

80543

ROCKY FLATS PLANT
LOW-LEVEL MIXED WASTE PLAN

November 29, 1989

ROCKWELL INTERNATIONAL
AEROSPACE OPERATIONS
ROCKY FLATS PLANT
P.O. BOX 464
GOLDEN, CO 80402-0464

"REVIEWED FOR CLASSIFICATION"
By A J Keller (U)
Date 11/29/89

ADMIN RECORD

A-SW-001474

ACKNOWLEDGMENT

This plan was prepared by WASTREN, Inc., in conjunction with Rockwell International personnel from the Waste Operations and Process Technology Development organizations from the Rocky Flats Plant.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Table of Contents	ii
Acronyms	iv
1.0 Executive Summary	1
2.0 Purpose	9
3.0 Scope	11
4.0 Background	14
5.0 Method for Evaluating Treatment Alternatives	16
5.1 Effectiveness/Development	17
5.2 Availability for Production	18
5.3 Secondary Waste Streams	18
5.4 Efficiency	19
5.5 Weighting Factors	20
6.0 Discussion of Individual Waste Streams	22
6.1 Pondcrete and Pond Sludge	23
6.2 Nitrate Salt and Saltcrete	42
6.3 Bypass Sludge	59
6.4 Roaster Oxide	73
6.5 Fluidized Bed Incinerator (FBI) Oil	79
6.6 Combustibles	94
6.7 Lead	108
6.8 PCBs (Solids, Liquids, Capacitors)	115
6.9 Fluidized Bed Incinerator (FBI) Ash	129

6.10 Beryllium Dust	137
6.11 Metal Chips	144
6.12 Filters	152
6.13 Fluorescent Lights	161
6.14 Acid	168
6.15 Composite Chips	180
6.16 Absorbed Organic Waste	190
6.17 Electrochemical Milling (ECM) Sludge	198
6.18 Contaminated Dirt	206
6.19 Cutoff Sludge	214
6.20 Summary of Waste Streams	227
7.0 Conclusions/Summary	231
7.1 Waste Currently Meeting Disposal Requirements.	231
7.2 Waste Characterization Requirements.	232
7.3 Stabilization/Solidification	233
7.4 Incineration	234
7.5 Melting/Vitrification.	235
7.6 Extraction	235
7.7 Wet Oxidation.	236
7.8 Biodegradation	236
7.9 Metal Precipitation Pretreatment	237
7.10 Cyanide Destruction.	237
7.11 Decontamination of Lead.	237
7.12 Ultra-violet (UV) Ozonation.	238
7.13 Plasma Arc	238
7.14 Scale Up of Technology Development	238
7.15 Recommendation for Future Activities	239
Appendix A.	241

LIST OF ACRONYMS

ADL	Above Detection Limits
AEA	Atomic Energy Act
BDAT	Best Demonstrated Available Technology
BTU/lb	British Thermal Units Per Pound
CCW	Constituent Concentrations In Waste
CCWE	Constituent Concentrations Waste Extract
CFR	Code of Federal Regulations
DOE	Department of Energy
DOT	Department of Transportation
ECM	Electrochemical Milling
EP	Extraction Procedure
EPA	Environmental Protection Agency
FBI	Fluidized Bed Incinerator
g	Gram
HCN	Hydrogen Cyanide
HEPA	High Efficiency Particulate Air
HOC	Halogenated Organic Compounds
HTFWR	High Temperature Fluid Wall Reactor
INEL	Idaho National Engineering Laboratory
LDR	Land Disposal Restrictions
LLW	Low-Level Waste
mg/kg	Milligram Per Kilogram (Equal to ppm)
mg/l	Milligrams Per Liter
ml	Milliliter
MSDS	Material Safety Data Sheet
nCi/gm	Nanocurie Per Gram
NTS	Nevada Test Site
PCB	Polychlorinated Biphenyl
pCi/ml	Picocurie Per Milliliter
pCi/g	Picocurie Per Gram
PCS	Phase Combining System (No Longer Available Thru Amersham)
ppb	Parts Per Billion
ppm	Parts Per Million
PSZ	Perimeter Security Zone
RCRA	Resource Conservation & Recovery Act
RFP	Rocky Flats Plant
ROM	Rough Order of Magnitude
SITE	Superfund Innovative Technology Evaluation
SSU	Saybolt Seconds Universal
TBD	To Be Determined
TCLP	Toxic Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
ug	Microgram
ug/kg	Microgram Per Kilogram
ug/g	Microgram Per Gram (Equal to ppm)
VOA	Volatile Organics Analysis
WAC	Waste Acceptance Criteria

WERF
WSIC

Waste Experimental Reduction Facility
Waste Stream Identification and Characterization

1.0 EXECUTIVE SUMMARY

This document has been prepared in response to a June, 1989 agreement between the Department of Energy (DOE) and the State of Colorado which committed the Rocky Flats Plant (RFP) to submit a plan defining their program to manage low-level mixed waste being stored within the Plant site. This plan establishes the necessary criteria that must be met to dispose of the RFP mixed waste and evaluates the possible treatment options that might achieve those criteria. This plan, however, is unable to predict when a disposal facility will agree to take the waste, even should it meet all anticipated restrictions on its form.

Nineteen individual waste types or streams are addressed by the plan. For each waste stream, characterization information is presented and compared to low-level radioactive waste disposal criteria (for the radiological component) and standards established by EPA's Land Disposal Restrictions found in 40 CFR 268 (for the RCRA hazardous component). Limitations in meeting those criteria or standards are identified as the treatment need for that specific waste. Possible treatment alternatives are proposed and evaluated using the following criteria:

- (1) its demonstrated effectiveness in achieving the required waste form;
- (2) its stage of development and availability for production;
- (3) its ability to treat the waste without producing other secondary wastes of concern; and
- (4) its efficiency considering such factors as waste volume reduction, process reliability, final waste form, and capital costs.

Figure 1.1 lists the nineteen mixed waste streams along with the results of the evaluation of treatment alternatives. Each treatment alternative has numbers shown in the column corresponding to the waste streams for which they were considered. These numbers indicate the relative results of the evaluation (i.e., "1" indicates the treatment alternative with the highest evaluation score, "2" the second highest, etc.) for that waste stream. Not

Figure 1.1 Results of Treatment Alternative Evaluation

Mixed Waste Stream	Treatment Alternative													
	Cementation	Polymer Solidification	Vitrification* 1	Extraction* 2	Chemical Destruction by Thermal Denitration	Biodegradation	Incineration	Wet Oxidation	Air Stripping	Redox/Chlorine Decontamination	Decontamination & Reuse	Discharge To Wastewater Treatment	UV Ozonation	No Action
1. Pondcrete	1	2	3	4										
2. Saltcrete	1	2			3	4								
3. Bypass Sludge	1	3	2											
4. Roaster Oxide														1
5. FBI Oil			2			5	1	2	4	5				
6. Combustibles		2	2	4			1	5						
7. Lead	2	2								1				
8. PCB's (solids)			2	3			1							
8a. PCB's (liquids)						2	1							
9. FBI Ash	3	2	1											
10. Beryllium Dust	1	2	2											
11. Metal Chips			3	2			1							
12. Filters	1	4	3	4			1	4						
13. Fluorescent New Lights	1	2	3											
14. Acid* 3	4	3	2								1			
15. Composite Chips* 4			3	1			2							
16. Absorbed Organic	1													
17. ECM Sludge* 5	3	2	1											
18. Contaminated Dirt	2		3	5			1						3	
19. Cutoff Sludge	2	4	3				1							

- *1 Vitrification refers to use of microwave, Joule melter, or plasma arc technologies
- *2 Extraction refers to several techniques to remove the RCRA hazardous components from waste
- *3 All of the alternatives for this waste include pretreatment for neutralization, and most include pretreatment for cyanide destruction
- *4 Extraction on the composite chip would be followed by cementation of the pyrophoric chips
- *5 For this waste stream, cementation and polymer solidification both include cyanide destruction as pretreatment

all treatment alternatives shown in Figure 1.1 are being given further consideration; some of the lower scored alternatives are being dropped.

Each waste stream subsection concludes with a schedule of events that represent the next step in working towards the implementation of successful treatment technologies. Table 1.1 provides a summary of those individual findings presented in terms of the steps or activities that are scheduled.

Development of specifications for well established technologies and performing bench scale testing of those technologies not well enough established are the activities described in this plan. Full scale treatment equipment and capabilities are expensive to put into place. Therefore, once bench scale testing has been completed, the treatment alternatives will be reevaluated based on the results of those tests. Only the technologies considered to be fully effective should be evaluated and the capability of a technology to treat multiple waste streams should be added to the evaluation criteria and be heavily weighted.

TABLE 1.1 Summary of Short Term Activities

Treatment Alternative	Activity	Mixed Waste Streams	Activity Completion
1. N/A	Characterization - Perform additional sampling and analysis for specific parameters to enable confirmation of applicable disposal criteria.	Pondcrete/ Pond Sludge Nitrate Salt/ Saltcrete Bypass Sludge Roaster Oxide Combustibles FBI Ash Metal chips Filters Acid Composite Chips Absorbed Organic ECM Sludge Contaminated Dirt Cutoff Sludge	9/90 (all)
2. Stabilization/ Solidification	Perform bench scale testing of cement (C) and/or polymer (P) solidification techniques on samples of mixed waste streams. This includes analyzing the solidified sample through use of extraction procedures and varying the process ingredients to optimize the results.	Pondcrete/ Pond Sludge Nitrate Salt/ Saltcrete Bypass Sludge Lead Combustibles FBI Ash Beryllium Dust (lab scale) Filters Fluorescent Lights Acid (lab scale) ECM Sludge Contaminated Dirt Cutoff Sludge	9/90(C) 3/91(P) 9/90(C) 3/91(P) 9/90(C) 9/91(P) 9/91(C) 9/92(P) -- 9/91(P) 6/91(C) 9/91(P) 9/91(C) 9/92(P) 9/91(C) 9/92(P) 8/91(C) 9/92(P) 6/91(C) 6/91(P) 9/92(C) 9/92(P) 9/91(C) -- 9/91(C) 9/92(P)

TABLE 1.1 Summary of Short Term Activities

Treatment Alternative	Activity	Mixed Waste Streams	Activity Completion
3. Incineration	Develop a plan for the restart of the existing fluidized bed incinerator (FBI) to accommodate the applicable mixed waste streams. Continue to pursue incineration of FBI Oil and possibly others (such as combustibles) at the Idaho National Engineering Laboratory.	FBI Oil Combustibles PCB Liquids Filters Cutoff Sludge	12/89 (plan)
4. Melting/ Vitrification	Perform bench scale testing of Joule and/or microwave melting on samples of mixed waste streams. This includes analyzing the vitrified sample to insure that leachability requirements are met.	Pondcrete/ Pond Sludge Nitrate Salt/ Saltcrete ¹ Bypass Sludge FBI Oil Combustibles FBI Ash Beryllium Dust (lab scale) Filters Fluorescent Lights (lab scale) Acid (lab scale) ECM Sludge Contaminated Dirt Cutoff Sludge	9/90(M) -- 9/91(M) 9/91(J) 9/91(M) -- -- 9/93(J) -- 9/91(J) 9/91(M) 9/92(J) 9/92(M) 9/92(J) -- 9/92(J) 9/92(M) -- 3/92(M) -- -- 9/92(J) 9/92(M) 9/92(J) 9/92(M) 9/92(J)

*1 For the nitrate salt/saltcrete waste, these treatment technologies are also being considered for their ability to destroy nitrates.

TABLE 1.1 Summary of Short Term Activities

Treatment Alternative	Activity	Mixed Waste Streams	Activity Completion
5. Wet Oxidation	Perform lab study scale testing of wet oxidation techniques on samples of mixed waste streams. This includes analyses to insure destruction of organics has occurred.	FBI Oil Combustibles Filters	9/93 6/92 9/92
6. Supercritical Fluid Extraction	Perform bench scale testing of the use of supercritical fluid (CO ₂) to extract organics from the mixed waste	Combustibles PCBs (solids) Metal Chips Filters Composite Chips Contaminated Dirt	9/92 9/92 9/92 9/92 9/92 9/92
7. Aqueous Wash	Perform bench scale testing on the use of aqueous washing to extract organics from mixed waste	Combustibles Metal Chips Composite Chips	9/92 9/92 9/92
8. Metal Extraction	A study will be performed to determine the feasibility of extracting heavy metals from the waste as a means to achieve the LDR standards	Pondcrete/ Pond Sludge	9/91

TABLE 1.1 Summary of Short Term Activities

Treatment Alternative	Activity	Mixed Waste Streams	Activity Completion
9. Biodegradation	Perform lab scale testing to determine the effectiveness of biodegradation on the mixed waste	FBI Oil PCBs (liquids)	9/94 9/94
10. Metal Precipitation Pretreatment	Perform lab scale tests on a pretreatment approach (flocculation and precipitation) for removal of heavy metals	Acid	12/91
11. Cyanide Destruction	Implement a production scale operation for destruction of cyanide	Acid ECM Sludge	9/91 (all)
12. Decontamination and Reuse	Perform lab scale testing to determine the success of smelting lead and removing radiological contamination in the dross. (This will likely be considered in conjunction with the addition of lead to vitrification recipes to form lead glass.)	Lead	9/91

TABLE 1.1 Summary of Short Term Activities

Treatment Alternative	Activity	Mixed Waste Streams	Activity Completion
13. UV Ozonation	Perform lab scale tests to determine the effectiveness of ultra-violet ozonation on destroying organics	Contaminated Dirt	9/92
14. Plasma Arc Furnace	Monitor testing being performed at the DOE facility in Butte, Montana. This work is being done to investigate the applicability of this technology DOE-wide.	PCBs (solids) PCB (capacitors) Metal Chips Composite Chips	9/90 EPA SITE Test & DOE Operational Tests

2.0 PURPOSE

In June of 1989, an agreement between the Department of Energy (DOE) and the State of Colorado committed the Rocky Flats Plant (RFP) to submit a plan defining their program for treating and disposing of mixed waste being stored within the Plant site. Mixed waste refers to waste that is both low-level radioactive and hazardous as defined by the Resource Conservation and Recovery Act (RCRA). The intent of this plan is to fulfill that commitment.

This plan establishes the necessary criteria that must be met to dispose of RFP waste and evaluates the possible treatment options that might achieve those criteria. Another option, not addressed in the plan, is the possibility of petitioning EPA to delist some of the treated waste from further regulation under RCRA. This would allow the delisted waste to be disposed as strictly low-level waste. Even though the delisting process is not simple, wastes applicable to delisting are identified in the plan.

This plan is unable to provide schedules by which the mixed waste currently being stored at the RFP will be removed from the site for two reasons: first, the schedule to achieve disposable waste forms is totally dependent on the development and installation of appropriate treatment technologies which have not yet been chosen; and second, the disposal of each waste stream must be negotiated with the disposal facility, expected to be the Nevada Test Site (NTS). Recent conversations with personnel at the NTS indicated that they are now in a regulatory position to take mixed waste for disposal as long as their waste acceptance criteria (WAC) is met. A major portion of their WAC is adherence to the standards established in EPA's Land Disposal Restrictions (LDR). Each waste stream will be accepted by NTS only after enough information is available on the waste to ensure them that their acceptance criteria are met. It is unlikely that sufficient information can be generated until the actual full scale waste treatment process has been started.

Within the RFP, the Process Technology Development organization has responsibility for developing technologies described in this plan and the Waste Operations organization has responsibility for implementing those technologies. The plan was prepared for submission to the State of Colorado, but will also receive wide distribution within the RFP and within DOE.

3.0 SCOPE

This plan looks at specific mixed wastes at the RFP, investigates their characteristics, determines disposal criteria applicable to them, and evaluates possible treatment alternatives that would achieve those criteria. The individual low-level mixed waste streams being considered are identified and briefly described as follows:

<u>Name</u>	<u>Description</u>
1. Pondcrete and Pond Sludge	Cemented and uncemented sludge from the closure of inactive solar evaporation ponds
2. Nitrate Salt and Saltcrete	Uncemented and cemented residue or salts from a wastewater treatment evaporator
3. Bypass Sludge	Vacuum filter sludge from a flocculation and precipitation wastewater treatment process
4. Roaster Oxide	Depleted uranium chips that have been roasted to an oxide form
5. Low-Level Mixed Waste Oil (FBI Oil)	Contaminated oil originally destined for burning in the RFP fluidized bed incinerator (FBI)
6. Combustibles	Combustibles (paper, cloth, plastics, etc.) contaminated with listed solvents
7. Lead	Radiologically contaminated lead
8. PCBs	PCBs in the form of solids, liquids and capacitors, some of which are also contaminated with listed solvents
9. Fluidized Bed Incinerator (FBI) Ash	Ash resulting from test burns of the FBI incinerator
10. Beryllium Dust	Unused or spilled beryllium dust before it has gone into manufacturing processes
11. Metal Chips	Metal chips from machining operations that are contaminated with listed solvents

- | | |
|--|---|
| 12. Filters | Miscellaneous air or water filters contaminated with listed solvents |
| 13. Fluorescent Lights | Crushed lights taken out of radiological contamination zones |
| 14. Acid | Waste acid solution from electrochemical process tanks |
| 15. Composite Chips | Chips of composite metals (including depleted uranium) from machining operations that are contaminated with listed solvents |
| 16. Absorbed Organic Waste | Used scintillation fluid absorbed onto hydrated calcium silicate |
| 17. Electrochemical Milling (ECM) Sludge | Accumulated sludge from a small ECM process |
| 18. Contaminated Dirt | Dirt picked up during investigations of old contaminated areas |
| 19. Cutoff Sludge | Sludge accumulated beneath an old cleaning or decontamination facility |

Each of the waste streams described above are discussed in detail. Where available, sampling and analysis data are presented along with process knowledge to provide a characterization of the waste. In several instances, sampling and analysis needs are identified and assumptions are made as to the waste's specific characteristics. Once a good description of the waste has been developed, the applicable disposal criteria are presented for comparison; wastes not meeting those criteria are candidates for treatment. Based on limitations in disposal criteria and existing waste forms, potential treatment alternatives are proposed. Each alternative is then evaluated based on a common set of criteria. Finally, schedules are provided for pursuing alternatives that appear to be viable.

Each of the wastes named above are considered to be mixed, which presents a major obstacle in developing treatment processes. This does not mean that processes applicable to hazardous wastes are not appropriate for mixed wastes, but rather that the testing, construction, and operation of such processes become much more complicated. This added complexity results from the

additional consideration that must be given to protect laboratory workers and equipment operators from radiation. Also of concern are the additional controls that must often be added to the equipment to reduce potential releases to the environment. These and other such considerations inevitably combine to stretch out the schedule for putting treatment technologies into place. The schedules shown in this plan are basically for bench and lab scale testing activities to determine effectiveness of treatment alternatives. For the most part these activities will take place at the RFP on dedicated equipment; the possibility of using commercial manufacturers to demonstrate technologies is usually not feasible because radiological contamination of their equipment would be unacceptable.

The Background section of this plan discusses the disposal criteria used to evaluate existing waste forms. The discussion will include a description of the criteria, why it was chosen, and the assumptions that went into the comparisons. Also, provided separately in the plan is a brief discussion on the evaluation process developed to rank the various treatment alternatives. Finally, at the end of the plan is a summary of the findings and the technology development actions to be taken next.

4.0 BACKGROUND

On May 1, 1987, the DOE issued an interpretive rule (effective June 1, 1987) which conceded the jurisdiction of RCRA over the hazardous components of mixed wastes. Prior to that time much of this waste had been disposed in landfills designed and regulated by DOE under the Atomic Energy Act (AEA) for the disposal of low-level radioactive waste. (Disposal of low-level mixed waste had actually stopped at most DOE facilities before the official ruling.) This practice was officially halted pending the disposal facilities obtaining the needed regulatory approvals to receive hazardous waste as required under RCRA. To a large extent this situation remains unchanged today; most DOE low-level radioactive waste disposal facilities have not yet obtained the necessary approvals to take mixed waste or have chosen not to make the attempt. This has left most DOE facilities in the mode of storing their mixed wastes or in some instances eliminating the RCRA characteristics via treatment so that disposal as strictly low-level waste can be accomplished.

The Nevada Test Site (NTS) now indicates that their regulatory status will allow them to take mixed waste as long as it meets all of the necessary requirements. Low-level waste from RFP has traditionally gone there for disposal and it is anticipated that NTS will be available to take low-level mixed waste once criteria are developed (with limited assumptions) that will provide a model for mixed wastes currently being stored or generated. Comparison to the model waste form will make treatment needs evident.

The disposal criteria applicable to low-level waste are considered first. All of DOE's low-level waste disposal facilities operate under their own individual set of waste acceptance criteria or WAC. The governing regulations are the same, so as might be expected, the various WACs are quite similar. In order to develop the model for low-level waste disposal, the Nevada Test Site (NTS) WAC was used and is referenced in several locations in the plan. The major considerations from the NTS WAC applicable to RFP mixed wastes are those

associated with the limitations on disposal of waste with fine particulate or free liquids.

For hazardous wastes, EPA has established a very complex regulation that sets criteria and standards that must be met before a waste can be accepted for land disposal. The intent of the regulation is to implement EPA's goal to significantly reduce the hazards associated with wastes going to land disposal facilities. The NTS WAC also stipulates that these EPA requirements must be met. The regulation, titled Land Disposal Restrictions, found in 40 CFR 268, establishes concentration standards that must be met or treatment technologies that must be used. Since the Land Disposal Restrictions (LDR) addresses criteria on an individual basis for the various hazardous waste designations, details will not be discussed further. It should be noted that numerous assumptions had to be made in determining the applicable criteria from the LDR. This is for two reasons; first, only two-thirds of the EPA hazardous waste designations have been addressed by the LDR, the remaining one-third are scheduled to have their criteria established by May 8, 1990 and; second, the LDR specifically exempt mixed waste from most of the standards until May 8, 1990. Where standards have been established for hazardous wastes only, it was assumed that the same numbers would be used for mixed waste. Where standards have just not yet been established, some assumptions were made.

Between these two, the NTS WAC and the LDR, a fairly complete picture could be achieved for the RFP waste characteristics and forms required. This picture was then used to determine if treatment was necessary. One more element of the LDR should be mentioned with regard to treatment technologies. Along with the disposal criteria for each type of waste, EPA identifies what it considers to be the "Best Demonstrated Available Technology" (BDAT) to achieve those criteria. In some cases the LDR require that the BDAT be used, but in most instances only the result is required.

5.0 PROCESS FOR EVALUATING TREATMENT ALTERNATIVES

The Process Technology Development Organization at the RFP has already reviewed technologies potentially suitable for the treatment of the plant's mixed low-level wastes. The treatment alternatives described in this plan are the most promising technologies identified in the initial review. The intent is to compare the alternatives identified for each waste in order to judge their attributes, identify those most promising as a means of prioritization, and possibly to highlight those that may not deserve further consideration.

A systematic evaluation approach was used to ensure consistency in comparing the numerous possibilities. It was decided that generating a numerical score that represented a composite from scores of several criteria would be a good way to show the comparison. The criteria or attributes of treatment technologies that appeared to require consideration are as follows:

- (1) its perceived or theoretical effectiveness in treating the waste;
- (2) its stage of development in demonstrating its effectiveness on the specific waste or one very similar;
- (3) its availability for production (or the time it could reasonably be expected to take to get full scale equipment installed and operational);
- (4) its ability to achieve the desired waste form with a minimum number of separate treatment steps and secondary waste streams;
- (5) its ability to reduce the waste volume;
- (6) the quality of its final waste form;
- (7) its capital cost; and
- (8) its operational or functional reliability.

The sections that follow discuss the evaluation criteria in more detail, including the hierarchy of success or applicability within each criterion. In several cases more than one of the attributes listed above have been combined into a single criterion for purposes of the evaluation. The final section of the chapter discusses the weighting factors to be applied to each of the individual criterion.

5.1 Effectiveness/Development

A major concern of any treatment process is how effective it is in treating the waste and achieving the desired waste form, i.e., a residue that, at a minimum, meets the disposal limits established by EPA's Land Disposal Restrictions. Evaluation of the effectiveness of a process normally requires testing of specific equipment on a specific waste stream. EPA has established a Best Demonstrated Available Technology (BDAT) for the treatment of most individual types of hazardous waste. However, because of the unique characteristics involved with the RFP waste, particularly the radiological component, it cannot be assumed that the BDAT is the best approach without testing, and other technologies may appear to have advantages that warrant consideration. For these reasons the attributes of effectiveness and stage of development were combined into a single criterion for purpose of the evaluation. The established BDAT can be used as a bench mark for comparison, but the results of actual testing on the waste or a simulation of the waste needs to be incorporated into the evaluation. The scoring scheme for this criterion can thus be laid out as a series of responses to the question, "Has the treatment alternative been demonstrated to be effective on the specific waste?" The levels of response, with their corresponding score are as follows:

<u>Score</u>	<u>Response</u>
4	The technology is the BDAT or equivalent as demonstrated in full scale testing
3	Bench scale testing complete, BDAT or encouraging results of equivalency
2	The technology is the BDAT or, in theory, should be as effective, but no testing has been done on the waste
1	The technology has shown or is expected to have low effectiveness, not equivalent to the BDAT.

