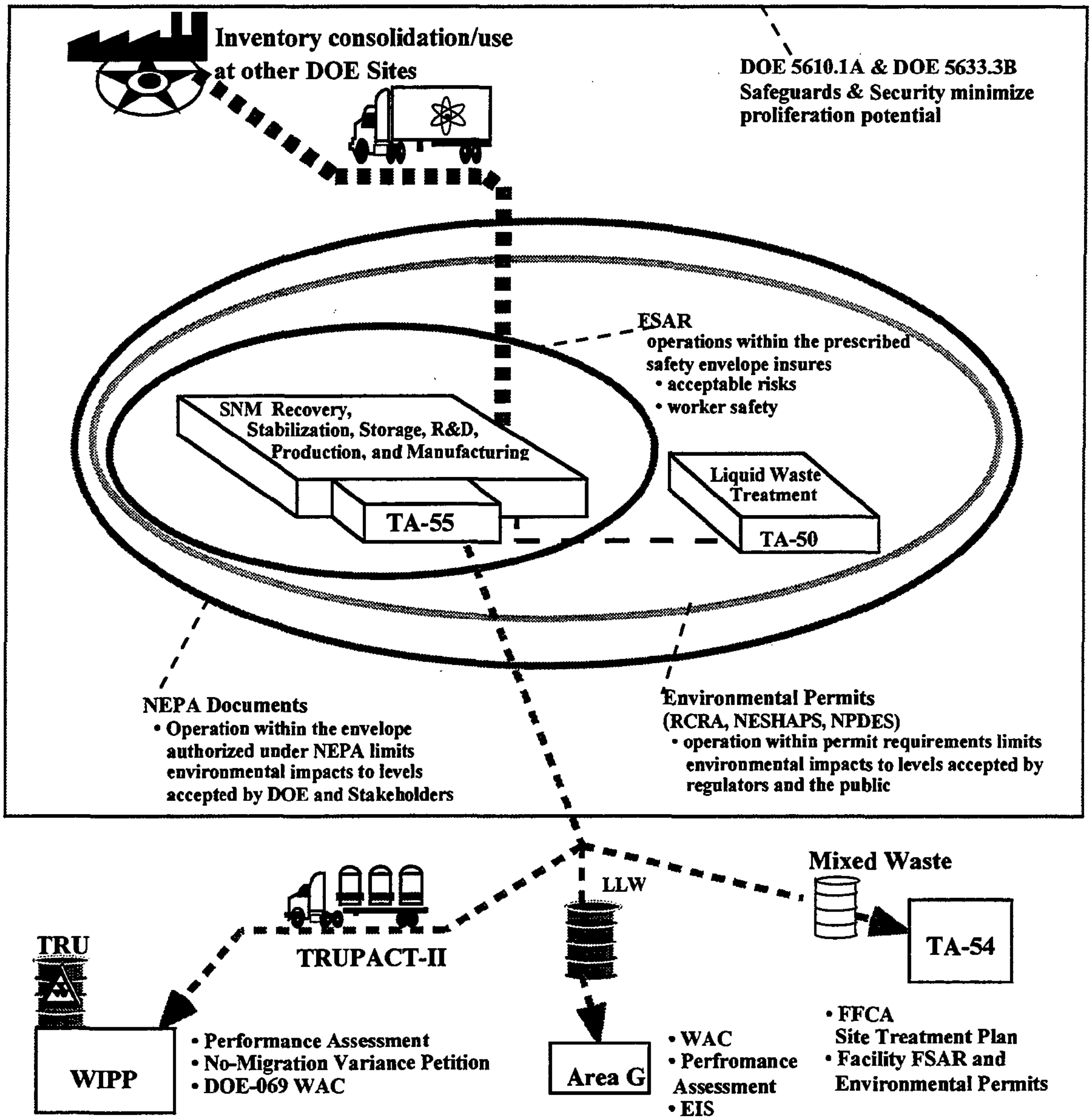
The following table has been extracted from a comprehensive analysis of the TA-55 legacy hydroxide cake inventory (Note that this table does not reflect other analyses performed on hydroxide cake containing actinides of higher specific activity that were dispositioned differently to minimize personnel exposure). What this table shows is that there was a clear benchmark in terms of plutonium concentration where discard below the benchmark and recovery above the benchmark minimized waste, personnel exposure, and costs.[15]

[15] Note that this analysis also determined which residues (heel) were recovered to below the Attractiveness Level E criteria for unconditioned hydroxide cake (0.2 wt•% Pu) and which residues were discarded to cementation (<5.0 wt•%). The table above does not allow for reporting that level of detail.