5.2 Availability for Production

Somewhat independent from its stage of development in testing, each technology will have different complexities in equipment, support facilities, and permitting requirements. These factors combine to dictate the time frame in which a technology can be put into production even if testing shows success. Based on the response to the question, "How quickly can the technology be put into a production scale operation?", the following scores are used:

<u>Score</u>	<u>Response</u>
3	The technology can be production ready in less than one year
2	It can be production ready in one to two years
1	It will take longer than two years to be production ready

5.3 Secondary Waste Streams

In some instances a treatment technology will offer a simple means to achieve the desired waste form as compared to another that will take multiple processing steps. Of particular concern in this area is whether the process involves any secondary waste streams, such as off-gases, that would also require collection and possibly treatment. The logic of simply transferring the hazardous component of the waste to another media should, at least, be questioned since it would likely impact numerous elements of the technology's chance for success. Based on the response to the question, "Does the treatment alternative produce a secondary waste stream of significant concern?", the following scores are used:

<u>Score</u>	<u>Response</u>
2	No secondary waste streams are generated or, at least, none hazardous.
1	Hazardous, but within LDR standards
0	Hazardous and exceeds LDR standards (treatment needed)

5.4 Efficiency

The remaining attributes identified at the front of this section appear to be at a lower level of concern. It's a benefit for the treatment technology to reduce the waste volume, but now that the Nevada Test Site (NTS) should be in the mode to take treated waste, it has become a less critical concern. The treated waste form must already meet established criteria for disposal which is considered in the "Effectiveness/Development" criterion; improving the waste form even further is an admiral goal, particularly for the long-term, but is not now a necessity. The capital costs will, of course, be considered, but at this stage of development for most of the technologies, it cannot be an overriding concern. The last element, the technology's reliability, is probably too subjective and based on too little information for many of the newer technologies to be given great importance at this time. For these reasons the remaining attributes were grouped under a single criterion with a very subjective scale of high, medium, and low. The evaluation then becomes relative to only the technologies being considered for a specific waste (i.e., a specific technology may be scored different for this criterion for different wastes). The evaluation for this criterion are scored as follows:

<u>Score</u>	<u>Evaluation</u>
3	High
2	Medium
1	Low

5.5 Weighting Factors

Weighting factors were developed by attempting to compare the relative importance of the evaluation criteria. In considering the RFP's desire to achieve compliance with environmental regulations and agreements as quickly as possible, it was decided that the evaluation should be slanted heavily toward alternatives that are effective and which can be put into operation quickly. Undoubtedly the most important criterion is the technology's ability to treat the waste to the needed waste form. With the goal of expeditious treatment, the criterion of next importance would be the technology's availability for production scale. The criterion which looks at the secondary wastes produced is next and is possibly of greater importance than might normally be expected. Because innovative technologies are often being considered due to the radiological component, this criterion should help provide a stabilizing influence on considering what's possible versus what's practical. The "Efficiency" criterion is by definition more subjective and less critical to the technology's evaluation and would thus be of the lowest importance.

With the hierarchy of relative importance established, the need is then to assign weighting factors accordingly. The first element or criterion must have the largest weight but the other elements should be capable of influencing the overall score. With only four criterion being considered and the middle two appearing to be of somewhat equal importance, the weighting scheme is proposed as follows:

<u>Evaluation Criteria</u>	<u>Weighting Factor</u>
Performance/Development	3
Availability for Production	2
Secondary Waste Streams	2
Efficiency	1

It is suggested that the above weighting scheme provides the appropriate scale for the relative importance of the evaluation criteria elements. An increment change in each of the middle criterion is worth more than an increment change in the first criterion. The last element will impact the composite score, but will probably only make a significant contribution to those evaluations where alternatives have scores which are very similar. In sections of the plan where evaluation score sheets are shown, the numbers on the sheets are the result of the evaluation criterion score multiplied by the weighting factor. Looking at the possible scores and the weighting factors, the highest possible composite score for a treatment alternative is 25.

6.0 Discussion of Individual Waste Streams

This section individually addresses each of the problem low-level mixed waste streams generated at the RFP. Each waste stream discussion includes the following subsections:

- (1) Generation Process;
- (2) Waste Characterization;
- (3) Regulatory and Waste Form Requirements;
- (4) Treatment Alternatives;
- (5) Evaluation of Alternatives; and
- (6) Schedule.

The first two subsections attempt to establish what the waste is and what it looks like. The third subsection describes the criteria that the waste must now, or in the future, meet in order to be acceptable for land disposal. In this case regulatory requirements refer to the EPA regulations on the hazardous components of the waste and waste form requirements refer to the requirements applicable to the radiological component. The next two subsections include a description of potential treatment alternatives to achieve the disposal criteria and a discussion of the results of an evaluation performed on those alternatives. The final section provides a brief summary of the schedule of events for the next step in evaluating the treatment alternatives.

As might be assumed from the description of information presented on each waste stream, there is a fair amount of duplication from waste stream to waste stream in the text. This is particularly true in the areas where regulatory and waste form requirements are discussed and in the evaluation of alternatives. There was no attempt made to avoid these duplications as it was felt that it may be valuable to have each waste stream subsection in a somewhat "stand alone" condition.

6.1 Pondcrete and Pond Sludge

6.1.1 Generation Process

Prior to operation of the Liquid Waste Treatment Facility at Building 374 (started up in the 1977 time frame), wastewaters currently going to that facility were sent to one of several solar evaporation ponds. After startup, waste streams were systematically rerouted from the evaporation ponds to the 374 facility and usage of the ponds was discontinued in 1986. Characterization of waste streams going to Building 374 (and which are assumed to have gone to the evaporation ponds in the past) indicates a collection of wastewaters coming from approximately 30 different Rocky Flats Plant buildings; most of those with multiple contributing streams. As one might expect from an industrial-type wastewater collection system, the contributing streams may be contaminated with a variety of hazardous constituents in addition to radiological contaminants. From a RCRA regulatory standpoint, several of the processes serviced by the wastewater collection system are of particular concern. They include:

- (1) various laboratory activities;
- (2) electroplating operations which include the use of cyanides;
- (3) metal machining/manufacturing including cleaning/degreasing with solvents; and
- (4) acid and caustic cleaning/rinsing solutions.

The evaporation ponds are currently being closed as mixed waste units under RCRA. Under this activity, clear water on top of pond sediments/sludge is pumped to 374 for treatment and the sludge is then slurried and pumped to the Pondcrete Facility at Building 788. Here the sludge is sent to a clarifier; the supernatant is returned to the pond and the settled sludge solids are pumped to a unit where they are mixed with Portland cement. The resulting material, pondcrete, is

placed in boxes, allowed to solidify, and prepared for off-site shipment.

The solidification process was actually started before arrangements were finalized for off-site disposal with the Nevada Test Site (NTS). At one point, a backlog of approximately 16,800 boxes had been generated. With shipments now underway, this inventory had been reduced to about 15,000 as of October 1989. Of the 15,000 containers in the current inventory, roughly 5,000 did not solidify properly and need to be remixed and repackaged. As of October 1989, the stored inventory amounts to about 9,452 cubic yards of Pondcrete and another 7,200 cubic yards will be generated as the evaporation pond cleanup is completed. With this information in mind, Pondcrete may be broken into three subcategories as follows:

- (1) backlog of Pondcrete in a form acceptable for shipment to NTS, but which must still be unpacked, inspected and repackaged for transport (6,400 cubic yards);
- (2) backlog of Pondcrete that must be reprocessed before shipment to NTS (3,200 cubic yards);
and
- (3) newly generated Pondcrete from the continuing closure of the evaporation ponds (7,200 cubic yards).

The Rocky Flats Plant has committed to complete cleanup of the evaporation pond sludge and to remove all Pondcrete from the facility by the end of October 1991 which will require a generation rate of 3,396 cubic yards per year until that time.

Through the remainder of this section, the pondcrete and pond sludge wastes will be referred to as pondcrete. However, it should be understood that both the pond sludge prior to cementation and that which has already been cemented are of concern. Any additional

treatment needs should consider the possibility of replacing the cementation process as well as augmenting it.

6.1.2 Waste Characterization

Pondcrete is sludge material generated from evaporating wastewater and is very high in salts, primarily calcium and potassium salts, with some sodium salts. It has been sampled and analyzed several times for numerous compounds and parameters. The material was sampled in September and October 1986 as part of the RFP Waste Stream Identification and Characterization effort which was published in April 1987. The material was also sampled in February 1988 and again in July of that same year. The final sampling event was in April 1989, when several pondcrete blocks were sampled and analyzed for total cyanide and cyanide amenable to chlorination. No sampling has been performed on the pond sludge prior to the cementation step. Provided below is a list of compound/parameter categories for which analyses were performed for each of the sampling events.

Category of Analytical Data	Number of Samples Analyzed				
	1986	2/88	7/88	4/89	Total
Volatiles	7	20	3*		30
Semi-volatiles	7	20	3*		30
Pesticides/PCBs	2				2
Metals	6				6
Cyanide (Total & Amenable)				6	6
Radiochemistry	5				5
RCRA Characteristics					
Ignitability	1				1
Corrosivity (pH)	7	20			27
Reactivity	7	20			27
EP Toxic Metals	6	20			26
Toxic Characteristic Leaching Procedure (TCLP)					
Volatiles			3		3
Semivolatiles			3		3
Methanol			3		3

* These analyses were only for those volatiles and semivolatiles that appear on the 40 CFR 268 Appendix III list of halogenated organic compounds (HOC) regulated under the disposal restrictions on California wastes (268.32)

Each of the data categories listed above and the results therein, will be described in the following paragraphs. EPA hazardous waste numbers that are applicable to this waste, based on analytical results and process knowledge will also be provided at the end of this section.

6.1.2.1 Volatiles

Only five volatile compounds registered above detection limits (ADL) in any of the 30 samples analyzed. Information on those analytes are summarized as follows:

<u>(Volatile) Analyte</u>	<u>No. of ADL Readings</u>	<u>Average of ADL Reading</u>	<u>Range of ADL Readings</u>
Methylene Chloride	3* of 30	16.9 ppb	7.3 to 35 ppb
Acetone	20 of 30	39.7 ppb	11 to 180 ppb
2-Butanone	9 of 30	16.7 ppb	12 to 23 ppb
Tetrachloroethene	10 of 30	20.2 ppb	5 to 73 ppb
1,1,2,2- Tetrachloroethane	1 of 30	160.0 ppb	-

* A series of three other samples indicated very high methylene chloride concentrations but were not included in the ADL readings shown because of very high concentrations in the blank also.

6.1.2.2 Semivolatiles

Only four semivolatile compounds registered above detection limits (ADL) in any of the 30 samples analyzed. Information on those analytes are summarized as follows:

<u>(Semi-Volatile) Analyte</u>	<u>No. of ADL Readings</u>	<u>Average of ADL Readings</u>	<u>Range of ADL Readings</u>
2-Nitroaniline (2)	1 of 30	970 ppb	-
di-n-Butyl phthalate	1 of 30	590 ppb	-
Fluoranthene	8 of 30	722 ppb	374 to 1,683 ppb
bis(2-Ethylhexyl) Phthalate	12 of 30	4,497 ppb	152 to 14,949 ppb

6.1.2.3 Pesticides/PCB

Of the two samples tested, all concentrations were below detection limits for the pesticide/PCB analytes.

6.1.2.4 Metals

Total metal analysis was performed on ~~six~~ samples. The results are summarized as follows:

<u>Metals</u>	<u>Average Concentration (ppm)</u>	<u>Range of Concentrations (ppm)</u>
Aluminum	27,330	16,820 to 33,400
Arsenic	8.98	4.11 to 24.6
Barium	600	205 to 2,000
Beryllium	54	1.16 to 77.6
Cadmium	390	8.16 to 590
Calcium	371,280	243,300 to 577,180
Chromium	278	176 to 420
Cobalt	30.9	20.9 to 33.8
Copper	155	23.4 to 236
Iron	13,620	9,730 to 17,620
Lead	29.6	2.38 to 43.0
Magnesium	5,670	1,210 to 7,680
Manganese	2,090	804 to 6,910
Mercury	1.43	<0.02 to 2.32
Nickel	116	57.4 to 156
Potassium	157,840	9,470 to 329,300
Silver	13.4	6.63 to 23.4
Sodium	26,090	1,580 to 53,230
Vanadium	43.6	28.8 to 62.7
Zinc	113	62.1 to 210
Percent Solids	67.8%	44.4% to 94%

6.1.2.5 Cyanides

Analyses for total cyanide and cyanide amenable to chlorination were performed on samples taken from five different blocks of pondcrete. A duplicate sample was taken from one of the blocks, therefore a total of ~~six~~ samples were analyzed. The results are summarized as follows:

<u>Analysis</u>	<u>Average Concentration (ppm)</u>	<u>Range of Concentrations (ppm)</u>
Total cyanide	9.65	7.14 to 12.1
Amenable cyanide	7.41	4.05 to 9.90

6.1.2.6 Radiochemistry

Radiochemistry was performed on five pondcrete samples. The results are summarized as follows:

<u>Analysis</u>	<u>Average Concentration (pCi/g)</u>	<u>Range of Concentrations (pCi/g)</u>
Gross Alpha	2,400	1,700 to 3,800
Gross Beta	38	12 to 53
Pu-239	750	130 to 1,800
Am-241	1,000	690 to 1,600
U-233,234	44	33 to 60
U-238	48	40 to 66
Tritium	1.7 pCi/ml	1.5 to 2.1 pCi/ml

Each individual radiochemistry analysis was originally reported with an associated +/- value. This value indicated the 95% confidence range for the radionuclide result. For simplicity, this value was excluded from the averaging process. In general terms, the 95% confidence interval was about +/- 100 pCi/g when the values were in the thousands and about +/- 10 pCi/g when the values were in or near the hundreds. For tritium, the interval was either +/- 0.2 or 0.3 pCi/ml for each analysis.

6.1.2.7 RCRA Characteristics

Ignitability - Pondcrete does not exhibit the RCRA characteristic of ignitability. One sample, analyzed for this characteristic, provided a flash point of greater than 100°C (well over the limit). Also, due to the nature of the waste and its generation (wastewater), ignitability would not be expected as an issue.

Corrosivity (pH) - By definition, a material must be aqueous or a liquid to qualify as corrosive. If the pondcrete is not in a fully solidified form, it would be considered corrosive since 16 of the 27 samples analyzed provided pH values equal to or greater than ~~12.5~~. The lowest pH measured was ~~9.6~~ the highest was ~~13.2~~.

Reactivity - The only reactive quality that could reasonably be attributed to pondcrete appears to be that associated with ~~cyanide and sulfide~~ content. According to RCRA, a cyanide or sulfide bearing waste is reactive if it can produce hazardous quantities of toxic gases when exposed to pH conditions between 2 and 12.5. Twenty-seven pondcrete samples were analyzed for their reactive cyanide and sulfide content (different than total cyanide and total sulfide). In all cases, sulfide concentrations were less than detectable and cyanide concentrations averaged 21.1 ug/g (ppm) with a low of 1.9 ug/g and a high of 45 ug/g. The current EPA ~~action level~~ for reactive cyanide is ~~250 ppm~~.

EP Toxic Metals - Twenty-six pondcrete samples were analyzed for EP Toxic Metals. The only metal to exceed its established limit was cadmium. Eight of the 26 samples exceeded the EP toxic limit of 1.0 mg/l (ppm) of cadmium. Of the eight readings, the average was 16.4 mg/l with a range of 1.5 mg/l to 42 mg/l.

6.1.2.8 Toxic Characteristic Leaching Procedure (TCLP)

TCLP Volatiles - Three pondcrete samples were subjected to the TCLP and analyzed for 21 volatile compounds. These are the volatile compounds that appear in 40 CFR 268.41, Table CCWE (Constituent Concentrations Waste Extract), for F001 through F005 spent solvents. Only three constituents were observed at concentrations above the detection levels and in each case this occurred in only one out of three results. The three compounds and their single concentration above detection are as follows:

<u>Compound</u>	<u>TCLP Concentration (ppb)</u>
1,1,1-Trichloroethane	8
Tetrachloroethane	5
Toluene	60

It should be noted that toluene was also detected in the blank at 23 ppb; it is shown above because it is significantly higher.

TCLP Semi-volatiles - The same three pondcrete samples were analyzed for the semi-volatile compounds that also appear on the Table CCWE for F001 through F005 spent solvents. None of the four compounds considered were observed at concentrations above detection.

6.1.2.9 Applicable EPA Hazardous Waste Numbers

The pondcrete waste has its origin in a collection of wastewaters coming from approximately 30 different buildings, most of those with multiple contributing streams. Although a major effort has been put into characterization of all Rocky Flat Plant waste streams, the applicable EPA hazardous waste numbers for pondcrete can also be derived through a process of elimination. This is because the wastewater of concern can be either directly or indirectly associated with most of the industrial processes occurring within the Plant. Conversely, hazardous wastes listed by EPA not applicable to Plant activities cannot be associated with the wastewater.

RCRA Characteristics - Whether or not pondcrete qualifies as a characteristic hazardous waste depends solely on the results of analytical tests performed on the material. Based on the information provided in Section 6.1.2.7, the following EPA Hazardous Waste Number may be applied to the pondcrete:

<u>Hazardous Waste Number</u>	<u>Description</u>
D006	EP Toxic for Cadmium

There appears to be considerable variability in the makeup of the pondcrete blocks as only eight of twenty-six samples qualified as EP Toxic for cadmium. However, unless representative sampling were performed on each block, the information available would require the D006 designation.

RCRA Listed Wastes - The "K" wastes from specific sources (40 CFR 261.32) can be eliminated because none of the described activities take place at the Rocky Flats Plant. Likewise, the "U" and "P" listed wastes (40 CFR 261.33) can be eliminated because it is not a practice to dispose of unused commercial grade chemicals down the wastewater system and there is nothing in the analytical data to indicate this is a problem. This leaves the "F" wastes (40 CFR 261.31) to be considered. Following is a list of "F" wastes that could be generated at the Rocky Flats Plant; designated are those associated with process wastewater going to Bldg. 374 and hence, that could be associated with pondcrete.

<u>Hazardous Waste Number</u>	<u>Wastewater/Pondcrete</u>	<u>Description</u>
F001	Yes	Spent halogenated solvents used in degreasing
F002	Yes	Spent halogenated solvents
F003	Yes	Spent non-halogenated solvents
F004	No	Spent non-halogenated solvents
F005	Yes	Spent non-halogenated solvents
F006	Yes	Wastewater treatment sludges from electroplating operations
F007	Yes	Spent cyanide plating bath solutions from electroplating

F008	No	Plating bath residues from electroplating where cyanides are used
F009	Yes	Spent stripping and cleaning bath solutions from electroplating where cyanides are used

6.1.3 Regulatory and Waste Form Requirements

6.1.3.1 Waste Form Requirements for Low-Level Waste Disposal

Since NTS has already approved shipment of pondcrete to their facility, there will be no further discussion on requirements to meet those criteria.

6.1.3.2 Applicable Land Disposal Restrictions

Hazardous or mixed wastes disposed at NTS must now meet the applicable Land Disposal Restrictions (LDR). It will be assumed that this will remain the case in the future and for any other disposal facility that might be considered for mixed waste.

LDR Requirements Now In-place - Because pondcrete is a radioactive mixed waste, many of the applicable LDR standards will not go into affect until 1990. However, those standards or prohibitions on solvents (F001 to F005) and on the California List wastes are applicable now.

The California List generally deals with liquids (should not be applicable to pondcrete); however, there is one element that could be applied. If a nonliquid hazardous waste exceeds the following limit, it is restricted from disposal:

<u>Component</u>	<u>Concentration (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The LDR regulations have established concentration limits for the F001 through F005 solvents, both for wastewaters and other wastes. These limits are based on "Constituent Concentrations Waste Extract (CCWE)", that is the concentration obtained through use of the TCLP. Limits have been established for 25 different solvents; the following list only shows those solvents shown to be in pondcrete at levels above detection in either the TCLP or the total volatile and semi-volatile analyses.

<u>F001 - F005 Solvent</u>	<u>CCWE Concentration (mg/l or ppm) -nonwastewaters-</u>
Acetone	0.59
Methylene Chloride	0.96
2-Butanone (Methyl ethyl ketone)	0.75
Tetrachloroethene	0.05
Toluene	0.33
1,1,1 - Trichloroethane	0.41

Future LDR Requirements - Those specific LDR standards or limits not yet established will be effective May 8, 1990. For those limits applicable to pondcrete, one has yet to be established (that for D006) and the others have already been set for regular hazardous wastes and can be assumed to remain unchanged for the comparable mixed wastes. Among those limits already set, some are in the form of CCWE while others are in terms of "Constituent Concentrations in Waste" (CCW). If a nonwastewater exceeds the following limits, it is restricted from disposal:

<u>F006, F007, F008 and F009 Category/Constituent</u>	<u>Concentration (ppm)</u>
CCWE	
Cadmium	0.066
Chromium (Total)	5.2
Lead	0.51
Nickel	0.32
Silver	0.072
CCW	
Cyanides (Total)	590
Cyanides (Amenable)	30

6.1.3.3 Impact of Restrictions or Waste Form Requirements

Solvents - No impact - Considering the analytical results for volatiles and semi-volatiles (sections 6.1.2.1 and 6.1.2.2 respectively), pondcrete is not even close to the 1000 ppm limit for halogenated organic compounds (HOC) established under the California list. This leaves the CCWE limits established for the F001 through F005 solvents. None of the three pondcrete samples subjected to the TCLP approached the LDR limits for the F001 through F005 solvents. As described in section 6.1.2.8, only three analytes were measured above detection for the three samples and for each analyte, only one of three samples was above detection. The highest value observed, in relation to the LDR standard was less than one fifth of the CCWE limit. It may be difficult to justify representative sampling with only three samples, but when it is considered that 30 samples were analyzed for total volatiles and semi-volatiles, the characterization appears more complete. Even comparing the extract (CCWE) limit with analytical results for total concentrations, the pondcrete is within limits. Of the analytes observed above detection levels, all have average values below the CCWE limit. In only one instance (tetrachloroethene) did the highest total concentration value observed, exceed the CCWE limit and that was 73 ppb versus a limit of 50 ppb.

Metals - Limits on metals are not met - No TCLP analyses have been run on pondcrete for metals, but the analytical data available indicates that the LDR standards for cadmium will not be achieved by the pondcrete as it is currently formulated. The EP toxicity limit of 1 ppm for cadmium was exceeded in 8 of 26 samples and the CCWE limit is significantly lower at 0.066 ppm. Furthermore, the TCLP is considered a more rigorous leach test than the EP toxicity test and would be expected to generate higher concentrations. By May of 1990, there will likely be an

LDR standard for the D006 category which will also be applicable to pondcrete. However, any such limit for D006 wastes will probably be no more stringent than that already established for cadmium in F006 through F009 wastes. For the remaining metals of concern (chromium, lead, nickel, and silver), it is uncertain as to whether or not CCWE limits are exceeded until the appropriate TCLP tests are performed.

Cyanides - No impact anticipated- Analytical data indicate that LDR standards for total and amenable cyanides should be met with no problem. Although only six samples were analyzed for total and amenable cyanide, all results were reasonably similar and well within the allowable limits for land disposal. The levels of reactive cyanide discussed in section 6.1.2.7 can also be considered as an indication of the levels present in pondcrete and there were 27 samples analyzed for this parameter. The reactive cyanide is a measure of cyanide that is released over time when subjected to acidic conditions. The highest reactive cyanide level observed was 45 ug/g, but this was reported on a dry weight basis and the percent solids in the samples varied from approximately 22 to slightly over 50. When adjusted to a total sample basis, the reactive cyanide levels were very similar to those reported for total cyanide in section 6.1.2.5. Also, the low cyanide concentrations are consistent with the fact that only dilute cyanide solutions are drained to the wastewater system from the electroplating operations in Building 444.

6.1.4 Treatment Alternatives

As described in section 6.1.1, pondcrete is generated from the solidification of evaporation pond sediments. Once properly solidified, the material has been approved for shipment and ultimate disposal at the Nevada Test Site. At present, the material meets the appropriate land disposal restrictions established under RCRA. On May

8, 1990, EPA is scheduled to put into effect additional restrictions that will likely make the current formulation of pondcrete inappropriate for land disposal. This is based on the assumption that standards or limits now established under the LDR will remain the same for corresponding mixed wastes.

It appears that the evaporation pond sediments will require an addition or a change to existing treatment (solidification) to achieve reduced leachability of metals. EPA has established the best demonstrated available technologies (BDAT) for treatment of this waste (F006, F007, F008 and F009 nonwastewaters) as alkaline chlorination followed by precipitation, settling, filtration, and stabilization of metals. The wastewater has essentially gone through much of this treatment process and cyanide concentrations appear to be within the future disposal limits. This leaves the pond sludge in a form that simply requires a less leachable, better stabilization approach.

The existing approach to stabilize the pondcrete (cementation) is normally considered the acceptable treatment method for this type of a waste. However, limited sampling has shown that its quality varies. This could be caused by inconsistencies in the sludge's physical form (i.e., moisture content, chemical parameters, particle size, etc.) or it could be that some material in the sludge is not compatible to the cementation process. The first attempt to improve the condition of the treated waste form should be to make small changes in the existing operation. Another alternative treatment approach would be to change the binding agent from cement to a synthetic, polymer-type material such as polyethylene. This treatment alternative will be referred to as polymer solidification. Other treatment alternatives would be much more aggressive and/or energy intensive such as metal extraction and vitrification.

The treatment alternatives chosen include cementation, polymer solidification, metal extraction and a method to vitrify the waste.

It should be noted that investigations into improved treatment methods will be accompanied by additional characterization of old and newly generated pondcrete. Of particular concern is the need to perform TCLP tests for metals to determine if the future (May 8, 1990) standards are now routinely exceeded or if there might be some correlation between sludge conditions and high leach rates. Should such a correlation exist, it might point out changes that could improve the existing process to meet future needs.

6.1.5 Evaluation of Alternatives

Four treatment alternatives were evaluated against the criteria described in section 5.0. The results of the evaluation are shown in Figure 6.1. The treatment approaches and the result of their evaluation are discussed as follows.

Cementation - The use of cement to achieve the desired waste form received the highest evaluation score. This technology is normally considered the BDAT for stabilization of metals and bench scale testing has been performed on an improved cementation process. However, the primary reason for this alternative scoring higher than the others evaluated was its score for the "Availability" criterion; this treatment is already in place, it's being performed at the RFP under RCRA interim status, and improved techniques could likely be put into operation in less than a year. Cementation does have drawbacks as indicated by its low score under "Efficiency"; it increases the waste volume significantly and, based on the existing cementation process, its reliability may be questionable.

Polymer Solidification - The use of a synthetic binding agent to replace cement received a lower score than cementation because of its stage of development. In theory it should achieve a good stable waste form, but it has not yet received bench scale testing on the pond sludge waste. This and the fact that a polymer solidification process

Figure 6.1: Evaluation of the Treatment Alternatives For Pondcrete

Need: Stabilization of Metals

Alternatives	Cementation	Polymer Solidification	Vitrification	Metal Extraction
Effectiveness/ Development	9	6	6	6
Secondary Waste	4	4	2	0
Availability	6	4	4	2
Efficiency	1	2	2	1
TOTAL	20	16	14	9

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

would likely have to be considered a new treatment under RCRA, would prevent its full scale implementation in less than a year even though it's a relatively simple treatment technology. Polymer solidification did receive a higher "Efficiency" score than cementation primarily because it should not increase the volume of the final waste form as much as with cement.

Vitrification - The vitrification approach being pursued in this instance is microwave treatment. Bench scale testing of the microwave system on radioactively contaminated waste has now been accomplished at the RFP and the results appear very promising. However, testing has not been performed on the actual waste. It ranked lower than cementation in "Availability" because it is a more complicated treatment and would require more time to obtain the necessary regulatory permits. It also received a lower score on "Secondary Waste Stream" since it produces an off-gas that would be of regulatory concern. It received a medium score on the "Efficiency" criterion because the glassified waste form takes up less volume than cementation and is considered a more stable, less leachable form, but it also represents a higher capital cost investment.

Metal Extraction - Several possible approaches will also be considered for extracting metals from the pond sludge waste. Ideally metals could be extracted for reuse or recycling and the resulting waste form would be within LDR standards. This alternative received the lowest score of those considered because bench scale testing has not been started and the total treatment would require multiple steps and, likely, multiple waste streams. These two factors also describe reasons why the "Availability" would be greater than two years.

6.1.6 Schedule

The plant is committed to complete clean up of all solar evaporation ponds and removal of all pondcrete from backlog storage by October, 1991. Because of this commitment, development activities shown in Table 6.1 will proceed first with the highest rated alternative, cementation. This development work will be aimed at improvements to the existing cementation process and successful implementation of a remix process for the pondcrete currently in storage that must be recemented before shipment to NTS.

Other alternative treatment technologies will also be pursued in order of priority. Should TCLP characterization determine further treatment beyond cementation is unnecessary, development work on these alternatives will cease, and these resources will be reallocated to other more serious problem wastes. In any event, work on microwave melting will continue, at least through bench scale testing, in order to determine feasibility and quantify parameters for larger scale development should it be required.

Metal extraction will only be pursued on pond sludge if TCLP tests of the cemented pondcrete waste form indicates problems with metal leachability.

Table 6.1 Schedule for Pondcrete Activities

	FY 90	FY 91	FY 92
1. Perform additional characterization, keying on TCLP for metals and solvents.			
<u>Vitrification</u>			
2. Microwave, Bench Scale A. N. 2.5.1.09.004			
<u>Solidification</u>			
3. Polymer Bench Scale Test A.N. 3.7.1.09.0012			
4. Cemented Waste Bench Scale Test A.N. 3.7.1.09.0012			
<u>Extraction</u>			
5. Metal Extraction Study A.N. 2.5.1.09.0004			

41

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.2 Nitrate Salt and Saltcrete

6.2.1 Generation Process

Saltcrete is generated by solidifying the nitrate salt residue from an evaporation process at the Liquid Waste Treatment Facility at Building 374. In very simplified terms, the 374 wastewater treatment operation can be broken into three processes. Depending on its radiological contamination and point of origin, wastewater can go straight into any one of the three; however, inside the facility, the processes are interrelated. The three basic processes are:

- (1) evaporation;
- (2) flocculation/precipitation; and
- (3) sludge dewatering.

The flocculation/precipitation activity is designed for the removal of radioactive material. The settled sludge from this process goes to the sludge handling step and the overflow goes to the evaporator. The evaporator also receives less contaminated wastewater directly. Thus the second process might be considered a pretreatment for the wastewater that doesn't go directly to the evaporator. The residue or concentrated salt solution from the evaporator is mixed with cement to immobilize particulate and remove the oxidizer and corrosive characteristics of the salt and/or concentrated salt solutions. The resulting waste form is referred to as saltcrete.

The wastewater now going to Building 374 includes that which previously went to the evaporation ponds from which pondcrete is generated. Therefore, in general terms, the waste streams contributing to the formation of saltcrete are similar to those previously identified for pondcrete. Multiple sources/activities are involved (about 30 different buildings), generating wastewater with both radiological and hazardous chemical contaminants. The major distinction being that only

wastewaters having radiological contamination below a specified level are sent directly to the evaporator. As identified in section 6.1.1, some of the processes generating wastewaters that are of particular concern from a RCRA standpoint include:

- (1) various laboratory activities;
- (2) electroplating operations which include the use of cyanides;
- (3) metal machining/manufacturing including cleaning/degreasing with solvents; and
- (4) acid and caustic cleaning/rinsing solutions.

Prior to March of 1989, the cemented evaporator residue or saltcrete from 374 was placed in plastic-lined fiberboard containers (triwalls). Since that time, the saltcrete has been packaged in lined plywood boxes awaiting approval for shipment to the Nevada Test Site disposal facility. As of October 1989, there is currently a backlog of approximately 2,200 cubic yards of saltcrete awaiting final disposition and new waste is generated at about 600 cubic yards per year.

6.2.2 Waste Characterization

As described above, saltcrete is generated from the mixture of cement with residue from a wastewater evaporation process. The end product was sampled in 1986 as part of the Plant Waste Stream Identification and Characterization effort which was published in April 1987. It was sampled again in April and August of 1988. The final sampling event was in June 1989 when several saltcrete blocks were sampled and analyzed for total cyanide and cyanide amenable to chlorination. Provided below is a list of compound/parameter categories for which analyses were performed for each of the sampling events.

Category of Analytical Data	No. of Samples Analyzed				Total
	1986	4/88	8/88	6/89	
Volatiles	2	13	3*		18
Semi-volatiles	2	13	3*		18
Metals	1				1
Cyanide (Total & Amenable)				5	5
Radiochemistry	1				1
RCRA Characteristics					
Ignitability	1				1
Corrosivity (pH)	2	13			15
Reactivity	2	13			15
EP Toxic Metals	2	13			15
Toxic Characteristic					
Leaching Procedure (TCLP)					
Volatile Organic Analyses (VOA)			3		3
Acid Compounds (semivolatiles)			3		3
Methanol			3		3

* The analyses for volatiles and semivolatiles were for the 40 CFR 268 Appendix III list only.

The analytical results for each of the data categories listed above will be described in the following paragraphs. Based on analytical results and process knowledge, EPA hazardous waste numbers that are applicable to this waste will be provided at the end of this section.

6.2.2.1 Volatiles

Only six volatile compounds registered above detection limits (ADL) in any of the 18 samples analyzed. Information on those analytes are summarized as follows:

<u>(Volatile) Analyte</u>	<u>No. of ADL Readings</u>	<u>Average of ADL Readings</u>	<u>Range of ADL Readings</u>
Acetone	15 of 15 ^{*1}	168 ppb	89 to 380 ppb
2-Butanone	15 of 15 ^{*1}	39 ppb	21 to 70 ppb
Benzene	1 of 15 ^{*1}	26 ppb	-
Methylene Chloride ^{*2}	2 of 18	14 ppb	7.7 to 20 ppb
Tetrachloroethene	2 of 18	7 ppb	6 to 8 ppb
Toluene	15 of 15 ^{*1}	22 ppb	5.1 to 51 ppb

*1 The Appendix III volatile analyses of samples taken 8/88 did not include these compounds, hence only 15 readings.

*2 The volatile analyses of samples taken 8/88 were all positive for this analyte, but because method and extract blanks were also positive at similar values, these values were not included as ADL readings.

6.2.2.2 Semi-volatiles

Only three semi-volatile compounds were ADL in any of the 18 samples analyzed. It should be noted that the semi-volatile analyses of samples taken 8/88 did not include any of the analytes observed ADL; therefore, the total number of readings is only shown as 15. Information on those analytes are summarized as follows:

<u>Analyte</u>	<u>No. of ADL Readings</u>	<u>Average of ADL Readings</u>	<u>Range of ADL Readings</u>
4-Chloro-3-methylphenol	1 of 15	660 ppb	-
Butyl benzyl phthalate	1 of 15	3,503 ppb	-
bis(2-Ethylhexyl) phthalate	1 of 15	4,156 ppb	-

The validity of these results is questionable. Should these materials truly be present in the saltcrete, one would not expect this much inconsistency in data. However, as a matter of being conservative, the information is presented.

6.2.2.3 Metals

Total metal analysis was performed on only one sample. The results are as follows:

<u>Metal</u>	<u>Concentration (ppm)</u>
Aluminum	11,520
Antimony	<6.96
Arsenic	4.04
Barium	160
Beryllium	0.70
Cadmium	4.30
Calcium	182,390
Chromium	117
Cobalt	19.8
Copper	17.9
Iron	14,290
Lead	3.55
Magnesium	2,860
Manganese	606
Mercury	<0.02
Nickel	30.4
Potassium	24,610
Selenium	<0.58
Silver	8.94
Sodium	4,870
Thallium	<1.16
Vanadium	38.3
Zinc	61.5

6.2.2.4 Cyanide

Analyses for total cyanide and cyanide amenable to chlorination were performed on samples taken from four different blocks of saltcrete. A duplicate sample was taken from one of the blocks, therefore, a total of five samples were analyzed. The results are summarized as follows:

<u>Analysis</u>	<u>Average Concentration (ppm)</u>	<u>Range of Concentrations (ppm)</u>
Total Cyanide	15.2	12.6 to 18.5
Amenable Cyanide	13.2	6.2 to 18.2

6.2.2.5 Radiochemistry

Radiochemistry was also performed on only a single sample. The results are as follows:

<u>Analysis</u>	<u>Concentration (pCi/g)*</u>
Gross Alpha	240 +/- 60
Gross Beta	170 +/- 60
Pu-239	160 +/- 10
Am-241	88 +/- 4
U-233,234	25 +/- 10
U-238	88 +/- 18
Tritium	1.3 +/- 0.3 (pCi/ml)

- Plus or minus (+/-) values indicate the 95% confidence range for the reported values.

6.2.2.6 RCRA Characteristics

Ignitability - Prior to its cementation, the evaporator residue or salt is considered an oxidizer because of its high nitrate concentration. Under RCRA regulation, this factor also classifies the evaporator salt as ignitable. A proposed DOT test to determine whether a material is a solid oxidizer was performed by the RFP on both the nitrate salt and the saltcrete. The nitrate salt did accelerate the burning rate of dry wood sawdust, while the cemented salt (saltcrete) would not sustain a fire. Therefore, saltcrete is not considered an oxidizer and ignitable, but the nitrate salt is. The single ignitability test performed on saltcrete produced a flash point of greater than 60°C (140°F) which shows the waste to be non-ignitable from a flash point perspective.

Corrosivity (pH) - As with pondcrete, by definition a material must be liquid to qualify as corrosive. If the saltcrete is not

in a fully solidified form, it should be considered corrosive since all 15 samples observed for pH provide values of 12.5 or above. The lowest pH measured was 12.5, the highest was 13.8.

Reactivity - Fifteen saltcrete samples were analyzed for their reactive cyanide and sulfide concentrations (different than total cyanide and total sulfide). In all cases but one, sulfide content was below detection limit, that single case was 13 ppm. (It should be noted that 13 of the samples had sulfide detection limits of 200 ppm while the other two had limits of 1 ppm.) Thirteen of the 15 samples analyzed for cyanide measured levels above the detection limit. Of those 13, the average was 3.57 ppm with a range of 0.97 to 6.30 ppm.

EP Toxic Metals - Of the 13 samples taken in 4/88, all analytical results for EP Toxic Metals except lead were below the following detection limits:

<u>Element</u>	<u>Detection Limit (ppm)</u>	<u>EP Toxicity Limit</u>
Arsenic	0.10	5.0
Barium	1.0	100.0
Cadmium	0.05	1.0
Chromium	0.5	5.0
Lead	0.5	5.0
Mercury	0.005	0.2
Selenium	0.1	1.0
Silver	5.0	5.0

Lead was observed in a single sample at a concentration right at the detection limit (0.5 ppm). Two samples taken within one month of each other in 1986 provided information that was less clear. The first provided positive readings for five metals while the second had less than detectable for all eight metals. These results are summarized as follows:

<u>Element</u>	<u>Concentration (ppm)</u>	
	<u>1st 1986 Sample</u>	<u>2nd 1986 Sample</u>
Barium	0.30	<20.0
Cadmium	0.092	<0.2
Chromium	2.99	<1.0
Lead	0.33	<1.0
Silver	0.050	<1.0

6.2.2.7 Toxic Characteristic Leaching Procedure (TCLP)

The TCLP analysis was performed for several groups of organic compounds (i.e., VOAs, acid compounds, and methanol) which essentially make up the list of F001 through F005 solvents regulated by Land Disposal Restrictions (40 CFR 268.41). Although only three saltcrete samples were subjected to the TCLP, none of the organics for which analysis was performed appear in the samples.

Acetone and methylene chloride appeared positive in each of the three samples at concentrations in the 10 to 25 ppb range. However, the method and extract blanks also had positive indications of these two parameters and at similar concentrations; their presence was, therefore, discounted.

Methyl isobutyl ketone, 2-butanone and toluene each had one or two reported readings out of the three samples, but in each case the reading was below the detection limit of 10, 10 and 5 ppb respectively. Again, the presence of these compounds was discounted.

6.2.2.8 Applicable EPA Hazardous Waste Numbers

Much of the rationale for assigning Hazardous Waste Numbers to pondcrete is applicable to saltcrete. Since a wastewater from

much of the Plant is involved, knowledge of processes contributing to the stream must be considered as well as analytical data.

RCRA Characteristics - In a cemented and fully solidified condition, saltcrete does not exhibit any of the characteristics of hazardous wastes, but in the unsolidified nitrate salt form, it exhibits one of the characteristics as follows:

<u>Hazardous Waste Number</u>	<u>Description</u>
D001	Ignitable (oxidizer)

RCRA Listed Wastes - Referring to the similar discussion on pondcrete found in section 6.1.2.9, the listed waste numbers applicable to saltcrete are as follows:

<u>Hazardous Waste Number</u>	<u>Description</u>
F001	Spent halogenated solvents used in degreasing
F002	Spent halogenated solvents
F003	Spent non-halogenated solvents
F005	Spent non-halogenated solvents
F006	Wastewater treatment sludges from electroplating operations
F007	Spent cyanide plating bath solutions from electroplating
F009	Spent stripping and cleaning bath solutions from electroplating where cyanides are used

6.2.3 Regulatory and Waste Form Requirements

6.2.3.1 Waste Form Requirements for Low-Level Waste Disposal

Authorization to dispose of saltcrete at NTS has already been requested and NTS acceptance is expected soon. Therefore, the waste form as now generated is acceptable for NTS disposal as long as current and future Land Disposal Restrictions are met.

6.2.3.2 Applicable Land Disposal Restrictions (LDR)

LDR Requirements Now In-place - Saltcrete is a radioactive mixed waste and many of the LDR standards do not go into effect until 1990. The restrictions now in place are those established for the California list of wastes and for the F001 through F005 solvents.

The California List restriction that applies to a nonliquid such as saltcrete, prohibits the land disposal of waste that exceeds the following limit:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The applicable LDR standards for F001 through F005 solvents are established in terms of CCWE for spent solvent wastes other than wastewater. Of the 25 solvents listed under this standard, only five have appeared in samples at levels above detection. These solvents and their applicable LDR limit are as follows:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration (ppm) non-wastewaters</u>
Acetone	0.59
Methylene Chloride	0.96
2-Butanone (Methyl ethyl ketone)	0.75
Tetrachloroethene	0.05
Toluene	0.33

Future LDR Requirements - Those LDR standards or limits not yet established will become effective May 8, 1990. For those specific limits applicable to saltcrete, some have already been set for regular hazardous wastes and it will be assumed that they will remain unchanged for mixed wastes. The applicable limits have been established with some parameters in terms of CCWE and others

in CCW. If a nonwastewater exceeds the following limits, it is restricted from land disposal:

<u>F006, F007, F008 and F009</u> <u>Category/Constituent</u>	<u>Concentration (ppm)</u>
CCWE	
- Cadmium	0.066
- Chromium	5.2
- Lead	0.51
- Nickel	0.32
- Silver	0.072
CCW	
- Cyanides (Total)	590
- Cyanides (Amenable)	30

LDR standards for wastes exhibiting the characteristic of ignitability (D001) have not yet been established. It may be that wastes exhibiting any of the RCRA characteristics will simply be banned from land disposal.

6.2.3.3 Impact of Restrictions or Waste Form Requirements

Solvents - No impact - The 1,000 ppm limit for HOCs is not a factor. The total of the maximum concentrations observed for volatiles and semi-volatiles (sections 6.2.2.1 and 6.2.2.2 respectively) is about 9 ppm. The HOCs included in that total are in the low ppb range. TCLP analysis for solvents performed on three saltcrete samples, provided no positive results. Comparing the results of normal analyses (which must be higher than TCLP values) to the CCWE standards, provides a stronger indication of no problem. The highest concentration observed (that for acetone) averaged just over one quarter of the CCWE limit and the maximum reading was still well below it.

Metals - Impact uncertain - No analyses have been performed on saltcrete for metals using the TCLP and only one sample has been run for total metals. Based on that single sample, cadmium, chromium, nickel and silver could all possibly exceed the CCWE

limits. However, in most cases, it would require essentially all of the metal to leach into the extract for this to occur. The fact that all results for EP toxic metals were at or less than detection limit also provides an indication that the CCWE limits may be met.

Cyanides - No impact - The highest total cyanide concentration observed was 18.5 ppm compared to LDR limit of 590 ppm. The highest concentration for cyanide amenable to chlorination was 18.2 ppm compared to an LDR limit of 30 ppm. Although only five samples were analyzed for total and amenable cyanide, all results were reasonably similar and well within the allowable limits for land disposal.

Ignitability - Impact uncertain - The LDR standards for ignitability have not yet been implemented. Cementation appears to eliminate the oxidizer characteristic of the nitrate salt; any other treatment alternate will have to consider adequate treatment for this parameter.

6.2.4 Treatment Alternatives

Saltcrete as currently generated appears to be acceptable to NTS for disposal and meets the applicable LDR standards for such an action. On May 8, 1990, EPA is scheduled to put into effect additional LDR standards which may or may not impact disposal of saltcrete. A representative sampling of the saltcrete needs to be subjected to the TCLP and analyzed for metals to determine if metal standards are met. This is, of course, assuming that the standards imposed for mixed waste do not change from those currently in effect for regular hazardous waste.

Should TCLP metal concentrations exceed LDR standards, it would be those standards identified for F006, F007, F008 and F009 wastes. EPA

has established BDAT for treatment of these wastes as alkaline chlorination followed by precipitation, settling, filtration, and stabilization of metals. However, the LDR establishes concentration-based standards rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards. The evaporation process has adequately separated the metals from the wastewater and the cyanide concentrations do not appear to be a problem. For the purpose of this waste category, stabilization of the metals appears to be the only concern and it may be adequately addressed by the existing cementation process.

In summary, in order for this waste form to meet all foreseeable restrictions on its disposal, it may require encapsulation, destruction or conversion of nitrates and stabilization of metals. The treatment alternatives being considered to accomplish these needs are two types of vitrification, two types of solidification, chemical destruction, and biodegradation.

Additional characterization of the on-going generation of saltcrete should be performed. Of particular concern is information on the results of TCLP analysis for metals. With cementation removing the oxidizer problem, the leachability of metals would be the only criteria in question for the existing waste treatment process.

6.2.5 Evaluation of Alternatives

Four treatment alternatives were evaluated against the criteria described in section 5.0. The results of the evaluation is shown in Figure 6.2. The treatment approaches and the result of their evaluation are discussed as follows.

Chemical Destruction by Thermal Denitration - Joule melter, microwave treatment and high temperature fluid wall reactor (HTFWR) are

Figure 6.2: Evaluation of the Treatment Alternatives For Nitrate Salt and Saltcrete

Need: Stabilization of Metals and Nitrate Destruction

Alternatives	Chemical Destruction by Thermal Denitration	Cementation	Polymer Solidification	Biodegradation
Effectiveness/ Development	9	9	9	9
Secondary Waste	2	4	4	0
Availability	2	6	4	2
Efficiency	2	1	2	1
TOTAL	15	20	19	12

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

alternatives under consideration. Joule melter and HTFWR have been feasibility tested at the pilot scale with surrogate waste. Nitrogen oxide emissions were controlled through addition of a reducing agent to convert the off-gas to nitrogen gas and water, or carbon dioxide. Microwave technology has been laboratory scale tested but no information is available on off-gas treatment. These technologies all produce a vitreous waste form which should meet LDR requirements. Since results have been promising they were given a score of nine for "Effectiveness/Development". Because this is a thermal treatment approach, a secondary waste stream (off-gas) is generated that is of concern and it was scored accordingly. Under the best circumstances it is estimated that production size treatment equipment could not be put into place within two years. A vitrified waste form generated by any of these technologies should not only destroy the nitrates and bind up the metals, but also should put radiological components of the waste in one of the best forms for disposal. These benefits, along with the fact that a vitrified waste form should be of smaller volume than a cemented waste, are offset by high capital operation and maintenance cost. This rationale resulted in a medium score under the "Efficiency" criterion.

Cementation - The continued use of cementation received the highest score, but an improved process needs to be developed. Bench scale testing on improved techniques have been initiated with promising results, the process would generate no secondary wastes, and the existing system could likely be upgraded in a relatively short period. These factors all contributed to cementation receiving a high score; it was marked down under "Efficiency" because cement solidification increases the waste volume and does not produce a final waste form as good as vitrification. The low score for "Efficiency" may indicate that cementation might not be the optimum treatment for the long term.

Polymer Solidification - The use of a low density polyethylene polymer to solidify the nitrate salt was scored very similar to cementation.