Analysis of Waste Management and Recovery Costs and Personnel Exposures for Alternatives Under Consideration									
Candidate Discard Criteria (g•Pu/kg)	g•Pu Recovered	g•Pu Discarded	Drums TRU Waste Generated	Waste Cost ($K)	Recovery Cost ($K)	Total Cost ($K)	Dose from Waste Management (mrem)	Dose from Recovery (mrem)	Total Dose (rem)
2	6247.2	268.8	34.0	437.5	282.3	719.8	1795.0	2045.9	3.8
10	6152.5	363.5	32.7	420.3	189.2	609.5	1704.4	1929.6	3.6
20	4149.3	2366.7	23.2	296.0	130.7	426.7	963.4	1744.3	2.7
25	3482.0	3034.0	21.6	274.8	76.6	351.3	1223.2	1471.7	2.7
35	2928.6	3587.4	35.4	449.8	66.0	515.8	1465.0	1363.3	2.8
100	860.9	5655.1	51.0	646.7	20.7	667.4	2461.1	905.5	3.4
All	0	6516	55.2	699.6	4.1	703.6	2731.7	459.1	3.2

It should be apparent that the quantitative consequence modeling described above only directly considers 5 of the 12 DP/EM criteria for disposition decisions: waste minimization (and consequently, environmental impacts), personnel safety, costs, and proliferation concerns. The rationale for emphasizing these criteria in decision-making at TA-55 is that, for operable facilities with a viable safety and environmental authorization basis, the other criteria are already satisfied as long as operations remain within the approved safety envelope. In other words, for a facility like TA-55 that operates using demonstrated technologies,[16] under an approved FSAR, environmental and waste permits, and NEPA documentation, and is approved to certify waste for disposal at WIPP, criteria like "disposal technical criteria, risk assessment, technical risk, regulatory concerns, stakeholder interests, and environmental impacts" are already satisfied by virtue of the established authorization bases. And as TA-55 has made very substantial progress in eliminating legacy residue inventories in response to DNFSB Recommendation 94-1, including packaging of recovered oxide in accordance with DOE-STD-3013-94, there is some measure of confidence that the PDM criteria of "storage concerns and implementation time/feasibility" can be satisfied in implementation of selected dispositions. This rationale is depicted below.

[16] Actually, TA-55 is in the business of developing, demonstrating, and deploying new nuclear processing technologies.



Operations Within Authorization Bases Insures Consideration of Environment, Health, and Safety Criteria

EIS -Environmental Impact Statement
FFCA -Federal Facilities Compliance Act
NESHAPS -National Emissions Standards for Hazardous Air Pollutants
NPDES -National Pollutant Discharge Elimination System
WAC -Waste Acceptance Criteria

The aforementioned rationale for satisfying the balance of the DP/EM criteria through a viable authorization basis not withstanding, the Nuclear Materials Technology Division also employs a numerical ranking system for all of the DP/EM criteria as a basis for selecting between alternatives with negligible differences in quantitative consequences. The implementation of this numerical ranking system is discussed in detail in plutonium disposition analyses published by the Laboratory.[15]

Lessons Learned from Plutonium Disposition Methodology Implementation

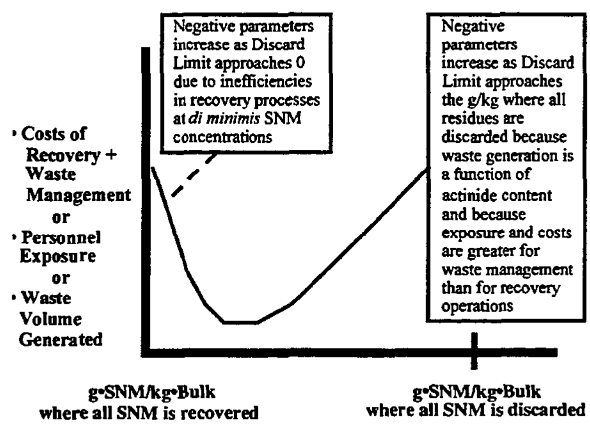
There are several valuable insights that are direct outputs from implementation of the PDM at TA-55.