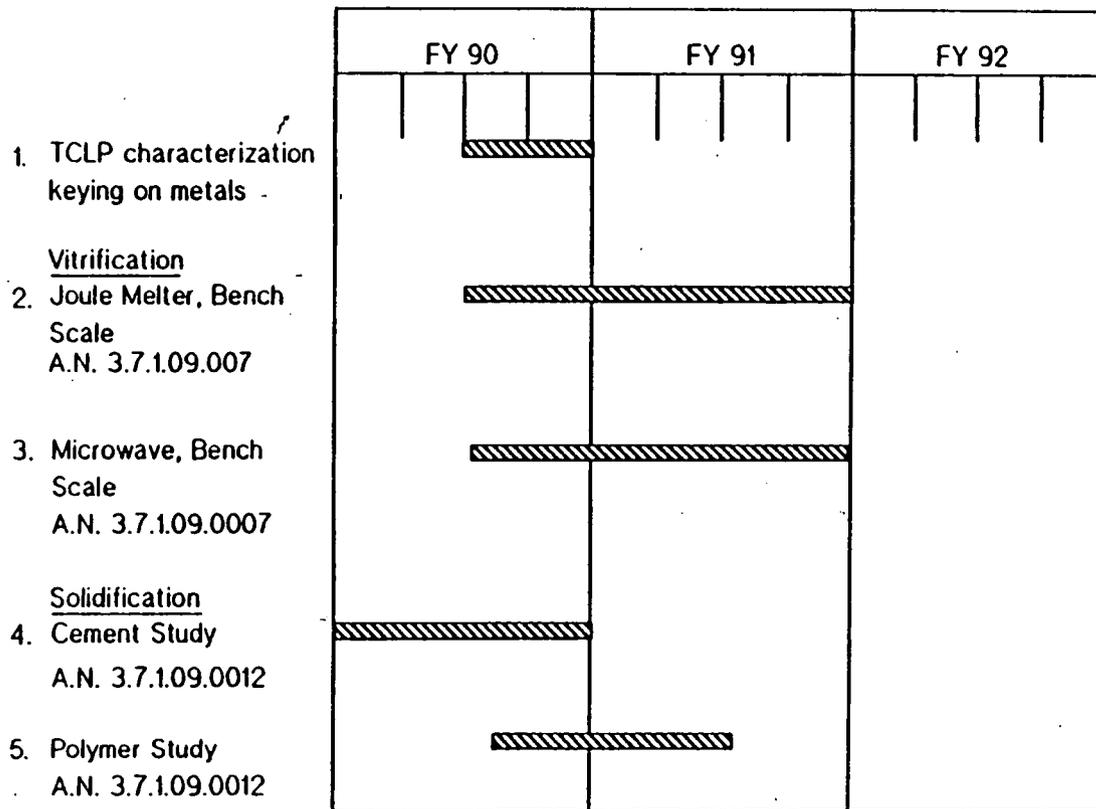
Bench scale testing has been initiated on the nitrate salt waste with promising results, but because it would likely be considered a new treatment, its full scale development may take more than a year if only because of the RCRA permitting implications. Capital costs are low and the waste form should meet all LDR requirements.

Biodegradation - Biodegradation has been successfully used in many instances to denitrify dilute aqueous waste such as the brine which generates nitrate salt, therefore, it received a fairly high score for "Effectiveness/Development". However, it received no points for "Secondary Waste Stream" because it would require multiple treatment steps to treat the brine to a waste form that which would stabilize both metals and radionuclides. This alternative also received a low score for "Efficiency" because the treatment would be slow and have questionable reliability due to the sensitivity of organisms to shock from environmental or waste characteristic changes. The total change to existing processes would also prohibit any full scale production from taking place faster than two years.

6.2.6 Schedule

The schedule for development activities associated with alternate treatment approaches for saltcrete are shown in Table 6.2. Development work is ongoing to improve the cementation process which is the highest ranked alternative. This work will be completed in FY 1990. Polymer solidification using low density polyethylene will be demonstrated beginning mid FY 1990 to mid FY 1991. Thermal denitration using the Joule melter, microwave energy, or HTFWR may be carried out at the bench scale should the TCLP characterization data warrant this robust a technology. This work will extend through FY 1991 if required.

Table 6.2: Schedule for Saltcrete Activities



58

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.3 Bypass Sludge

6.3.1 Generation Process

Bypass sludge (sometimes referred to as vacuum filter sludge) is generated from wastewater treatment processes in the Liquid Waste Treatment Facility at Building 374. As described in the corresponding section for saltcrete (section 6.2.1), the 374 wastewater treatment operation has three primary processes: (1) evaporation, (2) flocculation/precipitation, (3) and sludge dewatering. Bypass sludge is generated by dewatering the sludge that precipitates in the clarifier.

The flocculation, precipitation, and clarification process is designed for the removal of radioactive material. The settled sludge from the clarifier goes to the sludge handling step and the clarifier overflow goes to the evaporator. In the original sludge dewatering process, the sludge was intended to go through a rotary drum filter, then to a sludge dryer and finally a cementation process. However, the process was subsequently changed so that the sludge bypassed these two steps; hence, the waste became referred to as bypass sludge. In the current process, the sludge cut from the rotary drum filter is carried directly to a drum. Simultaneous with the sludge dumping into a drum, an approximately equal mixture of cement and diatomaceous earth enters through a separate screw feed system. The small amount of dry mixture is not intended to act as a cementation process but rather to absorb any free liquids that might separate from the sludge.

The feed for the rotary drum filter is collected in a sludge tank. In addition to the clarifier sludge from the flocculation/precipitation process, this sludge tank receives wastewater from a neutralization process for acidic wastewaters. With these two process sources (clarifier sludge and neutralized wastewater), waste streams contributing to the bypass sludge can be identified by facility as

follows:

- (1) Contributors to clarifier sludge via flocculation-precipitation process:
 - a. Building 559 - Plutonium Analytical Laboratory
 - b. Building 707 - Manufacturing Building
 - c. Building 774 - Liquid Waste Treatment Facility
 - d. Building 776 - Production Support Building
 - e. Building 779 - Plutonium Development Facility
 - f. Building 865 - Material and Process Development
 - g. Building 881 - Manufacturing and General Support
 - h. Building 883 - Manufacturing and General Support
 - i. Building 889 - Equipment Decontamination Facility
- (2) Contributors to neutralization process:
 - a. Building 371 - Plutonium Recovery Facility (Acid waste)
 - b. Multiple Buildings - containerized waste appropriate for treatment by neutralization.

There is some flexibility in the wastewater collection system for Building 374 processes. If wastewaters are not significantly contaminated with radionuclides (uranium, plutonium and americium are of primary concern), they go to the evaporator; if they have contamination then they go to the flocculation/precipitation process. In some instances, this decision is made on a batch basis. The buildings identified in (1) above are those normally going to the flocculation/precipitation process and thus contributing to generation of bypass sludge.

For several years, bypass sludge has been packaged and stored as mixed waste. As of September 1989, there is a current inventory of 1,763 drums (483 cubic yards) of bypass sludge awaiting disposition as radioactive mixed waste. It is estimated that generation of this waste form will continue in the future at a rate of about 216 cubic yards per year.

6.3.2 Waste Characterization

Bypass sludge is generated from the treatment of wastewater at Building 374. The treatment process precipitates radioactive metals, specifically uranium, plutonium, and americium. As would be expected, the sludge contains these materials as well as the chemicals added to promote the flocculation and precipitation process (i.e. ferric hydroxide and a polymeric flocculation agent). This treatment process is not specific to the radioactive metals, and co-precipitation of other heavy metals would also occur. These metals would be expected at lower concentrations since there are no major sources in the wastewaters entering this portion of the 374 treatment facility.

There is only limited analytical data available on the bypass sludge. In August 1988, three samples were taken and analyzed for the following parameters:

TCLP Spent Solvents

- VOA Compounds
- Methanol
- Acid Compounds

Appendix III* Volatiles

Appendix III* Semi-Volatiles

The analytical results on each of the listed parameters will be described in the following paragraphs. Based on the analytical results and process knowledge, EPA hazardous waste numbers that are or may be applicable to this waste will then be provided at the end of this section.

-
- This is Appendix III to 40 CFR 268 and is the list of HOCs regulated under the disposal restrictions on California wastes (268.32).

6.3.2.1 TCLP Spent Solvent

The three parameters or groups of parameters for which TCLP analyses were performed basically make up the list of F001 through F005 solvents regulated by LDR. The analytical results from three samples were consistent. Acetone and methylene chloride were both observed in all three samples at concentrations consistent with those seen in method and extract blanks (10 to 40 ppb range). The presence of these constituents were thus discounted. All of the other compounds were reported as "None Detected".

6.3.2.2 Appendix III Volatiles

Of the 34 volatiles for which analysis was performed, only methylene chloride was detected. It was seen in each of the three samples at an average concentration of 60 ppb (56 to 64 ppb range). Methylene chloride was also the only volatile showing up in both of the method blanks, but was seen at lower concentrations (19 and 12 ppb). Although questionable, the analytical results do not exclude the possibility of methylene chloride being present at low concentrations.

6.3.2.3 Appendix III Semivolatiles

The semivolatile analyses included 30 analytes. Hexachlorobenzene was the only compound reported in each of the three samples, but at concentrations (235, 175 and 191 ppb) below the detection limit of 330 ppb. Since the regulatory limit applicable to this material is 1,000 ppm for HOC, its presence or absence at these levels can be assumed to be insignificant.

6.3.2.4 Applicable EPA Hazardous Waste Numbers

The EPA hazardous waste numbers applicable to bypass sludge is quite similar to those of pondcrete and saltcrete. The primary exception is that some of the waste streams contributing to the two "cretes" have traditionally not gone through the flocculation/precipitation process but rather have gone directly to the evaporator. Some of the applicable hazardous waste numbers are identified as "likely". Because of the limited analytical data, additional sampling and analysis for a broader range of constituents will be required to determine whether or not these identifiers really do apply.

RCRA Characteristics - The only RCRA characteristic for dried, cemented sludge that is of particular concern is that associated with EP Toxicity. The major process contributing to the generation of this material is a wastewater treatment process designed to create a floc from metal hydroxides, followed by precipitation and clarification steps. This is standard treatment for industrial wastewaters contaminated with heavy metals. Although the Building 374 process is optimized for the removal of uranium, plutonium, and americium, co-precipitation of other heavy metals would be expected. The potential for these other metals being concentrated in the sludge cause the concern with respect to EP Toxicity.

The Waste Stream Identification and Characterization effort at the Plant sampled many of the individual waste streams coming to 374 from those buildings listed in section 6.3.1. Several of the waste streams as originally generated, contained EP Toxic metals. In fact, each of these metals, with the exception of barium and selenium, were seen in at least one waste stream. It is very unlikely that any of them would be in the 374 influent at levels approaching EP Toxicity limits because of dilution from other

waste streams. However, since they are known to be present and because they would be expected to precipitate to some extent in the treatment process, the following EP Toxic metals are of concern:

<u>Hazardous Waste Number</u>	<u>Description</u>
D004	Arsenic
D006	Cadmium
D007	Chromium
D008	Lead
D009	Mercury
D011	Silver

RCRA Listed Wastes - The applicable listed waste numbers for pondcrete and saltcrete are generally true for bypass sludge. The major difference is that wastewaters from Building 444, where electroplating activities take place, do not flow to the flocculation/precipitation process; they go directly to the evaporator. Therefore, the electroplating operations are not a source for the bypass sludge and the remaining listed wastes of concern are:

<u>Hazardous Waste Number</u>	<u>Description</u>
F001 to F005	Spent Solvents

6.3.3 Regulatory and Waste Form Requirements

6.3.3.1 Waste Form Requirements for Low-Level Waste Disposal

Bypass sludge may be generated as either low-level radioactive waste or transuranic waste depending on the concentration of transuranic nuclides in the specific waste container. If low-level, the waste will likely go to the Nevada Test Site (NTS) for disposal. The waste as currently stockpiled should be in an acceptable form for disposal at NTS once the issues related to acceptance of mixed waste are addressed. For bypass sludge the

two key requirements of the NTS Waste Acceptance Criteria (WAC) are those related to free liquids and particulates. The NTS WAC provides the following requirements:

Free Liquids. LLW disposed at NTS waste management sites must not contain free liquids. Waste containing liquids shall be solidified or have an absorbent, stabilizer, or both, added and mixed so that there will not be any free liquid during packaging, handling, transport, and disposal. Minor liquid residue remaining in well-drained containers, or liquids which have been entrapped, are acceptable. In no cases shall free liquid content exceed 0.5 percent by volume.

Particulates. Fine particulate wastes shall be immobilized so that the waste package contains no more than one weight percent of less-than-ten-micrometer-diameter particles, or 15 weight percent of less-than-200-micrometer-diameter particles, with radioactive contamination. When immobilization is impractical, the waste packaging shall include a sealed liner and be overpacked.

6.3.3.2 Applicable Land Disposal Restrictions (LDR)

LDR Requirements Now In-place - The applicable LDR regulations now in effect are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that applies, bans the land disposal of non-liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for specific spent solvents and can be found in 40 CFR 268.41. The regulation provides two concentration limits for each of 25 solvents: one applicable to wastewaters and the second to other waste forms. Of the 25 solvents, the only one detected in the bypass sludge is shown with its LDR limit as follows:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration(ppm)</u> <u>- nonwastewater -</u>
Methylene chloride	0.96

The solvent shown above was not observed (with any confidence) in the extract from the TCLP analysis. It is highlighted here because it is the only organic that appeared to be detected from the Appendix III analyses performed.

Future LDR Requirements - Most restrictions for mixed waste as well as those for the "final third" wastes are scheduled to go into effect May 8, 1990. Included in the "final third" wastes are those associated with RCRA characteristics. Although standards have not yet been set, bypass sludge could be impacted by these future standards as shown in the following:

<u>Potential Characteristic</u>	<u>Concentration Limit Set by LDR</u>
D004	TBD
D006	TBD
D007	TBD
D008	TBD
D009	TBD
D011	TBD

6.3.3.3 Impact of Restrictions or Waste Form Requirements

NTS Requirements - Possible impact - The key point for the bypass sludge form is the homogeneity of the sludge-cement mixture to insure no free liquids and limited fine particulate matter. Excluding RCRA issues, either of these problems could prohibit

disposal according to the NTS WAC. Additional inspection of the bypass sludge may be necessary to insure the quality of the waste form.

Solvents - No impact - The only solvent observed in the bypass sludge was methylene chloride and its presence was questionable based on laboratory quality control data. However, the levels seen in the total analysis were less than an order of magnitude below those that would ban land disposal if seen in the TCLP extract.

The information on solvent concentrations in the bypass sludge are based on very limited data, but since the data substantiates what would be expected from process knowledge, its value is significant. Concentrations in the wastewater would be small to begin with. There is no reason to expect solvents to concentrate in the sludge because of the flocculation/precipitation process and any tied up in the sludge would likely be lost during the vacuum filtration step.

Metals - Impact uncertain - Concentrations of EP Toxic metals in the sludge are unknown at this time as are the standards for LDR. These restrictions would not be in effect until May 8, 1990 at the earliest, but representative sampling of the bypass sludge should be performed as soon as possible to better characterize the waste.

6.3.4 Treatment Alternatives

The stored inventory of bypass sludge has questionable acceptability for land disposal based on its physical stability (free liquids and particulates are of concern) and possibly on its leachability for heavy metals. Based on the limited analytical data, the LDR requirements may be met with only the problem of free liquids

preventing the waste from being in a disposable form. Methods to stabilize the waste form and eliminate excess liquids should also take care of the one component that may cause the waste to exceed LDR requirements, leachability of heavy metals.

EPA has not yet published BDAT treatment standards in the LDR regulations for waste that is hazardous solely because it exceeds EP Toxicity limits for metals. However, for similar materials like sludges from treatment of electroplating wastewaters, stabilization of metals is the usual terminology used to describe the BDAT. In EPA guidance documents this normally refers to the addition of binding agents to the waste to ensure an acceptable, non-leachable waste form.

If bypass sludge must be treated differently to improve its form and decrease its leachability, reasonable treatment alternatives may be chosen. The first alternative should be to modify the existing treatment so that a more consistent, solidified waste is generated. This might be done by preconditioning the sludge to a drier more uniform consistency prior to adding the cement, by use of a better mixing mechanism once the cement is added, or by a combination of the two. This alternative may also include the consideration of a synthetic binding agent such as polyethylene. The next alternative would be more energy intensive, vitrification approach.

6.3.5 Evaluation of Alternatives

Three treatment alternatives were evaluated against the criteria described in section 5.0. The results of the evaluation are shown in Figure 6.3. The treatment approaches and the result of their evaluation are discussed in the paragraphs that follow.

Cementation - The use of cement to achieve the desired waste form received the highest evaluation score. This technology is normally considered the BDAT for stabilization of metals and bench scale testing

Figure 6.3: Evaluation of the Treatment Alternatives For Bypass Sludge

Need: Stabilization of Metals

Alternatives	Cementation	Polymer Solidification	Vitrification		
Effectiveness/ Development	9	6	9		
Secondary Waste	4	4	2		
Availability	6	4	4		
Efficiency	1	2	2		
TOTAL	20	16	17		

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

has been performed on an improved cementation process. However, the primary reason for this alternative scoring higher than the others evaluated was its score for the "Availability" criterion; this treatment is already present and is being performed on other waste streams at RFP under RCRA interim status. Cementation does have drawbacks as noted by its receiving the lowest score under "Efficiency". It increases the waste volume significantly and may be sensitive to changes in the waste characteristics. The low score for "Efficiency" may indicate that cementation might not be the optimum treatment for the long term.

Polymer Solidification - The use of a synthetic binding agent to replace the use of cement received a lower score than cementation because of its stage of development. In theory it should produce a good stable waste form, but it has not yet received bench scale testing. This and the fact that a polymer solidification process would likely have to be considered a new treatment under RCRA, would prevent its full scale implementation in less than a year. Polymer solidification did receive a higher "Efficiency" score than cementation primarily because it would not increase the volume of the final waste form as much as cement.

Vitrification - Both the microwave and the Joule melter were considered as possible treatment approaches to achieve a vitrified waste form. In this instance the evaluation reflects the higher score given to the microwave. Bench scale microwave testing using similar precipitation sludges has been initiated at the RFP with promising results. They rank lower than cementation and polymer solidification in "Availability" because they are more complicated treatment approaches and would require more time to procure and install equipment as well as to obtain the necessary regulatory permits. A higher score was given on the "Efficiency" criterion because the glassified waste form takes up less volume than cementation and is considered a more stable, less leachable form. In this case the higher score for "Efficiency"

reflects the evaluation of the microwave; the comparable score for the Joule melter was lower because the system is significantly more expensive and its added complexity raises potential issues of reliability.

All three treatment alternatives were scored fairly high, and microwave equipment is already available for testing. The successful testing of solidification approaches may prove valuable for short term improvement of the bypass sludge treatment and promising results from the microwave study may lead to a method of improving the ultimate waste form.

6.3.6 Schedule

The schedule for development activities associated with alternate treatment approaches for bypass sludge are shown in Table 6.3. Cementing ranked highest of the alternatives and will be developed to the extent practicable. Microwave treatment will be developed at the bench scale to determine feasibility and quantify parameters for larger scale development should it be required. The basis for applying thermal treatment or polymer solidification is based on the results of TCLP analysis. Should these results warrant, further development and implementation will be carried out expeditiously.

Table 6.3: Schedule for Bypass Sludge Activities

	FY 90	FY 91	FY 92
1. Analytical characterization of waste stream including TCLP solvents, EP Toxic metals, free liquids	▨		
<u>Solidification</u>			
2. Cement Tests A.N. 3.7.1.09.0012	▨		
3. Polymer A.N. 3.7.1.09.0012		▨	
<u>Vitrification</u>			
4. Microwave, Bench Scale A.N. 3.7.1.09.0008	▨	▨	

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.4 Roaster Oxide

6.4.1 Generation Process

Depleted uranium chips are roasted in Building 447 to an oxide form in order to eliminate their pyrophoric nature. The uranium oxide has been generated through one of two roasters. The old roaster was a four-tier furnace which used moving paddles to mix and convey chips to successive downward tiers. The chips readily sustained combustion once ignited. The uranium oxide was then collected in drums at the bottom of the roaster. The new chip roaster is a rotary calcine design. Uranium chips are fed into a hopper and through a shredder into a vat of water. A conveyor transfers the chips from the vat into the calciner which is a downward sloping tube with baffles for mixing. Heat is added to ignite the chips, but combustion is self-sustaining from that point. Again, uranium oxide is collected in drums at the end of the process.

Uranium chips are generated primarily through the machining of uranium metal which takes place in Buildings 444, 865 and 883. During this work, cutting/lubricating oil is applied to the metal being machined and, in the past, solvents were applied at the same location to remove the oil. The waste generated was thus a mixture of uranium chips, cutting oil and RCRA listed solvent. Hence the listed classification remained with the uranium waste chips through any subsequent processing or treatment. Currently, the use of listed solvents in the uranium machining process has been eliminated through use of an aqueous wash. The roasting process destroys the characteristic of ignitability and the final waste form is not hazardous. The roaster oxide is collected in 30-gallon drums which are in turn placed into 55-gallon drums. That uranium oxide waste which was generated when listed solvents were used has been stored in Building 884 and the 904 pad cargo containers. Because it is designated a radioactive mixed waste, no off-site facilities have been available for disposal. A total of 392 drums (107

cubic yards) are currently being stored at the Plant. As mentioned previously, this waste is no longer being generated so this inventory is not growing.

6.4.2 Waste Characterization

The roaster oxide waste has not been sampled, but process knowledge allows a fairly complete characterization. As generated, the uranium chip, oil, and solvent mixture qualifies as ignitable (D001) because of the pyrophoric uranium metal and is listed (F001) because of the use of the solvents 1,1,1-trichloroethane and 1,1,2-trichloro-1,1,2-trifluoroethane (freon TF) for degreasing the metal. The cutting oils and coolants used in the machining process are not hazardous per RCRA definitions. This was substantiated by the results of samples taken during the Waste Stream Identification and Characterization effort in 1987. Discussion on roaster oxide from this point on, apply only to that previously generated waste that qualifies as mixed. The roasting process eliminates the ignitability characteristic. However, the material must retain the following designation:

<u>Material</u>	<u>Hazardous Waste Number</u>	<u>Description</u>
Roaster oxide	F001	Uranium oxide that was previously contaminated with halogenated solvents used for degreasing

6.4.3 Regulatory and Waste Form Requirements

6.4.3.1 Waste Form Requirements for Low-Level Waste Disposal

Excluding any RCRA requirements, the roaster oxide inventory as currently packaged should probably meet the NTS Waste Acceptance Criteria (WAC). The Rocky Flats Plant must, of course, submit the appropriate documentation and certification to NTS as required by the WAC for their approval and waste acceptance. This has not

already happened because roaster oxide is radioactive mixed waste and currently there are limitations on the mixed wastes that NTS can accept for disposal. In the interim, physical characterization of the roaster oxide should be performed to ensure the amount of fine particulate does not exceed the NTS WAC criteria.

6.4.3.2 Applicable Land Disposal Restrictions (LDR)

Applicable LDRs are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that is applicable bans the land disposal of non-liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for spent solvents. The standards can be found in the CCWE Table in 40 CFR 268.41 and provide two concentration limits for each of 25 solvents: one applicable to wastewaters and the second for other waste forms. Although 25 different solvents are identified in the table, the following identifies only those suspected (from process knowledge) to be of concern for roaster oxide:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration (ppm) - nonwastewaters -</u>
1,1,1 - Trichloroethane	0.41
1,1,2 - Trichloro -	
1,2,2 - Trifluoroethane	0.96

If a waste (nonwastewater) exceeds the CCWE concentrations shown above, they are banned from land disposal.

6.4.3.3 Impact of Restrictions or Waste Form Requirements

No impact anticipated - Knowledge of the process generating roaster oxide makes it highly unlikely that significant residues of 1,1,1-trichloroethane or 1,1,2-trichloro-1,2,2-trifluoroethane could remain on the uranium oxide. It is even less likely that HOCs could reach concentrations of 1,000 ppm. However, representative samples should be taken of the inventoried roaster oxide and subjected to the TCLP for spent solvents. The presence of fine particulate should also be quantified to ensure criteria for disposal of low-level waste are met.

6.4.4 Treatment Alternatives

Currently there are no alternatives being considered for additional treatment or processing of the stored inventory of roaster oxide waste. The waste has already been treated with the BDAT (incineration) for non-liquids contaminated with F001 through F005 solvents. The form in which the waste currently exists should meet all applicable LDRs and be suitable for disposal provided fine particulate is not a problem. Once a disposal facility (likely NTS) is ready to accept this mixed waste, it will be shipped. Sampling of the roaster oxide will be required to verify that LDR standards and waste form requirements (fine particulate) are being met. Should the roaster oxide waste exceed the allowable level of fine particulate, a cementation process will be used to immobilize the particulates. One other option that may be considered in the management of this waste is delisting. A successful delisting would allow this waste to be disposed as low-level radioactive waste.

6.4.5 Evaluation of Alternatives

No treatment alternatives are being evaluated at this time. If necessary, a cementation process will be implemented to eliminate fine particulate problems.

6.4.6 Schedule

The schedule for activities associated with roaster oxide are shown in Table 6.4, and is limited to performing additional characterization of the waste. It is anticipated that the results of the characterization will indicate that no treatment technology development will be necessary. The characterization effort should be completed by the end of FY 1990.

Table 6.4: Schedule for Roaster Oxide Activities

Characterization of
waste, keying on
TCLP solvents and
fine particulate

	FY 90	FY 91	FY 92
			

6.5 Low-Level Mixed Waste Oil (FBI Oil)

6.5.1 Generation Process

Various operations generate waste oil that is contaminated with both hazardous and radiological constituents. This low-level mixed waste oil has been accumulated and stored at Building 774 with the intent of treatment through incineration in the Fluidized Bed Incinerator (FBI). Hence, the reference to this material as the FBI oil.

FBI oil is contaminated with plutonium and uranium at levels less than 100 nCi/gm and thus qualifies as low level waste. During the process in which the oil is used, it also becomes contaminated with spent solvents such as freon and carbon tetrachloride and as such qualifies as hazardous waste.

As of September 1989, almost 29,000 gallons of waste oil has been accumulated. The primary storage is in two 10,000 gallon tanks (Tanks T-102 and T-103) at 774; both are completely full and locked. The remaining inventory of FBI oil is being stored in drums inside buildings or cargo containers at various interim storage locations. It is estimated that this waste will continue to be generated at a rate of about 4,700 gallons per year.

6.5.2 Waste Characterization

Most of the FBI oil has been added as accumulated into the two 10,000 gallon tanks. The first tank to be filled has been sampled twice; once as part of the Waste Stream Identification and Characterization effort in 1986, and again in 1988. Provided below is a list of compound/parameter categories for which analyses were performed for both sampling events:

Category of Analytical Data	No. of Samples Analyzed	
	9/86	4/88
Volatiles	1	1
Semivolatiles	1	1
Metals		1
Radiochemistry	1	1
RCRA Characteristics		
Ignitability	1	
Corrosivity (pH)		1
EP Toxic Metals	1	

Each of the data categories listed above and the results of the sampling and analysis will be described in the following paragraphs. EPA hazardous waste numbers that are applicable to this waste, based on analytical results and process knowledge will also be provided at the end of this section.

6.5.2.1 Volatiles

Nine volatile compounds registered above detection limits (ADL) in at least one of the samples. Information on these analytes are as follows:

(Volatile) Analytes	ADL Concentrations (ppb)	
	9/86 Sample	4/88 Sample
1,1-Dichloroethane		24
Chloroform		40
1,1,1-Trichloroethane	8,000	1,374
Carbon tetrachloride		200
Trichloroethane		30
1,1,2-Trichloro-1,2,2,- trifluoroethane*	7,900	154
1,1,2,2-Tetrachloroethane		10
Toluene		1,044
Ethylbenzene		424

* Freon TF

6.5.2.2 Semivolatiles

No semivolatiles were observed at concentrations above detection levels in either sample.

6.5.2.3 Metals

Total metal analysis was performed on a single sample with the following results:

<u>Metal</u>	<u>Concentration (ppm)</u>
Aluminum	25.85
Antimony	<2.0
Arsenic	0.02
Barium	10.68
Beryllium	6.2
Cadmium	0.2
Calcium	230.0
Chromium	5.67
Cobalt	1.21
Copper	5.80
Iron	81.60
Lead	92
Magnesium	57.40
Manganese	3.08
Mercury	0.2
Molybdenum	ND
Nickel	4.1
Potassium	305
Selenium	<0.005
Silver	ND
Sodium	692.22
Strontium	1.1
Titanium	<0.01
Vanadium	ND
Zinc	69.95

6.5.2.4 Radiochemistry

Radiochemistry was performed on both samples, but not for all the same parameters. The results of the analyses are as follows:

<u>Analysis</u>	<u>Concentration (pCi/L)</u>	
	<u>9/86 Sample</u>	<u>4/88 Sample</u>
Gross Alpha	44,000 +/- 2,000	55,000 +/- 4,000
Gross Beta	16,000 +/- 1,000	
Pu-239	220 +/- 30	10,000 +/- 1,000
Am-241	480 +/- 70	
U-233,234	29,000 +/- 1,000	
U-238	21,000 +/- 1,000	
Uranium (Total)		46,000 +/- 7,000
Tritium	400 +/- 220	

6.5.2.5 RCRA Characteristics

Ignitability - The single test for ignitability indicated a flash point of 49.2°C. The oil does qualify as ignitable.

Corrosivity - The single analysis for pH provided a value of 5.9 indicating the FBI oil does not qualify as corrosive.

EP Toxic Metals - The one sample analyzed for EP Toxic metals indicated that only lead exceeded the criteria limit at a measured concentration of 200 ppm.

6.5.2.6 Other Characteristics

Several other characteristics were investigated for one of the samples with the following results:

<u>Test</u>	<u>Result</u>
Total Chloride	0.224 weigh %
Specific Gravity at 25°C	0.8869
Heat Content	22,168.5 +/- 1,872.8 BTU/lb
Viscosity at 100°F	210.4 +/- 1.4 SSU

6.5.2.7 Applicable EPA Hazardous Waste Numbers

FBI oil is generated from numerous locations and processes and the individual accumulations would be expected to have varying characteristics. The limited sampling substantiated this. Prior to treatment, additional sampling will likely be required to better characterize this waste, but based on the data available, the following categories would be applicable.

RCRA Characteristics - The following hazardous waste characteristics are applicable to FBI oil:

<u>Hazardous Waste Number</u>	<u>Description</u>
D001	Ignitable
D008	EP Toxic for lead

The available data shows only lead exceeding RCRA characteristic limits. But the total metals analysis data suggests that other metals could exceed the limits on some batches of oil as values vary. Additional samples and analyses for EP toxic metals would likely be required to insure that D008 is the only number that is applicable.

RCRA Listed Wastes - This waste is hazardous because the oil has been contaminated with listed solvents that have been utilized in cleaning/degreasing activities. The applicable waste numbers are as shown below:

<u>Hazardous Waste Number</u>	<u>Applicable Solvent(s) Observed</u>
F001, F002	Trichloroethene, 1,1,1-Trichloroethane, Carbon Tetrachloride, 1,1,2-Trichloro--1,2,2-Trifluorethane
F003	Ethylbenzene
F005	Toluene

Again, additional sampling of the accumulated oil will likely be required to better characterize the concentration of solvents present. However, it is unlikely that additional RCRA hazardous waste numbers will be identified.

6.5.3 Regulatory and Waste Form Requirements

6.5.3.1 Waste Form Requirements for Low-Level Waste Disposal

Even excluding any RCRA requirements, FBI oil does not meet waste form requirements for disposal as low-level waste. Because of its liquid nature and ignitability, treatment will be required before this waste can be disposed.

6.5.3.2 Applicable Land Disposal Restrictions (LDR)

As a liquid, the FBI oil is already banned by RCRA from disposal through landfilling; treatment is required. Listed wastes are present in the oil, thus any treatment residue will remain a listed waste by definition, and will require subsequent disposal in accordance with RCRA requirements. Some of the LDR would be applicable to treatment residue today, others will not be applicable until 1990. These restrictions are further described as follows:

LDR Requirements Now In-Place - The applicable LDR regulations now in effect are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that applies, bans the land disposal of liquids or non-liquids that exceed the following standards:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for specific spent solvents and can be found in 40 CFR 268.41. The regulation provides two concentration limits for each of 25 solvents; one applicable to wastewaters and the second (of concern here) applicable to other waste forms. Of the 25 solvents, those detected in the FBI oil are shown with their LDR limit as follows:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration (ppm) -nonwastewater -</u>
1,1,1-Trichloroethane	0.41
Carbon Tetrachloride	0.96
Trichloroethane	0.091
1,1,2-Trichloro- 1,2,2-trifluoroethane	0.96
Toluene	0.33
Ethylbenzene	0.053

Future LDR Requirements - With the exception of those identified above, restrictions for mixed waste are scheduled to go into effect May 8, 1990. Included are restrictions associated with RCRA characteristics. Although the standards have not yet been set, FBI oil or its treatment residue, could be impacted by these future standards as shown in the following:

<u>Potential Characteristic</u>	<u>Concentration Limit Set by LDR</u>
D001	TBD
D008	TBD
Other Metals	TBD

6.5.3.3 Impact of Restrictions or Waste Form Requirements

Low-Level Waste Disposal Requirements - Unacceptable - As a liquid, FBI oil is unacceptable for land disposal as low-level radioactive waste. Once the waste is treated to remove free liquids, the waste should meet low-level waste form requirements.

Solvents - Unacceptable - Solvent concentrations also restrict it from land disposal in general. Limited analytical data shows four F001-F005 solvents at concentrations well over the LDR limits in at least one of the two samples. It should be noted that the LDR limits for these solvents are expressed in terms of CCWE and the analytical data available was not from formal use of the TCLP. However, when analyzing liquids, there should be little if any difference in results between the TCLP and standard methods.

RCRA Characteristics (metals and ignitability) - Impact uncertain - LDR limits have not yet been established for these parameters, but it is highly unlikely that the waste would be acceptable for land disposal exhibiting characteristics it now has. Any treatment eliminating the liquid nature of the waste would likely eliminate the ignitability characteristic, but may also concentrate the metal constituents.

6.5.4 Treatment Alternatives

The stored inventory of FBI oil is presently unacceptable for land disposal. Concentrations of solvent and possibly metals along with the waste's ignitability and liquid nature, make treatment mandatory. EPA has established the BDAT for treatment of nonwastewater F001 through F005 solvents as incineration. However, the LDR establishes concentration-based standards for these wastes rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards. But the waste's heat content, ignitability, and liquid nature all appear to be a perfect match for incineration.

Since incineration would concentrate metals in the fly ash and bottom ash, the treatment residue would likely be hazardous because of EP Toxic metals. EPA has not yet published BDAT treatment standards in the LDR regulations for waste that exceeds EP Toxicity for metals.

However, based on similar wastes, stabilization of metals will likely be the terminology used to describe the BDAT.

In summary, the goal for treatment of the FBI oil should be the destruction of liquid organics and the stabilization of heavy metals in the residue. The alternatives evaluated include: incineration, wet oxidation, and biodegradation. Each of these treatment methods would likely involve a stabilization step for heavy metals. One possible treatment method, the Joule melter, which should destroy organics and provide a stabilized waste form is also considered. Two other alternatives are air stripping to remove the volatile solvents in the oil and radionuclide decontamination to remove the oil from the category of mixed waste.

6.5.5 Evaluation of Alternatives

Six treatment alternatives were evaluated against the criteria described in section 5.0. The results of the evaluation are shown in Figure 6.5. The treatment approaches and the result of their evaluation are discussed in the paragraphs that follow.

Incineration - This treatment alternative received the highest evaluation score primarily because it is the BDAT and has been shown to be effective on wastes very similar to the FBI oil. Incineration does produce a secondary waste stream (off-gas) but if its destruction efficiency meets RCRA requirements, this waste stream is of little concern. This alternative received a zero for "Secondary Waste Stream" because the resulting ash will undoubtedly require solidification to meet disposal criteria for low-level waste and possibly to meet RCRA requirements for leachable metals. This waste is well suited for treatment in the existing fluidized bed incinerator(FBI), but it is estimated that it would take greater than two years to have the FBI or another incinerator in full production. This alternative also

**Figure 6.5: Evaluation of the Treatment Alternatives
For Low-Level Mixed Waste Oil (FBI Oil)**

Need: Destruction of Organics

Alternatives	Incineration	Joule Melter	Wet Oxidation	Biodegradation	Air Stripping	Radionuclide Decontamination
Effectiveness/ Development	12	6	9	6	6	6
Secondary Waste	0	2	0	0	0	0
Availability	2	2	2	2	2	2
Efficiency	3	2	1	1	2	1
TOTAL	17	12	12	9	10	9

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

received the highest score in "Efficiency" because of its proven reliability and the volume reduction achieved through its use.

Joule Melter - Use of the Joule melter received the second highest evaluation score. The reason for a score lower than incineration was the lack of bench scale testing on this specific waste to verify the treatment alternative's effectiveness. In theory it is felt that the melter can achieve the destruction efficiency required by EPA for thermal treatment of organics and the score reflects the assumption that the off-gas is not a problem. Additionally, the resulting glass residue would not require further treatment so the alternative was given a higher score for "Secondary Waste Stream" than was incineration. As with incineration, it is assumed that it would take greater than two years to get to a production scale of a Joule melter, even if testing was successful. The melter was scored lower than the incinerator in "Efficiency" because of higher capital cost, lower volume reduction, and reliability concerns.

Wet Oxidation - The alternative of wet oxidation through acid digestion was evaluated as another means to destroy organics. This technology was developed to full scale at the Hanford Engineering Development Laboratory. Bench scale testing to determine applicability to this waste is under way at Rocky Flats. The treated waste results in metal salts in the form of sludge which needs alternate solidification, an aqueous distillate, and an off-gas of oxides of sulfur and nitrogen. By definition it carries the designation of a listed waste; and even if the waste were delisted, additional treatment would be required to get it into a form suitable for disposal as low-level waste. It was also felt that a treatment approach to accomplish all of this would take longer than two years to implement. This alternative also received a low score for "Efficiency" because of its apparent lack of volume reduction and its questionable reliability in achieving the required destruction efficiency.

Biodegradation - Biodegradation has proven to be a possible treatment approach for most organic materials. Testing done at Notre Dame University in FY 1988 was not very encouraging. However, there are many different forms of biological treatment, but it is assumed that the resulting waste will require additional treatment to be put into a disposable form. The resulting waste will still be a listed waste. Because multiple treatment steps appear necessary, this alternative received a zero for "Secondary Waste Stream". Testing, developing and permitting of such a system would take greater than two years to accomplish. Because biological systems are normally slow and sensitive to upset, this alternative received a low score for "Efficiency".

Air Stripping - It should be possible to strip the FBI oil of volatile components through contact with an air stream, but this has not been tested on the specific waste. Hazardous solvents may be removed from the oil at a relatively high efficiency, but the remaining oil will undoubtedly require additional treatment to make it acceptable for land disposal. The resulting air stream would also be of regulatory concern. For these reasons this alternative received a zero score for "Secondary Waste Stream". "Availability" of the treatment approach is also considered poor because significant time would be required for the development phase. Air stripping received a medium score on "Efficiency" because it does not reduce volume. Furthermore, it is not certain that the treated oil would be within the LDR standards for solvents.

Radionuclide Decontamination - Another treatment option with potential is to remove radiological contamination from the oil so that it can be destroyed or recycled commercially. There are currently techniques available in industry that are capable of removing radionuclide contamination from oils to below regulatory concern. However, since testing has not been performed on the FBI oil, this option received only a six for "Effectiveness/ Development". This decontamination

would also generate two waste streams (radionuclides and the oil) that would both require additional treatment, and thus decontamination warrants a zero score for "Secondary Waste Stream". No real development work has been done so this alternative also scores low in the "Availability" area. The lack of volume reduction and the uncertainty of achieving contamination levels below regulatory concern, resulted in this alternative receiving a low score for "Efficiency".

The results of the evaluation show incineration to be the most viable alternative for treatment of the FBI oil. Currently, at the direction of DOE, a plan is being prepared to put the existing fluidized bed incinerator into an operational mode. Use of the WERF incinerator at the Idaho National Engineering Laboratory (INEL) is also being considered for incineration of the FBI oil and negotiations are on-going. Treatment alternatives that did not score as high as incineration are also being considered. Testing of the Joule melter, wet oxidation, and biodegradation will continue in hopes of developing a sound backup alternative for incineration.

6.5.6 Schedule

The schedule for development activities associated with alternate treatment approaches for FBI oil are shown in Table 6.5. Potential use of the existing RFP and INEL incinerators are continuing as shown on the schedule. Although the FBI start up plan is scheduled to be completed by the end of CY 1989, there is currently no firm schedule for the decision on whether or not to implement the plan. A trial burn of 200 gallons of the FBI oil at the INEL incinerator is still tentatively scheduled to occur by January 1990. If this burn does actually take place successfully, then burning of small quantities may continue until the INEL incinerator upgrades are completed. Lab scale testing in FY 1990 is underway for wet oxidation to determine the feasibility of this technology. Should the feasibility be

demonstrated, lab scale, followed by bench and pilot scale work will proceed in FY 1991-93. Prototype Joule melter development is planned for FY 1990. However, application to this waste stream cannot be made before 1993.

Table 6.5: Schedule for FBI Oil Activities

	FY 90	FY 91	FY 92	FY 93	FY 94
1. FBI Startup Plan					
2. Pursuit of incineration at the INEL - 200 gallon trial burn - Continued negotiations	 				
3. Joule Melter Bench Scale Test A.N. 3.7.1.09.0018					
4. Wet Oxidation Lab Study A.N. 3.7.1.09.0002					
5. Biodegradation Lab Scale Test (Not Funded)					

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.6 Combustibles

6.6.1 Generation Process

Combustibles, generated at numerous locations, are generally composed of such materials as paper, cloth and plastics. The material is contaminated at low concentrations with depleted uranium and plutonium through contact during manufacturing and related processes. The waste is also considered hazardous because of co-contamination with solvents that are used in the manufacturing process. The materials making up this waste are items that have been used to wipe off products being machined, cleaned or otherwise handled.

As a mixed low-level waste, there are currently no off-site treatment, storage or disposal facilities available to accept this waste. As of September 1989, RFP had accumulated 153 cubic yards (546 drums and one 4' x 4' x 7' box) of combustible waste. Combustible waste is generated at a rate of approximately 41 cubic yards (150 drums) per year.

6.6.2 Waste Characterization

Combustible waste has had limited sampling for hazardous constituents; however, its characterization has been primarily based on process knowledge. The waste is both radioactive and hazardous because of the materials used in the manufacturing process. Solvents are applied to radioactive materials (primarily uranium and plutonium) and wiped off or contacted by the combustible materials making up this waste stream. The major solvents felt to be involved in these cleaning/degreasing activities are provided below:

Solvent

1,1,1-Trichloroethane
Methylene Chloride
1,1,2-Trichloro-1,2,2-trifluoroethane
2-Butanone
Toluene
Acetone
Trichlorofluoroethane
Ethylbenzene
Trichlorofluoromethane

The first three solvents listed are those most often found in the generating processes. Because of the small quantities and the volatility of the solvents involved, the concentrations of any of these materials in the waste form will be small. However, the RCRA hazardous designation accompanies the waste independent of hazardous constituent concentrations.

Limited sampling of combustibles was accomplished in 1986 and 1987 for the RFP Waste Stream Identification and Characterization (WSIC) published in 1987. Provided below is a list of compounds/parameters categories for which analysis were performed for each of the sampling events.

<u>Category of Analyte Data</u>	<u>Number of Samples Analyzed</u>			
	<u>1986</u>	<u>2/87</u>	<u>3/87</u>	<u>Total*</u>
Volatiles	4	4	6	14
Semi-volatiles			2	2
Metals	1			1
Radiochemistry	3	2	2	7
RCRA Characteristics				
Ignitability			1	1
Reactivity			1	1
EP Toxic Metals			4	4

*The WSIC includes 20 combustible waste streams that are identified as mixed waste in the December 1987 Part B Permit Application for the RFP. Of those 20 waste streams only fourteen (14) were sampled as part of the WSIC effort; the remaining six (6) were characterized by process knowledge only.

The analytical results for each of the data categories listed above will be described in the following paragraphs. Based on analytical results and process knowledge, EPA hazardous waste numbers that are applicable to this waste will be provided at the end of this section.

6.6.2.1 Volatiles

Thirteen (13) volatile compounds were seen above detection limits (ADL) in one or more of the fourteen (14) samples analyzed. Information on those compounds are summarized as follows:

<u>(Volatile) Analyte</u>	<u>Number of ADL Readings</u>	<u>Average of ADL Readings</u>	<u>Range of ADL Readings</u>
Methylene Chloride	10 of 14	883 ppb	120 - 2400 ppb
Toluene	4 of 14	286 ppb	32 - 750 ppb
Chloroform	4 of 14	297 ppb	29 - 620 ppb
1,1 - Dichloroethane	1 of 14	53 ppb	
Total Xylenes	5 of 14	3937 ppb	15 - 18000 ppb
Trichlorofluoroethane	1 of 14	61 ppb	
1,2 - Dichloropropane	1 of 14	73 ppb	
Acetone	8 of 14	2000 ppb	130 - 6800 ppb
1,1,2 - Trichloro- 1,2,2 - Trifluoroethane	3 of 14	2043 ppb	130 - 3800 ppb
2 - Butanone	2 of 14	3715 ppb	130 - 7300 ppb
Ethylbenzene	1 of 14	410 ppb	
Trichlorofluoromethane	1 of 14	340 ppb	
1,1,1 - Trichloroethane	1 of 14	3700 ppb	

6.6.2.2 Semi-Volatiles

Only one semivolatile compound was seen above detection limit (ADL) in either of the two samples analyzed. Information on the analyte is summarized as follows:

<u>Semi-Volatile Analyte</u>	<u>Number of ADL Readings</u>	<u>Average of ADL Readings</u>
Di-n-Octyl Phthalate	1 of 2	20000 ppb

6.6.2.3 Metals

Total metal analysis was performed on only one sample. The results are summarized as follows:

<u>Metals</u>	<u>Concentration (ppm)</u>
Aluminum	36.6
Antimony	171
Arsenic	2.57
Cadmium	4.38
Chromium	35.8
Cobalt	17.4
Copper	7.56
Iron	2390
Lead	63.8
Manganese	80.3
Nickel	10.9
Potassium	1270
Selenium	1.6
Silver	20.0
Zinc	2.9

6.6.2.4 Radiochemistry

Radiochemistry was performed on seven (7) samples. The results are summarized as follows:

<u>Analysis</u>	<u>Ave. Conc. (pCi/g)</u>	<u>Range of Conc. (pCi/g)</u>
Gross Alpha	211	0.3 - 1400
Gross Beta	304	0.1 - 2100
Pu-239	1.03	0 - 7.2
Am-241	0.57	0 - 0.36
U-233, 234	18.9	0.01- 130
U-238	159	0.05- 1100
Tritium	0.74 pCi/ml	0 - 3.1 pCi/ml

Each individual radiochemistry analysis was originally reported with an associated +/- value. This value indicated the 95% confidence range for the radionuclide result. For simplicity, this value was excluded from the averaging process. In general terms, the 95% confidence interval was about +/- 100 pCi/g when

the values were in the thousands and about +/- 10 pCi/g when the values were in or near the hundreds. For tritium, the interval was either +/- 0.2 or 0.3 pCi/ml for each analysis.

6.6.2.5 RCRA Characteristics

Ignitability - One sample was found to be above the 60°C flash point limit.

Reactivity - One sample was analyzed for its reactive sulfide and cyanide concentration (different than total sulfide and total cyanide). Sulfide concentration was found to be below the detection limit. The cyanide concentration measured above the detection limit (ADL) at a level of 375 ppm. The current EPA action level for reactive cyanide is 250 ppm.

EP Toxic Metals - Four samples were analyzed for EP Toxic metals. Only one had a metal above detection limit and that was for mercury. The single result for mercury also exceeded its EP Toxicity limit of 0.2 ppm; it had a reading of 51.4 ppm.

6.6.2.6 Applicable EPA Hazardous Waste Numbers

Combustible waste has been characterized by process knowledge with some limited sampling. There is considerable variability in the makeup of the combustible waste drums, and this causes problems in getting good representative samples. In many cases the following hazardous waste designations represent a potential concern rather than a true description of the waste.

RCRA Characteristics - Combustibles qualify as a characteristic waste based on the results of individual analytical tests performed on the material in the various drums. The following EPA hazardous waste numbers may be applied to the combustibles:

Hazardous Waste
Number

Description

D009
D003

EP Toxic for Mercury
Reactivity

Additional sampling and analysis for EP toxic metals and reactivity would likely be required to insure that D009 and D003 are applicable. These designations are due to results of only one sample.

RCRA Listed Wastes - The primary reason for this waste to be considered mixed is process knowledge. It is known to be contaminated with listed solvents and low concentrations of depleted uranium and plutonium from manufacturing processes. The applicable waste numbers are as follows:

Hazardous Waste
Number

Description

F001

Spent halogenated solvents used in degreasing

F002

Spent halogenated solvents

F003

Spent non-halogenated solvents

F005

Spent non-halogenated solvents

Additional sampling of the combustibles will likely be required to better characterize the concentrations of solvents present in each drum of waste.

6.6.3 Regulatory and Waste Form Requirements

6.6.3.1 Waste Form Requirements for Low-Level Waste Disposal

If the combustible wastes were low-level rather than mixed waste, they would likely be suitable for disposal. Depending on the specific disposal facility, some additional treatment or handling may be required in order to improve the physical stability and or reduce the volume of the waste. Compaction or incineration

with ash stabilization would be the most traditional methods to improve the waste form. The NTS acceptance criteria states that this type treatment should be performed where practical, but does not appear to make it mandatory. However, such requirements could easily become more stringent in the future.