First, during the last decade, the prevalent misconception that plutonium recovery from residues involved generation of untoward volumes of secondary waste was the basis for discounting recovery as a viable solution for inventory problems throughout the Complex. The DOE EM Program certainly adopted this viewpoint when the Rocky Flats residues were accepted from DP to "...be managed with the sole intent of meeting waste disposal criteria and with no regard for material recovery."[18] However, rigorous analyses of TA-55 recovery processes under the PDM have demonstrated that this simply is not the case. On the contrary, consequence modeling for processing of graphite, SS&C, hydroxide cake, and pyrochemical salt residues reveals that recovery options afford 25–40-fold reductions in waste generation, as opposed to direct disposal options. This, in fact, should be intuitively obvious when considering that the WIPP Waste Acceptance Criteria and TRUPACT-II limits drive waste quantities by means of actinide limits (criticality and decay heat limits). For example, if one examines the pyrochemical salt inventory at Rocky Flats, which contains about 1 metric ton of plutonium, it is easy to see that the salts would comprise at least 6000 drums if directly disposed, assuming 167 g•Pu/drum to account for a 10% assay error. If 95% of the plutonium is recovered,[17] the remaining 5% would only amount to about 300 drums (actually, much less because salt recovery efficiencies approach 99.5%). This amounts to a clear 20-fold reduction in waste.

And as waste is reduced by SNM recovery, so are costs. The waste component of any plutonium recovery process is the clear economic driver. Cost estimates for TRU waste management range from $7 K to $12.6 K per drum in documents published by various organizations throughout the DOE Complex.[19, 20] Using the minimum estimate of $7 K/drum, the cost of managing waste for direct disposal of the Rocky Flats salts would be $42 million, compared with the cost of managing waste where the plutonium is recovered, which would be only $2.1 million, another 20-fold reduction.

And as waste and costs are reduced by SNM recovery, so is personnel exposure. Health physics studies at TA-55 clearly show waste management as the largest source of dose in plutonium processing, again confirming intuitive observations. The reasons are simple. Waste packaging involves the most hands-on work. In contrast, most of the exposure in recovery processes is to the hardware. When plutonium in residues is consolidated as an oxide instead of being processed as waste in numerous packages of less-concentrated materials, overall personnel exposure is minimized.

However, there is a point (a *di minimis* plutonium concentration) where recovery is no longer practical and below which costs, waste, and exposure begin to increase. The quantitative analyses of the PDM make it possible to identify this point, and consequently make intelligent disposition decisions. This point is numerically clear in the table above and conceptually clear in the adjacent illustration. It is our responsibility as stewards of the environment, taxpayer dollars, and the health of fellow workers, to find the appropriate minimum consequence disposition for plutonium-bearing materials.



[17] For the purposes of this analysis, secondary waste is ignored; secondary waste for salt dissolution or distillation is negligible (0.002 drums TRU per 3.5 kg•bulk recovered).

A second lesson learned from PDM analyses is that the conceptual basis for the Attractiveness Level E criteria (the mean concentration of plutonium in heel from single-contact recovery) is an appropriate operational discard limit from a waste, personnel exposure, and cost perspective. While dispositions for the larger legacy inventories under the PDM have optimized recovery processing consequences through intelligent construction of recovery processing campaigns to account for inventory characteristics and application of immobilization technologies, they have also confirmed that consideration of the Attractiveness Level E ceilings minimize the integrated processing consequences of waste, personnel exposure, and cost for operational discards (SNM-bearing materials arising from ongoing programmatic operations).

Finally, the Laboratory's quantitative approach to implementation of the PDM has been accepted by both the DOE and the New Mexico Environment Department. This means that for TA-55 there are no jeopardies related to the application of RCRA to residues and no questions as to what processes require permitting under RCRA. The rationale described herein for distinguishing between product for recovery and waste for disposal has been accepted as, not only valid, but in the best interest of the nation, the State of New Mexico, the environment, and Laboratory workers.

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