6.6.3.2 Applicable Land Disposal Restrictions (LDR)

The current LDR regulations applicable to the combustible waste are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that applies, bans the land disposal of non-liquids that exceed the following standards:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated Organic Compound (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for spent solvents. The standards can be found in 40 CFR 268.41 and provide two concentration limits for each of 25 solvents: one applicable to wastewaters and the second for other waste forms. Process knowledge and analytical results show the following solvents to be of concern in the samples:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration (ppm) - nonwastewater -</u>
Acetone	0.59
2-Butanone	0.75
Methylene Chloride	0.96
Toluene	0.33
1,1,1-Trichloroethane	0.41
1,1,2-Trichloro- 1,2,2-Trifluoroethane	0.96
Trichlorofluoromethane	0.96
Ethylbenzene	0.053
Xylene	0.15

If a waste other than wastewater exceeds the CCWE concentrations shown above, they are banned from land disposal.

6.6.3.3 Impact of Restrictions or Waste Form Requirements

Low-Level Waste Disposal Requirements - No impact - The present form of combustible waste has no free liquids and meets the criteria for disposal as low-level waste.

RCRA Characteristics - Impact uncertain - One sample of combustible waste exhibited the characteristic of reactivity because of cyanide and one sample exhibited the characteristic of EP Toxicity because of mercury. However, these analytical results may not be representative of the waste and, in any case, EPA has not yet established LDR standards for wastes exhibiting RCRA characteristics.

RCRA Listed Wastes (Solvents) - Unacceptable - Nine (9) F001 through F005 solvents were identified in Section 6.6.3.2 as being of concern and were shown with their applicable LDR standard. Of those nine solvents, seven were observed in a least one sample at levels equal to or higher than its applicable LDR standard. Solvent concentrations in some instances were observed which were an order of magnitude greater than the standard. It should be noted that the analytical results are for total concentrations, whereas the LDR standards are in terms of TCLP concentrations. However, based on the information available, it can be safely assumed that some of the combustible waste will exceed the TCLP-based standards.

6.6.4 Treatment Alternatives

Representative samples of the combustible waste are difficult to obtain because of the manner in which the waste is generated. Solvent

concentrations in the waste vary significantly based upon manufacturing practices. However, limited sampling indicates at least some of the waste exceeds LDR standards for solvents and will require treatment. It is assumed that the isolated incidents where cyanide and mercury were observed, do not represent a separate treatment need for the waste.

EPA has established the BDAT for treatment of nonwastewater F001 through F005 solvents as incineration. However, the LDR establishes concentration-based standards for these wastes rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards. The waste's heat content and combustible nature does appear to be an excellent match for incineration and ash solidification. The resulting waste form would be significantly reduced in volume and stabilized for disposal.

The goal of treatment technologies should be the thermal destruction of the organic contaminants (solvents). However, since the LDR do not mandate destruction of the organics, other types of treatment are also being considered.

6.6.5 Evaluation of Alternatives

Five treatment alternatives were evaluated against the criteria described in section 5.0. The results of the evaluation are shown in Figure 6.6. The treatment approaches and the result of their evaluation are discussed in the paragraphs that follow.

Incineration - This treatment alternative received the highest evaluation score primarily because it is the BDAT and has been shown to be effective on wastes very similar to the combustible wastes. Incineration does produce a secondary waste stream (off-gas) but if its destruction efficiency meets RCRA requirements the off-gas or its

Figure 6.6: Evaluation of the Treatment Alternatives For Combustibles

Need: Destruction of Organics

Alternatives	Incineration	Joule Melter	Wet Oxidation	Extraction	Polymer Solidification
Effectiveness/Development	12	6	6	6	6
Secondary Waste	0	2	0	0	2
Availability	2	2	2	4	2
Efficiency	3	2	2	1	2
TOTAL	17	12	10	11	12

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital-cost, and its overall reliability.

residue are not LDR problems. However, this incineration received a zero for "Secondary Waste Stream" because the existing fluidized bed incinerator (FBI) uses a catalyst (chromium oxide) which will likely cause the ash to be hazardous because of EP Toxic metals. Treatment of the ash will be required in order to be within LDR requirements. Combustible waste is well suited for treatment in the existing FBI, but because of regulatory requirements, it is assumed that it would take greater than two years to have the incinerator in full production. This alternative also received the highest score in "Efficiency" because of its proven reliability and the volume reduction achieved through its use.

Joule Melter - Use of the Joule melter received the second highest evaluation score, although significantly less than incineration. This was due to the lack of bench scale testing on the specific waste to verify the treatment's effectiveness. The melter should achieve the destruction efficiency required by EPA for thermal treatment of organics and the score reflects the assumption that the off-gas should not be a significant problem. Additionally, the resulting glass residue would not require further treatment so the alternative was given a higher score than incineration for "Secondary Waste Stream". It is assumed that it would take greater than two years to get to a production scale Joule melter, even if testing was successful. The melter was scored lower than the incinerator in "Efficiency" because of higher capital cost, lower volume reduction, and reliability concerns.

Wet Oxidation - Wet oxidation through acid digestion was also evaluated as a means to destroy organics. It received the lowest score; its effectiveness has not been demonstrated on the specific waste, and the resulting waste would require significant treatment to be acceptable for disposal. It was also felt that this treatment approach would take longer than two years to implement into production. The alternative was given a medium score for "Efficiency" because volume

should be reduced, but the reliability of achieving the required destruction efficiency is questionable.

Extraction - Two types of treatment are being considered to extract the hazardous solvent contamination from the combustible waste: (1) supercritical fluid (using CO₂) and (2) aqueous wash. Aqueous wash scored slightly higher than supercritical fluid because it is a much simpler technology and it was assumed that it could be put into production much faster. Aqueous wash has received more testing of the two, but is still in question as to its ability to routinely achieve solvent levels below the LDR standards. Residues from both extraction processes remain hazardous by definition as does the extracted material so the "Secondary Waste Stream" is scored zero. "Efficiency" was scored low because the waste volume is not reduced (and may be increased) and the ability of both technologies to achieve LDR standards is questionable.

Polymer Solidification - The use of a polymer binding agent to decrease the leachability of the organic contaminants is a possible alternative since applicable LDR standards are in the form of contaminant levels in an extract. This approach should work, but it has not been tested on the specific waste. Polymer solidification received a zero under "Secondary Waste Stream" because the extrusion process is done at elevated temperatures, and volatiles will be driven off. This causes the off-gases to be of regulatory concern and they would probably require additional treatment. The combustible waste also would likely require some type of "sizing" pretreatment. This process could not be developed to a production stage in less than two years. It was given a medium score for "Efficiency" because it is a relatively straight forward treatment process.

The results of the evaluation show incineration to be the most viable alternative for treatment of the combustible waste. A plan is being prepared to bring the existing fluidized bed incinerator (FBI) into

an operational mode. Treatment alternatives that did not score as high as incineration are also being considered. Testing of the Joule melter, wet oxidation, both types of extraction, and polymer solidification will continue in order to develop a sound backup alternative for incineration.

6.6.6 Schedule

The schedule for development activities associated with alternate treatment approaches for the combustible wastes are shown in Table 6.6. Although the FBI startup plan is scheduled to be completed by the end of CY 1989, there is currently no firm schedule for the decision on whether or not to implement the plan.

Table 6.6: Schedule for Combustible Waste Activities

	FY 90	FY 91	FY 92
1. Characterization of waste, keying on TCLP for spent solvents, EP Toxic metals, and cyanides	▨		
2. FBI Startup Plan <u>Vitrification</u>	▨		
3. Joule Melter Bench Scale Tests A.N. 3.7.1.09.0018 <u>Wet Oxidation</u>	▨	▨	▨
4. Lab Study A.N. 3.7.1.09.0002 <u>Extraction</u>	▨	▨	▨
5. Super Critical Fluid Bench Scale Tests CO ₂ Decon P.N. 970009 A.N. 3.7.1.09.0016	▨	▨	▨
6. Aqueous Wash Bench Scale Test A.N. Not Identified <u>Solidification</u>	▨	▨	▨
7. Polymer Bench Scale Tests A.N. 3.7.1.09.0022	▨	▨	

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.7 Lead

6.7.1 Generation Process

Lead waste is generated at numerous locations throughout the RFP, normally in the form of discarded shielding. The lead is considered inappropriate for reuse and hence waste, because it is radiologically contaminated. The waste shielding, usually sheets, is often size reduced by cutting in order to fit inside 55-gallon drums or other containers for storage.

Some of the waste lead is suspected to contain radiological contamination solely because of the work areas from which it is generated. Uranium and plutonium are the radiological contaminants most often present. Also, some of the lead is designated contaminated because it has been painted and it is common practice to paint over portions of items that have non-removable surface contamination.) The waste lead is considered mixed waste because elemental lead fails the EP Toxicity test. There are no other types of solvent or chemical contamination suspected in this waste.

Since there are no off-site facilities taking this waste for disposal or treatment, the accumulation of waste lead is being stored on-site in Buildings 776 and 884. As of October 1989, an inventory of 111 drums and three half-boxes (30.4 cubic yards total for both the drums and the half-boxes) are being stored at the Plant. It is estimated that this waste will continue to be generated at a rate of approximately 20 cubic yards per year.

6.7.2 Waste Characterization

The lead waste has not been sampled, but process knowledge allows a relatively complete characterization of this waste stream. Lead metal has been shown to fail the EP Toxicity tests in numerous

tests. The concentration of lead in the extract may vary due to several factors such as the amount of surface oxidation or amount of surface area exposed to the leaching action, but values exceeding the limit of 5 mg/l are the norm. The radiological contamination that makes the lead inappropriate for direct reuse or recycling makes it a mixed waste. The EPA hazardous waste number applicable to this waste is as follows:

<u>Material</u>	<u>Hazardous Waste Number</u>
Lead	D008

6.7.3 Regulatory and Waste Form Requirements

6.7.3.1 Waste Form Requirements for Low-Level Waste Disposal

The difficulty in handling and disposing of this waste is primarily due to the RCRA hazardous characteristic that it exhibits. If the lead waste were solely low-level radioactive, it would likely be suitable for disposal in its present form.

6.7.3.2 Applicable Land Disposal Restrictions (LDR)

The specific criteria or limitations for RCRA characteristic waste have not yet been promulgated or proposed. Since this waste is hazardous only because it exhibits the characteristic of EP Toxicity for lead, it is not yet covered by the LDR. However, the criteria are scheduled to be in effect by May 8, 1990. Until that time, lead could legally be disposed in a RCRA facility if one were available for mixed waste.

Although standards have not yet been set, lead waste could be impacted by future standards applicable to the following:

<u>Potential Characteristic</u>	<u>Concentration Limit Set by LDR</u>
D008	TBD

6.7.3.3 Impact of Restrictions or Waste Form Requirements

Impact uncertain - The long term impacts on its disposal are uncertain since the LDR regulations for this specific waste have not yet been proposed. There is a possibility that the LDR will simply ban the disposal of wastes that exhibit any of the RCRA hazardous characteristics. Should this occur, the waste would have to be put into a more stable, less leachable form or it would have to be treated to remove the radiological contamination and reused. In the first instance the waste would no longer be RCRA hazardous and in the second instance the material would no longer be a waste. Another possibility would be the setting of an extraction concentration higher than the EP Toxicity limit which would allow waste still qualifying as hazardous to be disposed. Depending on the limit set, the lead could possibly require no additional treatment before disposal.

6.7.4 Treatment Alternatives

The need for treatment is uncertain since it is uncertain whether the lead waste will exceed LDR standards. EPA has not yet published BDAT treatment standards in the LDR regulations for waste that is hazardous solely because it exceeds EP Toxicity limits for metals. However, based on BDATs for similar materials like sludges from treatment of electroplating wastewaters, stabilization of metals will be a possible approach.

Since the waste of concern is basically elemental lead, the option or possibility of recycling is an obvious consideration. Radiological contamination is not easily separated from the lead; however, there has been some work done in this area that appears promising.

Until applicable LDR standards are finalized, the need for this waste stream is assumed to be treatment to a less leachable form or treatment to allow reuse or recycling. The alternatives being considered are use of the microwave system to form lead glass, decontamination through smelting, and solidification through cementation or with a polymer binder.

6.7.5 Evaluation of Alternatives

Four treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.7. The treatment approaches and the result of their evaluation are discussed as follows.

Decontamination and Reuse - This process involves the smelting of lead and collection of the radiological contamination in the dross. The dross would then have to be stabilized to a non-leaching form and the product metal would be clean enough for reuse. This process has been demonstrated at the INEL with some success on certain types of contamination. The process was given a nine under "Effectiveness/Development" because it has been shown to be successful on bench scale testing. It was given a zero for "Secondary Waste Stream" because the dross would require treatment to be suitable for disposal. It is assumed that process development and equipment procurement would take greater than two years to get to a production scale. The "Efficiency" was given a high score because the volume of waste is significantly reduced with portions being made available for reuse.

Figure 6.7: Evaluation of the Treatment Alternatives For Lead

Need: Recycling and/or Stabilization

Alternatives	Decontamination and Reuse	Polymer Solidification	Cementation			
Effectiveness/Development	9	6	6			
Secondary Waste	0	0	0			
Availability	2	2	2			
Efficiency	3	1	1			
TOTAL	14	9	9			

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

Polymer Solidification and Cementation - Both of these alternatives were scored identically and are, thus, addressed together. Ideally, either process could be used to micro-encapsulate lead such that leachability tests would be passed. However, no significant testing has been completed to verify the success of this approach. Both options were scored zero under "Secondary Waste Stream" because the lead waste would require significant conditioning or treatment to put it into a form amenable to micro-encapsulation. Considering the early stage of development of the process, it is anticipated that more than two years would be required to get to production scale. The score for "Efficiency" was low because the waste volume is increased and the leachability of the waste form is unknown.

Present plans are to consider all three of the alternatives described above for additional testing. Decontamination received the highest score and appears to offer the most promise. However, the solidification techniques are relatively simple to evaluate and, if successful, offer alternatives which are much less costly and less energy intensive. It is also possible that a treatment approach may be found to be more appropriate for a certain form of lead than others. As an example, testing on decontamination of lead through smelting has not been shown to be affective on removing all types of radiological contamination.

6.7.6 Schedule

The schedule for development activities associated with alternate treatment approaches for lead waste is shown in Table 6.7. Lab scale testing of decontamination and vitrification will run through the end of FY 1991 while bench scale testing of the solidification approaches should be completed by the end of FY 1992.

6.8 PCBs (Solids/Liquids/Capacitors)

6.8.1 Generation Process

The polychlorinated biphenyl (PCB) waste discussed in this section is in the form of solids, liquids, or capacitors which are considered to be radiologically contaminated. PCBs are regulated under the Toxic Substances Control Act (TSCA) rather than under RCRA; hence, by definition PCBs cannot be RCRA hazardous wastes. However, EPA regulations may change to put the management of PCB waste under the jurisdiction of RCRA. The waste then would present a similar problem to that encountered with a mixed waste. Also, much of the PCB waste accumulated at RFP has been contaminated with hazardous constituents and does meet the definition of mixed waste. This type of waste has the distinction of being regulated under the AEA, RCRA, and TSCA.

PCB solid waste refers to items such as contaminated equipment and cleanup materials that have been generated during removal of PCB transformers. The waste has been generated at various locations throughout the Plant. During removal operations, waste was drummed for storage with no pretreatment. In some instances, items were cleaned or wiped off using solvent to dissolve the transformer oil. Rags or kimwipes so generated were also put into the drums. Drums containing these cleanup materials are also designated as RCRA hazardous because the solvent used was 1,1,1-trichloroethane which is a listed waste when it is used for the purpose of cleaning or degreasing. (Historically, trichloroethene was also used for this type of cleaning activity, but its use was discontinued on a plant-wide basis in the early 1970s and the oldest drum of PCB waste in storage was generated in 1981.)

PCB solid waste is no longer being generated since replacement of PCB transformers has now been completed. Eighty-four (84) drums of this waste have been generated and are currently being stored.

PCB liquid waste is generated during the removal of PCB contaminated electrical or hydraulic equipment. The liquid may vary from high percentage PCB transformer oil to hydraulic fluids contaminated with comparably low concentrations of PCB. This waste has been generated at locations throughout the Plant and it is not expected to be generated in the future. This waste has also been packaged in drums for storage. Some containers are designated as RCRA hazardous because of the use of solvent for cleaning or rinsing hardware items. Twenty-five 55-gallon drums are currently being stored.

Radiologically contaminated PCB capacitors are also being accumulated and stored in drums for future treatment/disposal. The capacitors, which are generally sealed units, are of various sizes and individually contain liquid quantities between 0.25 and 4.2 gallons. Continued generation of this waste is not anticipated and the inventory of drums is 32. Unlike the other categories of PCB waste, the capacitors are not suspected of being contaminated with any RCRA hazardous constituents.

The drums of PCB wastes are currently being stored in Buildings 666, 776 and 884. The wastes stored in Building 666 are all non-RCRA wastes (i.e., PCB and radiological contamination are the only regulatory concerns). A majority of the drums stored in 776 are RCRA regulated and all of the drums in 884 are RCRA (mixed waste) in addition to TSCA regulated.

6.8.2 Waste Characterization

The PCB waste has not been sampled; characterization is based on knowledge of the generation process and the materials going into the

waste. The PCB contaminated transformers, capacitors, equipment and hydraulic fluids were identified while in use, and it was then clear that PCB contaminated waste would be generated from removal of these items. RCRA concerns were also involved whenever solvents were used to clean PCB oils from equipment or other items. Based on recent process knowledge, the only solvent used for this purpose was 1,1,1-trichloroethane. This solvent generates wastes identified by EPA hazardous waste numbers F001 and F002.

6.8.3 Regulatory and Waste Form Requirements

6.8.3.1 Waste Form Requirements for Low-Level Waste Disposal

This waste is not suitable for disposal as low-level waste. Both the liquid PCB and capacitors containing liquid have free liquid problems that make them unsuitable for disposal without treatment. Depending on the specific criteria of the disposal facility, volume reduction and/or stabilization of the PCB solids could also be required to generate a more physically stable waste form.

6.8.3.2 Applicable Land Disposal Restrictions (LDR)

Even though the portion of the PCB wastes that are subject to RCRA are also mixed waste, the applicable LDR regulations are now in effect. They are those established for the California List of wastes and for the F001 through F005 solvents. One of the California List restrictions that is applicable bans the land disposal of liquids and non-liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The California List restrictions also ban the disposal of liquid hazardous wastes that exceed the following:

<u>Component</u>	<u>Concentration Limit (ppm)</u>
PCB	50

The applicable F001 through F005 standards are set in terms of CCWE for spent solvents. The standards can be found in the CCWE Table in 40 CFR 268.41 and provide two concentration limits for each of 25 solvents: one applicable to wastewaters and the second for other waste forms. Although 25 different solvents are identified in the table, the following identifies only those suspected (from process knowledge) to be of concern for the PCB wastes:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration (ppm)</u> <u>- nonwastewaters -</u>
1,1,1-Trichloroethane	0.41

6.8.3.3 Restrictions on Disposal of PCBs

The regulations covering the handling and disposition of PCBs are found in 40 CFR 761. In general the requirements are based on the form of the waste and the concentration in which the PCBs are found. As a very brief overview, if the original material had PCB concentrations of less than 50 ppm, the resulting waste is not regulated. If the material was greater than 500 ppm the wastes are required to be incinerated and if the material was between 50 and 500 ppm of PCB then the resulting waste can usually be disposed in a chemical landfill. In all cases, incineration is acceptable and is often the required disposal or treatment approach. It should be noted that "incineration" and "chemical landfill" as referred to in 40 CFR 761 are activities specifically approved by EPA for the management of PCBs. Each activity includes stringent

requirements that must be met before approval can be obtained (similar to the permitting process under RCRA). The remainder of this section addresses TSCA requirements in relation to the specific types of PCB waste of concern at the RFP.

PCB solid waste having PCB concentrations in excess of 50 ppm can either be incinerated or placed in a PCB chemical landfill. This requirement applies even if the PCB concentrations are in excess of 500 ppm with the provision that the material is restricted to soil, rags or other debris, and provided that liquids were not intentionally processed into non-liquid forms to avoid the incineration requirement.

PCB liquid waste with concentrations greater than 500 ppm must be incinerated to meet the requirements of 40 CFR 761. Liquids with PCB concentrations between 50 and 500 ppm, may be incinerated, placed in a chemical landfill, or burned in a high efficiency boiler that complies with a specific list of criteria.

Disposal requirements for PCB capacitors differ based on the quantity of fluid they contain. With the size of capacitors accumulated at the Plant, it can be safely assumed that the entire inventory is large enough to require incineration.

6.8.3.4 Impact of Restrictions or Waste Form Requirements

The impacts of restrictions and waste form requirements will be addressed for each PCB waste form (i.e., solid, liquid, and capacitor).

PCB Solids - Impact uncertain - Much of the PCB solid waste is also mixed waste. Thus for disposal in its present form, the waste must go to a facility approved to take PCB, RCRA

hazardous constituents, and low-level radioactive waste. Although no such facility is currently available, the waste would be acceptable for such action if the RCRA listed solvent concentrations are within the LDR limits. This cannot be determined unless sampling and analysis of the PCB solid waste is accomplished. Should the waste exceed the LDR limits, then treatment would be necessary.

PCB Liquids - Treatment required - Low-level radioactive waste disposal criteria prohibit the disposal of waste with free liquids as do the RCRA regulations. Assuming the liquid has PCB concentrations above 500 ppm, the PCB regulations require treatment/destruction before disposal. Finally, the RCRA regulations will require treatment if listed solvents are in concentrations above the LDR limits. Even without further characterization, the need for some type of treatment is evident.

PCB Capacitors - Treatment required - The primary driving force for treatment of this waste is the PCB regulations. It is mandatory that these wastes be disposed of through incineration.

6.8.4 Treatment Alternatives

If PCB solid waste exceeds the LDR limits for concentrations of listed solvents, then all of the PCB waste forms will require treatment prior to any final disposition. The treatment approach that is either required or specifically identified as acceptable for all the waste forms is incineration. The LDR regulations identify incineration as the BDAT for treatment of all wastes other than wastewater contaminated with listed solvents. Depending on the waste form and concentration, PCB regulations either require incineration or identify it as one of the allowable options. The

paragraphs that follow breakdown the alternative treatment approaches according to PCB waste form.

6.8.4.1 Alternatives for PCB Solids

The primary objective of treatment alternatives should be the destruction of those F001 through F005 organic solvents which exceed the LDR standards. However, if the PCBs are also destroyed, this would eliminate the need to go to a PCB-approved chemical landfill. Also, if the PCB solid waste contains any equipment that has not been completely drained, this waste must be incinerated or sorted and drained as appropriate. The treatment alternatives being considered include one method to clean the waste (solvent cleaning followed by incineration); one method which combines cleaning and destruction (crushing followed by Joule melting); and two methods that would destroy both the solvent organics and the PCBs.

6.8.4.2 Alternatives for PCB Liquids

The requirement for the liquid waste is that the PCBs be destroyed and the solvents either be destroyed or fixed in the treated waste. Ideally the treatment approach chosen would facilitate both needs. The alternatives being evaluated include incineration and biodegradation.

6.8.4.3 Alternatives for PCB Capacitors

The requirement for the capacitors is solely the destruction of the PCBs. The alternatives to be evaluated are the same as those for PCB solids.

6.8.5 Evaluation of Alternatives

Treatment alternatives for each form of PCB waste were considered separately. However, evaluations of PCB contaminated solids and capacitors will be discussed together.

6.8.5.1 Evaluation for PCB Solids/Capacitors

Three alternatives for the treatment of PCB solids and capacitors were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.8a. The approaches for treating these wastes and the results of their evaluation are discussed as follows.

Extraction - Two types of extraction processes (solvent and supercritical CO₂) were considered during the evaluation process. The intent of an extraction process is to clean or strip the waste of PCBs such that the resulting solid waste is no longer regulated under TSCA, even though the secondary extraction fluid would be. In the case of PCB contaminated solids, both of the resulting waste streams (cleaned solid waste and the extraction fluid) would retain the original RCRA designation because of the initial presence of listed wastes. This process received a six for "Effectiveness/Development" because testing has not been done. It received a zero for "Secondary Waste Stream" because the extract will definitely require additional treatment. "Availability" also received a low score because it is felt that it would take more than two years to put an extraction process into full operation. The "Efficiency" score was low because the treatment does not reduce the waste volume and it is questionable whether an extraction process will reliably attain the PCB and solvent removal efficiencies required. One benefit to this approach is the potential to convert the problem aspects of the waste into

**Figure 6.8a: Evaluation of the Treatment Alternatives
For PCB Contaminated Solids and Capacitors**

Need: Destruction of Organics

Criteria	Extraction	Plasma Arc	Incineration (not F91)			
Effectiveness/ Development	6	6	12			
Secondary Waste	0	2	2			
Availability	2	2	2			
Efficiency	1	1	3			
TOTAL	9	11	19			

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

a form which can be treated more easily. As an example, the existing fluidized bed incinerator (FBI) would probably not be appropriate for any significant quantities of metal scraps and debris, but could accommodate an extraction fluid.

Plasma Arc - Plasma technologies are currently being tested at facilities other than the RFP. In theory, they should be capable of destroying the PCB wastes and generating a vitrified waste form from the residue. However, its score was lower because it has not been tested on the subject waste and a production scale process would probably be more than two years away. Its "Efficiency" was given a lower score because the reliability of the equipment is still in question.

Incineration - Incineration received the highest score of the alternatives being evaluated. Incineration is considered the BDAT for this type waste and has been effectively demonstrated on a full scale. It was given a two for "Secondary Waste" because it produces an ash that would likely require solidification before disposal. Incineration is not a technology that could be put into production rapidly, and the existing FBI would not normally be considered appropriate for this type waste. It was, however, given a high score for "Efficiency" because of its volume reduction capabilities and because it is a proven technology.

The only technology for treatment of this waste currently being considered for additional testing at the RFP is extraction through use of supercritical CO₂. It is favored over solvent extraction primarily because of the smaller secondary waste volume generated. The plasma arc technology is being developed as part of a DOE-wide effort at the DOE facility at Butte, Montana, and will be monitored by RFP personnel. At the present time, incineration of PCB solids and capacitors at RFP

is not possible. However, as identified above, the development of a successful extraction process could lead to the use of the FBI for treatment of the extract.

6.8.5.2 Evaluation for PCB Liquids

Two treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.8b. The approaches for treating the PCB liquids and the results of their evaluation are discussed as follows.

Incineration - Incineration is the most promising of the alternatives for treatment of this waste. It scored the highest primarily because it is considered the BDAT and is a mature technology. In this instance, it was assumed that the waste could be burned in the existing FBI (if restarted) and because of the catalyst used, the resulting waste or ash would require additional treatment for stabilization of metals. This caused it to receive a zero for "Secondary Waste". It is also assumed that full production will still take more than two years. Incineration did receive a high score for "Efficiency" since the waste volume reduction in this case would be significant and because the technology is proven.

Biodegradation - Biodegradation has proven to be a possible treatment approach for most organic materials, including PCBs, but it has not been tested on the specific waste. There are different forms of biological treatment, but it is assumed that the resulting waste will require additional treatment to be put into a disposable form. The resulting waste will still be a listed waste. Although multiple treatment steps appear necessary, this alternative received a two for "Secondary Waste" to provide some credit for removing the waste from TSCA regulation. Testing, developing and permitting of such a

**Figure 6.8b: Evaluation of the Treatment Alternatives
For PCB Contaminated Liquids**

Need: Destruction of Organics

Criteria	Incineration	Biodegradation				
Effectiveness/ Development	12	6				
Secondary Waste	0	2				
Availability	2	2				
Efficiency	3	1				
TOTAL	17	11				

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

system would take greater than two years to accomplish. Because biological systems are normally slow and sensitive to upset, this alternative received a low score for "Efficiency".

The results of the evaluation show incineration to be the most viable alternative for treatment of the PCB liquids. Currently a plan is being prepared to put the existing FBI into an operational mode. Biodegradation is also being considered as an alternative to incineration. Testing of the alternative treatments will continue in order to develop a sound backup for incineration.

6.8.6 Schedule

The schedule for development activities associated with alternate treatment approaches for the PCB wastes are shown in Table 6.8. Although the FBI start up plan is scheduled to be completed by the end of CY 1989, there is currently no firm schedule for the decision on whether or not to implement the plan.

Table 6.8: Schedule for PCB Waste Activities

	FY 90	FY 91	FY 92	FY 93	FY 94
<u>Solids/Capacitors</u>					
1. Extraction through Supercritical CO ₂ Bench Scale Test (PCB Not Identified As a Waste Stream) P.N. 970009					
<u>Liquids</u>					
2. FBI Start up Plan					
3. Biodegradation Lab Tests					
Not Identified as a Program or Activity					

- Solids/Capacitors
- 1. Extraction through Supercritical CO₂ Bench Scale Test (PCB Not Identified As a Waste Stream) P.N. 970009
- Liquids
- 2. FBI Start up Plan
- 3. Biodegradation Lab Tests
- Not Identified as a Program or Activity

A.N. = Activity Number in 5 Yr Plan
 P.N. = Program Number for Current Project

6.9 FBI Ash

6.9.1 Generation Process

RFP has operated a fluidized bed incinerator (FBI) in Building 776. The ash from this activity, referred to as FBI ash, has been accumulated in drums and is currently being stored as a mixed waste. The oils burned in the FBI were compressor oil from refrigeration units, crank case oil and diesel fuel. The solids burned consisted of office trash and combustible waste generated within plutonium buildings, but outside glove box lines. Hence, the material came from zones of potential radiological contamination.

The FBI ash has been accumulated as mixed waste because radioactivity has been measured at levels above background inside the incinerator. As a mixed low-level waste, there are currently no off-site treatment, storage or disposal facilities available to accept this waste. To date, 42 drums (11.5 cubic yards) of FBI ash have been accumulated for future disposition.

6.9.2 Waste Characterization

No sampling and analysis has been performed on the FBI ash; waste characterization is based on process knowledge. In addition to being treated as low-level waste the ash is considered hazardous because of potential solvent and heavy metal contamination. The next two paragraphs further described the concern in these two areas.

It is very likely that solvent contaminated combustibles went into the incinerator during trial burns that occurred between 1979 and 1981. Solvents were often used to clean items in the areas of the glove box lines and were likely wiped off with rags or wipes that were later sent to the incinerator. There is also the possibility

that the compressor oil burned during this time may have been contaminated with freon. However, this would have required a refrigerant leak for the freon to reach the compressor oil, so this is not considered a likely possibility. In either case the solvents involved are listed as hazardous waste under RCRA regulations when they are discarded. Also, it is the regulatory nature of listed wastes that the hazardous designation is carried through to anything with which it is mixed or to the residue of any subsequent treatment.

Heavy metal contamination at levels above EP Toxicity limits may be expected from either the catalyst used in the incinerator or the concentrating in the ash of any small amounts of metals in the original feed materials. The catalyst used was an alumina, chromium sesquioxide (Cr_2O_3) material. It was used extensively in the incinerator's afterburner in order to increase the burning rate at the operational temperature. The catalyst material was also used in the primary burner, but here it was added in a 20% catalyst and 80% sodium bicarbonate formulation. It is apparent that the catalyst makes up a good portion of the FBI ash and chromium is a significant component. Other heavy metal contamination could consist of any of the metals of concern. An example would be the crank case oil which could easily be contaminated with lead from fuel combustion and other metals from engine component wear.

The EPA hazardous waste numbers which may be applicable to the FBI ash are the F001 through F005 solvents and the D004 through D011 EP Toxic metals.

6.9.3 Regulatory and Waste Form Requirements

6.9.3.1 Waste Form Requirements for Low-Level Waste Disposal

This waste would probably not meet acceptance criteria for disposal as a low-level waste because of the fine particulate nature of ash. The NTS criteria requires that fine particulate be immobilized, but does allow the use of a sealed inner container when immobilization is not practical. Treatment to immobilize the ash would appear to be appropriate in this case.

6.9.3.2 Applicable Land Disposal Restrictions (LDR)

LDR Requirements Now In-Place - Even though the FBI ash is a mixed waste, a portion of the LDR regulations suspected to be applicable are already in effect. They are those established for the California List of wastes and for the F001 through F005 solvents. The limits set for these wastes are provided in 40 CFR 268, but are not addressed here because the BDAT for non liquids with these contaminants is incineration. Since the BDAT has already been applied in this instance, no problem is anticipated in meeting the existing LDR standards.

Future LDR Requirements - Those specific LDR standards or limits not yet established are scheduled to go into effect May 8, 1990. The additional LDR standards that may be applicable to the FBI ash are those for EP Toxic metals, D004 through D011.

6.9.3.3 Impact of Restrictions or Waste Form Requirements

Low-Level Waste Disposal Requirements - Unacceptable - In its current condition, FBI ash is unacceptable for disposal as low-

level radioactive waste. Exclusive of any RCRA considerations, ash treatment such as stabilization to remove the fine particulate problem is required.

Solvents - No impact - Although the waste will likely be required to keep a designation as a listed solvent, it has already been treated by the most appropriate method for this type contamination. There should be no problem with this waste being within the established LDR limits for solvents.

RCRA Characteristics (EP Toxic Metals) - Impact uncertain - LDR standards for this type waste have not been established, and the waste has not been characterized to determine whether the criteria would even be applicable.

6.9.4 Treatment Alternatives

The stored inventory of FBI ash is presently unacceptable for land disposal because of its form (fine particulate). Future land disposal may not be possible because of concentrations of EP Toxic metals. These two factors appear to make treatment of this waste mandatory before disposal can be performed. EPA has not yet published BDAT treatment standards in the LDR regulations for waste that exceeds EP toxicity for metals. It's possible that land disposal of RCRA characteristic wastes in general will be prohibited. Another possibility, based on BDATs for similar wastes, is that a limit may be set and stabilization of metals may be the recommended approach to achieve the limit. In either case, a stabilization treatment such as cementation would be required and concurrently would meet the need to improve the waste form.

In summary, the only apparent treatment needed to make the FBI ash meet all anticipated disposal criteria is stabilization to eliminate fine particulate and reduce leachability of EP Toxic metals. Until

characterization is performed, it is only assumed that the latter is necessary. The three treatment alternatives being considered are intended to generate a solidified waste form; one utilizing cement, one a polymer binder, and the other high energy to generate a vitrified waste.

6.9.5 Evaluation of Alternatives

Three treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.9. The treatment approaches and the results of their evaluation are discussed in the paragraphs that follow.

Polymer Solidification/Cementation/Vitrification - The alternatives being considered for treatment of the FBI ash are addressed together since they all were scored essentially the same. Each process should be capable of achieving the necessary criteria for a disposable waste form, but none have been developed through completion of bench scale testing. None of the alternatives involve volatilization of organics as a secondary waste stream and any of them could likely be put into a production mode within two years. The only difference in scoring between the alternatives was in the area of "Efficiency". Cementation was scored lowest because it produces the largest increases in waste volume and the resulting waste form is considered less dense. Polymer solidification received a higher score since it generates less volume and is considered a better form for disposal. Vitrification, which includes the Joule melter and microwave melting, received the highest score because of the stable, glass form of the resulting waste.

Figure 6.9: Evaluation of the Treatment Alternatives For FBI Ash

Need: Stabilization of Metals

Criteria	Alternatives	Polymer Solidification	Cementation	Vitrification			
Effectiveness/Development	6	6	6				
Secondary Waste	4	4	4				
Availability	4	4	4				
Efficiency	2	1	3				
TOTAL	16	15	17				

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

6.9.6 Schedule

The schedule for development activities associated with the treatment approaches for the FBI ash are shown in Table 6.9. Since the volume of the problem waste is relatively small in this instance, bench scale testing of the alternatives is of lower priority than for other wastes and extends through FY 1992.

Table 6.9: Schedule for FBI Ash Activities

	FY 90	FY 91	FY 92
1. Characterization of Waste, keying on EP Toxic metals			
<u>Solidification</u>			
2. Polymer Bench Scale Test A.N. 3.7.1.09.0012			
3. Cementation Bench Scale Tests A.N. 3.7.1.09.0012			
<u>Vitrification</u>			
4. Microwave Bench Scale Test A.N. 3.7.1.09.0012			
5. Joule Bench Scale Test A.N. 3.7.1.09.0018			

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.10 Beryllium Dust

6.10.1 Generation Process

Most of the beryllium waste generated at the RFP comes from manufacturing processes in which beryllium parts are machined. Wastes from these processes do not exhibit any of the four characteristics of RCRA hazardous waste nor are they found among the lists of wastes from non-specific sources ("F" wastes) or from specific sources ("K" wastes). The lists for discarded commercial chemical products ("P" and "U" wastes) do not apply to these beryllium wastes because these lists are specific to commercial chemical products or manufacturing chemical intermediates. Once a chemical on the P or U list has gone through a manufacturing process, it no longer qualifies as a listed hazardous waste under those categories. To be considered hazardous under RCRA, the waste must be included in other hazardous waste lists or exhibit one or more of the characteristics.

Beryllium metal working and forming processes are also conducted in the Building 865 research and development area. Beryllium dust or powder is placed into a form and subjected to high temperature and pressure, generating a beryllium casting. The waste from this process is beryllium dust that has not been used, but has been discarded or spilled and cleaned up. This waste form does qualify as a "P" listed waste.

As of October 1989, only three drums (0.8 cubic yards) of beryllium dust waste had been generated and stored for future disposition. The estimated annual generation rate is approximately one cubic yard.

6.10.2 Waste Characterization

The beryllium dust waste has not been sampled, but process knowledge allows a reasonably complete characterization. The waste consists of beryllium dust and materials contaminated with beryllium dust. The waste is considered to be radiologically contaminated, and no other RCRA hazardous materials are suspected of being present. The EPA hazardous waste number applicable to this waste is as follows:

<u>Material</u>	<u>Hazardous Waste Number</u>
Beryllium	P015

6.10.3 Regulatory and Waste Form Requirements

6.10.3.1 Waste Form Requirements for Low-Level Waste Disposal

The beryllium waste would likely not meet the waste form requirements to qualify for disposal as low-level radioactive waste. Most radioactive waste disposal facilities, including the one at the NTS, require that fine particulate wastes be immobilized to reduce the associated hazards. Since the beryllium waste would probably exceed limitations for fine particulate and since beryllium dust is a particularly toxic form, additional treatment or special packaging would be required.

6.10.3.2 Applicable Land Disposal Restrictions (LDR)

LDR Requirements Now In-place - There are no LDR in effect at the present time for the beryllium waste. The only LDR that are now applicable to radioactive mixed wastes are those for the F001 through F005 solvents, Dioxin wastes, and California List wastes. None of these are applicable to beryllium dust waste.

Future LDR Requirements - Those specific LDR standards or limits not yet established are scheduled to go into effect May 8, 1990. The specific standard applicable to beryllium dust has yet to be set for hazardous waste that is not mixed; therefore, there has been no published indication of what may be applicable to mixed waste. The future standard that will impact this waste is identified as follows:

<u>Waste Designation</u>	<u>Concentration Limit Set by LDR</u>
P015	TBD

It is likely that the LDR limit will be established as a CCWE since at least two other metals on the "P" list have been handled that way.

6.10.4 Treatment Alternatives

The stored inventory of beryllium waste is likely unsuitable for disposal at the present time because of fine particulate material present. RCRA regulations that would restrict land disposal of the waste will not be in effect until May 8, 1990, but will likely require the TCLP concentration for beryllium to be below a specified limit. Until the 1990 date, solidification of some type would eliminate the fine particulate problem and allow disposal at a facility permitted for mixed waste if such a facility were available. As with the LDR standard, EPA has not published a BDAT that would be applicable to this waste after May 8, 1990. Based on other metal contaminated waste, stabilization of some sort may be the recommended approach.

In summary, the only apparent treatment needed to make the beryllium waste meet all anticipated disposal criteria is stabilization to

eliminate fine particulate and reduce leachability. Since the major toxicity problem with beryllium waste is associated with respiration, its susceptibility to erosion may be a more appropriate term than leachability. The three treatment alternatives being considered to achieve this need are two solidification processes (one utilizing cement, the other a polymer binder) and vitrification.

6.10.5 Evaluation of Alternatives

Three treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.10. The treatment approaches and the result of their evaluation are discussed as follows.

Polymer Solidification/Cementation/Vitrification - The alternatives being considered for treatment of the beryllium waste are addressed together since they all were scored the same. Each process should be capable of achieving the necessary criteria for a disposable waste form, but none have been developed through completion of bench scale testing. Since volatilization of organics is not an issue, none of the alternatives involve a secondary waste stream and any of them could likely be put into a production mode within two years. Cementation received a medium score because of the very low capital costs required to treat this small volume waste. The other two alternatives provide waste forms that are considered to be of better quality, but were discounted because of high capital costs and development time constraints.

6.10.6 Schedule

The schedule for development activities associated with the treatment approaches for the beryllium dust are shown in Table 6.10. Bench scale testing of the cementation is scheduled to be completed.

Figure 6.10: Evaluation of the Treatment Alternatives For Beryllium Dust

Need: Stabilization of Metals

Criteria	Alternatives	Polymer Solidification	Cementation	Vitrification			
Effectiveness/Development	6	6	6				
Secondary Waste	4	4	4				
Availability	2	4	2				
Efficiency	1	2	1				
TOTAL	13	16	13				

Effectiveness and Stage of Development

Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

in FY 1991. Polymer solidification and vitrification will be tested
in FY 1992 if required.

Table 6.10: Schedule for Beryllium Dust Activities

	FY 90				FY 91				FY 92			
<u>Solidification</u>												
1. Cementation	/ / / / / / / / / / / / / /											
Lab Scale Tests												
A.N. 3.7.1.09.0012												
(Not Identified as Waste Stream Program)												
2. Polymer									/ / / / / / / / / / / / / /			
Lab Scale Tests												
A.N. 3.7.1.09.0012												
(Not Identified as Waste Stream Program)												
<u>Vitrification</u>												
3. Lab Scale Tests									/ / / / / / / / / / / / / /			
A.N. 3.7.1.09.0018												
(Not Identified as Waste Stream Program)												

A.N. = Activity Number in 5 Yr Plan
 P.N. = Program Number for Current Project

6.11 Metal Chips

6.11.1 Generation Process

During metal machining operations cutting oils and solvents are applied to the stock material. Cuttings or chips from the metals along with residues from the oils and solvents are mixed during the machining process. The metal chips are recovered, drained, and placed in drums for future disposition. They have been designated as a problem waste because the solvents used in machining operations are listed solvents under RCRA hazardous waste regulations.

The metal chips are generated in small quantities. As of September 1989, only 14 drums (4 cubic yards) of the waste had been accumulated and are being stored as mixed waste. The annual generation rate for this waste is about 0.3 cubic yards or about one drum.

6.11.2 Waste Characterization

The metal chip waste has not been sampled, but process knowledge allows a fairly complete characterization. The metals being machined typically consist of stainless steel, beryllium, or aluminum. The chips, from these metals, are contaminated with cutting oil and solvents. The cutting oil is not a hazardous material or waste, but the solvents used (1,1,1-trichloroethane and 1,1,2-trichloro-1,2,2-trifluoroethane) are subject to RCRA regulation once they have become a waste. The waste solvent and the metal chips are required to retain the following designations:

<u>Hazardous Waste Number</u>	<u>Description</u>
F001	Waste contaminated with halogenated solvents used for degreasing

The metal chip waste is also considered low-level radioactive waste because of suspected radiological contamination. As with chemical contaminants, no analytical data has been obtained to support this suspicion, it is based on process knowledge.

6.11.3 Regulatory and Waste Form Requirements

6.11.3.1 Waste Form Requirements for Low-Level Waste Disposal

Excluding any RCRA requirements, the metal chip waste as currently packaged and stored should meet normal disposal facility acceptance criteria. The only potential concern would be whether the chips have been adequately drained to eliminate the presence of free liquids. Visual inspection of the waste may be necessary to ensure this is not a problem.

6.11.3.2 Applicable Land Disposal Restrictions (LDR)

The applicable LDR regulations, now in effect, are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that is applicable bans the land disposal of non liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit</u> <u>(mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for spent solvents. The standards can be found in the CCWE Table in 40 CFR 268.41 and provide two concentration limits for each of 25 solvents: one applicable to wastewaters and the second for other waste forms. The following identifies only those solvents suspected (from process knowledge) to be of concern for the metal chip waste:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration (ppm)</u> <u>- nonwastewaters -</u>
1,1,1-Trichloroethane	0.41
1,1,2-Trichloro-	0.96
1,2,2-trifluoroethane	

6.11.3.3 Impact of Restrictions or Waste Form Requirements

Impact Uncertain - Knowledge of the process generating the metals chips does not allow the determination of whether or not the current waste form will meet disposal requirements. Even well drained metal chips may contain significant residues of the listed solvents identified in the previous paragraph. The 1,000 ppm limit for HOCs should not be exceeded, but the individual limits for solvents are roughly three orders of magnitude smaller and could, therefore, be a concern. Representative samples must be taken of the stored metal chip wastes and subjected to the TCLP for spent solvents. The results from this sampling and analysis should determine whether or not LDR limits are met.

6.11.4 Treatment Alternatives

Should metal chip waste contain traces of solvents at levels above the LDR limits, EPA has established incineration as the BDAT for this type of waste. However, the LDR has established concentration-based standards for F001 through F005 solvents rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards.

Assuming LDR standards are not met, the treatment need for the metal chip waste is destruction of organics. This may be accomplished in one step by incineration or vitrification which destroys the

organics or it could be done in two steps by extracting the organics from the chips, generating a secondary waste which must then be treated. Characterization of the metal chip waste should be completed before treatment considerations are pursued. Based on process knowledge of the metal chip wastes, the list of spent solvents provided in 40 CFR 268.41, Table CCWE - Constituent Concentrations Waste Extract, are the primary contaminants for which analysis should be performed.

6.11.5 Evaluation of Alternatives

Three treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.11. The treatment approaches and the result of their evaluation are discussed as follows.

Incineration - Incineration received the highest score of the alternatives being evaluated because it is considered the BDAT for this type waste and has been shown to work on a full scale. Incineration was given a two for "Secondary Waste" because it produces an ash that would likely require solidification before disposal. It is not a technology that could be put into production rapidly, particularly since the existing fluidized bed incinerator (FBI) would not normally be considered appropriate for this type waste. It was, however, given a high score for "Efficiency" because of its volume reduction capabilities and because it is a proven technology.

Vitrification - The plasma arc technology is being considered under this alternative. In theory it should be capable of destroying organics and providing a vitrified waste form. However, it has not been developed through bench scale testing for this particular waste. Because destruction efficiency is not known at this time, it is assumed that the off-gas will be of regulatory concern and the

Figure 6.11: Evaluation of the Treatment Alternatives For Metal Chips

Need: Destruction of Organics

Alternatives	Incineration (not FBII)	Vitrification	Extraction			
Effectiveness/Development	12	6	12			
Secondary Waste	2	2	0			
Availability	4	2	6			
Efficiency	3	1	2			
TOTAL	21	11	20			

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

alternative was given a two under "Secondary Waste". In this case the technology is fairly complex and considering the stage of development, could not be put into production scale in less than two years. The "Efficiency" was also scored low because of the high capital costs of these systems and because their reliability has not been proven.

Extraction - Two types of treatment are being considered: aqueous washing and super critical fluid cleaning using liquid carbon dioxide. Aqueous washing has been tested sufficiently on similar types of metal chips to receive a score of 12 on the "Effectiveness/Development" element. Liquid carbon dioxide should work as well but has not been developed. This treatment approach produces a secondary waste that will require additional treatment while the treated chips retain their designation of a listed waste. Extraction is considered a relatively simple technology and could be put into production in less than a year. They received a medium score for "Efficiency" because they involve fairly low capital costs and have shown promising results.

The technologies for treatment of the metal chip waste currently being considered for additional testing at the RFP are extraction by aqueous washing and supercritical fluid cleaning with CO₂ and vitrification using a plasma arc. The plasma arc technology is being developed at other locations including as part of a DOE-wide effort at the DOE facility at Butte, Montana, and will be followed by RFP personnel. At the present time, there are no plans for developing another incinerator for use at the RFP. However, the development of a successful extraction process could lead to the use of the fluidized bed incinerator for treatment of the extract.

6.11.6 Schedule

The schedule for development activities associated with alternate treatment approaches for metal chips is shown in Table 6.11. Because the waste stream is small, development activities will have a lower priority than those for other wastes and extend through FY 1992. The first action on the schedule is the characterization of the waste to determine if treatment is even necessary to put the metal chip waste into a disposable form.

Table 6.11: Schedule for Metal Chip Activities

	FY 90	FY 91	FY 92
1. Characterization of metal chips, keying on TCLP for spent solvents and free liquids	▨		
<u>Extraction</u>			
2. Supercritical Fluid/ Aqueous Wash Bench Scale Tests P.N. 970009 A.N. 3.7.1.09.0016		▨	

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.12 Filters

6.12.1 Generation Process

Waste filters are generated at several locations within the RFP and in different forms. The filters of concern are of activated carbon, cartridge and HEPA types which were used to filter liquid or air with suspected radiological and solvent contamination. The filter materials vary, as do the contaminants involved, based on the specific process from which they came. However, in each case the nature and level of radiological contamination qualifies the filter as low-level waste and the only suspected RCRA hazardous constituents are solvents.

As of September 1989, the stored inventory of filter waste is 10 drums (3 cubic yards) and consists of only two types of filters. The first is HEPA filters from glove box ventilation systems. In this case, the suspect hazardous constituents are solvents that were used, evaporated inside the glove box, and picked up in the filter. The second type is activated carbon filters that were used in a research and development project for removing solvents from water. These filters are also considered contaminated with spent solvents.

As a mixed waste, there are currently no off-site treatment, storage or disposal facilities available to accept this waste. As mentioned above, the September 1989 inventory of this waste was only ten drums that had been accumulated and stored for future disposition. Current projections for future generation of this waste are about 0.3 cubic yards (or one drum) per year.

6.12.2 Waste Characterization

The waste filters have not been sampled for radiological or hazardous constituent analysis; their characterization has been based on process knowledge. The materials of concern were used to filter fluid streams (air or liquid) that had come into contact with solvents and radioactive items. Without further characterization, the EPA waste designations applicable to this waste are:

<u>Waste</u>	<u>Hazardous Waste Number(s)</u>
Filters	F001 through F005

6.12.3 Regulatory and Waste Form Requirements

6.12.3.1 Waste Form Requirements for Low-Level Waste Disposal

The filter waste may have some problems meeting acceptance criteria for disposal as normal low-level waste. Some additional handling or treatment may be necessary to insure that the amount of fine particulate material in the waste does not present a problem. This may be particularly true for HEPA filters that are specifically designed for particulate collection. Another potential concern is that filters used for liquids be well drained and contain no free liquids. Visual inspection of the waste may be necessary to ensure this is not a problem.

6.12.3.2 Applicable Land Disposal Restrictions (LDR)

The applicable LDR regulations now in effect are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that is applicable bans the land disposal of non liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for spent solvents. The standards can be found in the CCWE Table in 40 CFR 268.41 and provide two concentration limits for each of 25 solvents: one applicable to wastewaters and the second for other waste forms. Process knowledge of the waste does not allow the list of 25 solvents to be significantly narrowed. In referring to the CCWE Table, the concentrations for waste forms other than wastewater is the applicable category.

6.12.3.3 Impact of Restrictions or Waste Form Requirements

Impact uncertain - Without sampling and analysis being performed, the impact of disposal restrictions cannot be fully determined. Depending on the specific disposal facility's acceptance criteria, the amount of fine particulate in the waste may not be an issue. However, there is a high likelihood that concentrations of solvents in the waste filters will be high enough that land disposal will be unacceptable. Solvent concentrations in the fluid stream being filtered are likely very small but the filters will concentrate those levels. It is doubtful that the 1,000 ppm limit for HOCs will be exceeded, but the limits for individual solvents could definitely be an issue.

6.12.4 Treatment Alternatives

Should samples of the waste filters indicate concentrations of solvents in levels above the LDR limits, EPA has established incineration as the BDAT for this type of waste. However, the LDRs

specify concentration-based standards for F001 through F005 solvents rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards.

The goal of alternate treatment technologies should be the destruction of the organic contaminants (solvents). However, the applicable LDR does not mandate destruction of the organics; therefore, other types of treatment are also being considered. Incineration, vitrification with the Joule melter, wet oxidation, and supercritical extraction are being evaluated and would involve destruction of the organics. Also to be evaluated is polymer solidification.

6.12.5 Evaluation of Alternatives

Five treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.12. The treatment approaches and the results of their evaluation are discussed as follows.

Incineration - The results of the evaluation indicate an incinerator to be the most promising of the alternatives for treatment of the filter waste. It scored the highest primarily because it is considered the BDAT and is a proven technology. It was assumed that the waste could be burned in the existing fluidized bed incinerator (FBI) and the resulting waste or ash would require additional treatment for stabilization of metals. This caused it to receive a zero score for "Secondary Waste". It is also assumed that full production will still take more than two years. Incineration did receive a high score for "Efficiency" since the waste volume will be reduced and because the technology is proven.

Figure 6.12: Evaluation of the Treatment Alternatives For Filters

Need: Destruction of Organics

Alternatives	Incineration	Vitrification	Wet Oxidation	Cementation	Polymer Solidification	Supercritical Extraction
Effectiveness/Development	12	6	6	6	6	6
Secondary Waste	0	2	0	4	0	0
Availability	2	2	2	6	2	2
Efficiency	3	3	1	1	1	1
TOTAL	17	13	9	17	9	9

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

Vitrification - Vitrification through use of the Joule melter is being considered. Use of the Joule melter received the second highest evaluation score, although significantly less than incineration. This was due to the lack of bench scale testing on the specific waste to verify the treatment's effectiveness. The resulting glass residue should not require further treatment so the alternative was given a higher score for "Secondary Waste" than was incineration. However, because of the questionable destruction of organics it was not given the highest score. (Incomplete destruction of organics would require the off-gas to receive additional treatment.) It is expected that it would take greater than two years to get to a production scale of the Joule melter, even if testing is successful. The melter was scored lower than the incinerator in "Efficiency" because of higher capital cost, lower volume reduction, and reliability concerns.

Wet Oxidation - The alternative of wet oxidation through acid digestion was evaluated as another means to destroy organics. It received the lowest score because it has not been tested and because the resulting waste form presents similar problems for its ultimate disposal: i.e., the treated filter waste would, by definition, still carry the designation of a listed waste and the secondary waste would definitely require some type of additional treatment prior to disposal. It was also felt that a treatment approach to accomplish all of this would take longer than two years to implement. This alternative received a low score for "Efficiency" because of its apparent lack of volume reduction and its questionable reliability in achieving the required destruction efficiency.

Cementation - The use of cement to achieve the desired waste form received a high evaluation score. This technology would normally be considered the appropriate technology for stabilization of filter media, but no testing has been performed on this particular waste to

determine its effectiveness on organic contaminants. However, until characterization is performed, the extent of organic contamination is also unknown; if LDR standards are already being met, cementation would look even better to achieve a disposable waste form. This alternative scored higher than others evaluated for the "Availability" criterion because treatment is already being performed at the RFP under RCRA interim status on other wastes and improved techniques could likely be put into operation in less than a year. Cementation does have limitations as noted by its receiving the lowest score under "Efficiency". It increases the waste volume significantly and may be sensitive to changes in the waste characteristics. The low score for "Efficiency" may indicate that cementation might not be the optimum treatment for the long term.

Polymer Solidification - The use of a polymer binding agent to decrease the leachability of the organic contaminants is also considered as a possible alternative since the applicable LDR standards are in the form of contaminant levels in an extract. This approach should work, but it has not been tested on the specific waste. Polymer solidification received a zero score under "Secondary Waste" for two reasons: first, the process involves the application of heat which may drive off volatiles causing the off-gas to be of concern; and second, the waste would likely have to be preconditioned by sizing before it could be solidified. Because of this added complexity and the stage of development, it was assumed that this process could not be developed to a production stage in less than two years. It was given a low score for "Efficiency" because of its questionable reliability in achieving a non-leaching waste form for organic contamination.

Supercritical Extraction - This alternative involves the use of a supercritical fluid (CO₂ in this case) to extract the solvent contamination from the filter waste. This technology has been tested on some wastes, but not on filter waste, therefore it

received a score of only six under the first criterion. Extraction produces a secondary waste that will require additional treatment while the treated filters retain their designation of listed waste. The technology is considered relatively simple, but taking into consideration its stage of testing on this particular waste, it is assumed that it would take over two years to get to a production scale. The alternative received a low score in "Efficiency" because it does not reduce waste volume and has not yet proven to be reliable in achieving the necessary solvent removal with this waste stream.

The results of the evaluation show incineration to be the most viable alternative for treatment of the filter waste. A plan is being prepared to put the existing FBI into an operational mode. The other alternatives evaluated will continue to be considered. Development of the alternatives will provide a sound backup for incineration.

6.12.6 Schedule

The schedule for development activities associated with alternate treatment approaches for the filter wastes are shown in Table 6.12. Although the FBI start up plan is scheduled to be completed by the end of CY 1989, there is currently no firm schedule for the decision on whether or not to implement the plan. Treatment alternatives will not be pursued until waste characterization results are known. Cementation scored as high as incineration and will be developed first. Should the cemented waste form be unacceptable for disposal, the more robust treatment technologies will be developed in FY 1992.

Table 6.12: Schedule for Filter Waste Activities

	FY 90	FY 91	FY 92
1. Characterization of filter waste, keying on TCLP for solvents and free liquids.			
2. FBI Startup Plan			
3. Joule Melter Vitrification Bench Scale Tests A.N. 3.7.1.09.0018			
4. Wet Oxidation Lab Scale Tests A.N. 3.7.1.09.0002			
5. Cementation Bench Scale Tests A.N. 3.7.1.09.0002			
6. Polymer Solidification Bench Scale Tests A.N. 3.7.1.09.0022			
7. Supercritical Fluid Extraction (CO ₂ Decon) Bench Scale Tests A.N. 3.7.1.09.0016 P.N. 970007			

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.13 Fluorescent Lights

6.13.1 Generation Process

Fluorescent lights are used throughout the uranium and plutonium processing areas of RFP. In some areas of the Plant the lights become radioactively contaminated during use or are considered to be contaminated as a matter of waste policy when they are removed. In these instances the light tubes or bulbs are low-level waste and the hazardous constituents normally found inside qualify them as hazardous waste. The light bulbs are crushed and stored in drums for future disposition.

As a mixed low-level waste, there are currently no off-site treatment, storage or disposal facilities available to accept this waste. As of October 1989, only one drum of this waste had been accumulated and annual generation rates are expected to be about 0.4 cubic yards.

6.13.2 Waste Characterization

The fact that normal fluorescent lights contain mercury is well documented. One sample, analyzed for mercury, using the EP Toxicity test method, verified that leachable mercury levels were sufficient to require the waste to be designated as RCRA hazardous. There is no reason to suspect the presence of any other RCRA hazardous constituents. The results of the single analysis are as follows:

<u>EP Toxic Metal</u>	<u>Observed Concentration (mg/l)</u>	<u>Regulatory Limit (mg/l)</u>
Mercury	0.77	0.2

Radiochemistry has not been performed on the fluorescent light waste; its radiological characterization is based on process knowledge. The lights are removed from contaminated areas or areas

of high potential for contamination. Because of the radioactive constituents of concern (primarily uranium and plutonium), it is policy that any waste coming from these areas be considered contaminated also.

6.13.3 Regulatory and Waste Form Requirements

6.13.3.1 Waste Form Requirements for Low-Level Waste Disposal

In its present form the fluorescent light waste would likely be acceptable for disposal as low-level waste (disregarding any RCRA requirements). There are some respirable fines associated with the materials inside the bulbs, but they are of such a minor quantity that acceptance criteria would probably not be exceeded. Of course a final determination would rest with the disposal facility.

6.13.3.2 Applicable Land Disposal Restrictions (LDR)

The LDR regulations applicable to the fluorescent light waste are not yet in effect. The specific criteria or limitations for RCRA characteristic waste have not yet been promulgated or proposed. Since this waste is hazardous only because it exhibits the characteristic of EP Toxicity for mercury, it is not yet covered by the LDR. However, the applicable criteria are scheduled to be in effect by May 8, 1990. Until that time, the waste could legally be disposed in a RCRA facility if one were available for mixed waste.

Although standards have not yet been set, fluorescent light waste could be impacted by future standards for the following waste code:

<u>Characteristic</u>	<u>Concentration Limit Set by LDR</u>
D009	TBD

6.13.3.3 Impact of Restrictions or Waste Form Requirements

Impact uncertain - It is anticipated that waste form requirements for disposal as low-level waste will not be a problem. However, the impact of LDR after May 8, 1990 are uncertain as the applicable standards have not yet been proposed. There is a possibility that the LDR will simply ban the disposal of wastes that exhibit any of the RCRA hazardous characteristics. Should this occur, the waste would have to be put into a more stable, less leachable form and it would no longer be considered RCRA hazardous. Another possibility would be the setting of an extraction concentration higher than the EP Toxicity limit which would allow waste still qualifying as hazardous to be disposed. Depending on the limit set, the fluorescent light waste could possibly require no additional treatment before disposal.

6.13.4 Treatment Alternatives

Since it is uncertain whether the fluorescent light waste will exceed LDR standards, the need for treatment is also uncertain. EPA has not yet published BDAT treatment standards in the LDR regulations for waste that is hazardous solely because it exceeds EP Toxicity limits for metals. However, based on BDATs for similar materials, like sludges from treatment of electroplating wastewaters, stabilization of metals will be the likely approach. Pursuit of a stabilization method that could eliminate the EP Toxic classification would still be warranted. This would significantly improve disposal options by eliminating the RCRA requirements, allowing the waste to be disposed as strictly low-level waste.

The treatment need for this waste is stabilization to a less leachable form; specifically required is the stabilization of the mercury component. The treatment alternatives to be considered in meeting this need are two solidification processes (one utilizing cement, the other a polymer binder) and use of the microwave to provide a vitrified waste form.

6.13.5 Evaluation of Alternatives

Three treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.13. The treatment approaches and the results of their evaluation are discussed as follows.

Polymer Solidification - The use of a synthetic binding agent to solidify the fluorescent light waste received the second highest evaluation score. This technique should be capable of producing a stable waste form with low leachability, however, it has not been tested on the specific waste. The solidification process should generate no secondary waste stream and received a high score for this criterion. Although it is a relatively simple process, the stage of development, along with the necessary permits and approvals that would be required, combine to make the availability of a production scale unit between one and two years. The alternative received a medium score for "Efficiency" because waste volume is increased slightly, but the resulting waste form is anticipated to be of good quality, possibly better than through cementation.

Cementation - This alternative received the highest evaluation score. Like polymer solidification, cementation should provide a stable waste form, but has not been tested on the specific waste. It also does not involve a secondary waste stream. Cementation scored higher than polymer solidification because it is already

Figure 6.13: Evaluation of the Treatment Alternatives For Fluorescent Lights

Need: Stabilization of Metals

Alternatives	Polymer Solidification	Cementation	Vitrification			
Effectiveness/Development	6	6	6			
Secondary Waste	4	4	0			
Availability	2	4	2			
Efficiency	2	1	2			
TOTAL	14	15	10			

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

being done at the RFP and thus could be put into a production operation quicker. It received a low score for "Efficiency" because the resulting waste volume is increased (probably more than for polymer solidification) and the waste form is not considered as dense as with other alternatives.

Vitrification - Use of the microwave is being considered to produce a vitrified form. This technique should be capable of a stable waste form, but has not been tested on the specific waste. It received a zero under "Secondary Waste" because the mercury contaminants might vaporize during the process, generating an off-gas of regulatory concern. Because of the additional testing required and the permitting issues involved, it is expected that a production scale treatment could not be put into operation in less than two years. The vitrification alternative receive a medium score for "Efficiency". Although it develops the best waste form of the options considered, it also involves more complex, capital intensive equipment. The potential problem of mercury vaporization was also considered as an issue in the technology's ability to reliably achieve the treatment goal, stabilization of metals.

6.13.6 Schedule

The schedule for development activities associated with the treatment approaches for the fluorescent light waste are shown in Table 6.13. Testing of treatment alternatives extends through FY 1991. The priority for these activities are lower than for some of the other wastes because the volume of fluorescent light waste is relatively small. Cementation will be developed first. Should this waste form prove unacceptable, polymer solidification and/or vitrification will be developed in FY 1992.

Table 6.13: Schedule for Fluorescent Light Waste Activities

Solidification
Cementation
 Bench Scale Tests
 A.N. 3.7.1.09.0012

Polymer
 Bench Scale Tests
 A.N. 3.7.1.09.0012

Vitrification
Microwave
 Lab Scale Tests
 A.N. 3.7.1.09.0018

	FY 90				FY 91				FY 92			
	/											
	/											
	/											

A.N. = Activity Number in 5 Yr Plan
 P.N. = Program Number for Current Project

6.14 Acid

6.14.1 Generation Process

The acid is a combination of two waste streams from the chemical milling process within Building 444 at the RFP. In this process beryllium parts are chemically milled through use of an acidic bath. After chemical milling, parts are placed in electropolishing tanks which also contain an acidic solution. The spent milling and polishing solutions are then drained to a common sump tank and pumped to acid dumpsters outside of the building.

In most cases within the Plant, such solutions would be transported to the Building 374 wastewater treatment facility. However, neutralization of this waste using the existing aqueous waste treatment system, creates a gel-like material which plugs the system. Pending the development of an alternate treatment approach, this waste has been accumulated in polyethylene drums for storage in cargo containers near Building 561. As of September 1989, 30 drums (8 cubic yards) had been accumulated and yearly generation rates are estimated at about two drums (0.6 cubic yards).

6.14.2 Waste Characterization

Limited sampling has been performed on the acid waste. Most of its characterization can be based on process knowledge of the chemicals originally used to make up the contents of the tanks and the manner in which the materials were used. The chemical milling bath contains a mixture of 75% phosphoric acid, 3% sulfuric acid, and chromium trioxide. The electropolishing tanks also contain phosphoric acid. The solutions from each of the two steps in the process were sampled in 1987 as part of the Plant's Waste Stream Identification and Characterization effort which was published in April 1987. The samples were analyzed for the following parameters:

<u>Parameters Analyzed</u>	<u>Milling/Acid Solution</u>	<u>Electropolishing Solution</u>
RCRA Characteristics		
Corrosivity	X	X
Reactivity		X
EP Toxic Metals	X	X
Radiochemistry	X	X

The analytical results for the parameters listed above will be described in the following paragraphs. Based on analytical results and process knowledge, EPA hazardous waste numbers that are applicable to this waste will be provided at the end of this section.

6.14.2.1 RCRA Characteristics

Corrosivity - Both solutions qualify as RCRA corrosive with pH values less than 2.0

Reactivity - The electropolishing solution was analyzed for its reactive cyanide and sulfide concentrations (different than total cyanide and total sulfide). Reactive cyanide was measured at 2,800 ppm while sulfide content was below the detection limit. Since EPA has established 250 mg HCN/kg as the action level, this waste would qualify as reactive because of its cyanide concentration. It should be noted that the combination of low pH and cyanide presents a very hazardous condition. Based on the analytical results, hydrogen cyanide gas build-up has likely occurred in the stored containers. Extreme caution should be used in dealing with this waste.

EP Toxic Metals - Both solutions were analyzed for EP Toxic metals. Provided below are all readings above detection limits for both samples:

<u>Metal</u>	<u>EP Toxic Concentration (ppm)</u>		
	<u>Limit</u>	<u>Acid Bath</u>	<u>Electropolishing</u>
Arsenic	5.0	-	153
Cadmium	1.0	7.49	1.90
Chromium	5.0	92,700	85.0
Lead	5.0	71.9	406
Selenium	1.0	-	0.27
Silver	5.0	16.9	-

6.14.2.2 Radiochemistry

Radiochemistry was also performed on each of the two samples. The results are as follows:

<u>Analysis</u>	<u>Concentration* (pCi/L)</u>		
	<u>Acid Bath</u>		<u>Electropolishing</u>
Am-241	-	-	3.3 +/- 2.5
U-233,234	14	+/- 18	-
U-238	51	+/- 43	-
Tritium	-	-	110 +/- 220

- * The plus or minus (+/-) values indicate the 95% confidence range for the reported values.

6.14.2.3 Applicable EPA Hazardous Waste Numbers

The two waste streams contributing to the acid waste have been described above on an individual basis. However, it is estimated that the streams contribute to the mixture in equal proportions and concentrations of the mixture can easily be estimated from measured values of the separate streams. Using this approach, reasonable assumptions can be made based on the limited analytical data.

RCRA Characteristics - The following RCRA characteristic numbers are applicable to the liquid acid waste:

<u>Hazardous Waste Number</u>	<u>Description</u>
D002	Corrosive
D003	Reactive
D004	EP Toxic for arsenic
D006	EP Toxic for cadmium
D007	EP Toxic for chromium
D008	EP Toxic for lead
D011	EP Toxic for silver

RCRA Listed Wastes - The applicability of listed waste numbers to the acid waste is based almost entirely upon process knowledge. The process involved in generating this waste is basically an electroplating process. EPA specifically excludes chemical etching and milling of aluminum from electroplating operations, but thereby infers that all other types of etching and milling are included. This coupled with the fact that a significant cyanide concentration was observed in the electropolishing solution, leads to the determination that the following RCRA hazardous waste codes are also applicable to the acid waste or any sludges resulting from its treatment:

<u>Hazardous Waste Number</u>	<u>Description</u>
F006	Wastewater treatment sludges from electroplating operations
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used

6.14.3 Regulatory and Waste Form Requirements

6.14.3.1 Waste Form Requirements for Low-Level Waste Disposal

Because of its liquid nature, the acid waste does not meet waste form requirements for disposal of low-level waste. Treatment will be required before this waste can be disposed.

6.14.3.2. Applicable Land Disposal Restrictions (LDR)

The applicable Land Disposal Restriction is the California List requirement, now in effect, that prohibits the land disposal of liquid hazardous wastes having a pH less than or equal to two. The restrictions that will impact the future disposition of the acid waste are those associated with RCRA characteristics and those for electroplating processes. Regulations for characteristic wastes have not yet been promulgated even for straight hazardous waste, but those that will be applicable are as follows:

<u>Characteristic</u>	<u>Concentration Limit Set by LDR</u>
D002	TBD
D003	TBD
D004	TBD
D006	TBD
D007	TBD
D008	TBD
D011	TBD

Restrictions for the electroplating series of waste numbers have already been set for regular hazardous wastes and it will be assumed that they will remain unchanged for mixed wastes. The applicable limits have been established with some items in terms of CCWE and others in CCW. If a nonwastewater exceeds the following limits, it is restricted from land disposal:

<u>F006, F007, F008 and F009 Category/Constituent</u>	<u>Concentration (ppm)</u>
CCWE	
- Cadmium	0.066
- Chromium	5.2
- Lead	0.51
- Nickel	0.32
- Silver	0.071
CCW	
- Cyanides (Total)	590
- Cyanides (Amenable)	30

6.14.3.3 Impact of Restrictions or Waste Form Requirements

Low-Level Waste Disposal Requirements - Unacceptable - In its current liquid condition, the acid waste is unacceptable for disposal as low-level radioactive waste. This is not taking into consideration any additional requirements levied by RCRA regulations. Were the waste to be treated to remove free liquids, it would likely meet low-level waste form requirements.

California List Prohibitions - Unacceptable - The acid waste is clearly unacceptable for land disposal under this criteria.

RCRA Characteristics (metals and corrosivity) - Impact uncertain - Although LDR limits have not yet been established for these parameters, it is highly unlikely that the waste would be acceptable for land disposal exhibiting its present characteristics.

Electroplating Standards - Unacceptable - The acid waste has metal concentrations far in excess of the allowable limits for electroplating wastes even when using the EP method. Total cyanides and cyanides amenable to chlorination have not been measured, but based on the reactive cyanides, will also exceed the allowable concentrations.

6.14.4 Treatment Alternatives

The stored inventory of acid waste is presently unacceptable for land disposal based on its liquid corrosive condition, concentrations of heavy metals, and possibly concentrations of cyanides. EPA has not yet published BDAT treatment standards in the LDR regulations for waste that is hazardous because of EP Toxicity, reactivity or corrosivity. Wastes exhibiting these characteristics

may simply be banned from land disposal; that is, the waste would have to be neutralized, the cyanides destroyed, and the metals either removed or stabilized. For F006, F007, F008 and F009 wastes, EPA has established BDAT for treatment as alkaline chlorination followed by precipitation, settling, filtration, and stabilization of metals. However, the LDR establishes concentration-based standards rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards.

The requirements to be met by treatment of this waste are threefold:

- (1) It must be neutralized to remove its corrosive characteristic,
- (2) Cyanide must be destroyed to remove the characteristic of reactivity and to meet LDR requirements (pending the results of cyanide analyses), and
- (3) Heavy metals must be stabilized to meet LDR requirements.

The alternatives to be evaluated all include pretreatment of some type. One option is to then discharge to the existing Building 374 wastewater treatment process, the others involve more extensive pretreatment followed by solidification or vitrification of the resulting sludge. Testing on the acid waste has already shown that neutralization with lime eliminates the formation of the gel-like material encountered when sodium hydroxide was used.

Another option is material substitution in the waste generating process. Ideally there should be some alternate chemical composition for the solutions in the two process tanks involved that will serve the intended purpose and make direct discharge to the wastewater collection system viable. This would eliminate the future generation of this problem waste stream. This option is being pursued independently of the treatment options for the waste already generated.

6.14.5 Evaluation of Alternatives

Four treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.14. The treatment approaches and the results of their evaluation are discussed as follows.

Neutralization, CN Treatment, Discharge to Wastewater Treatment -

The acid would be neutralized with lime followed by the destruction of cyanide through the use of alkaline chlorination. The resulting wastewater would then be discharged to the wastewater treatment system in Building 374 where it would undergo a physical-chemical treatment (flocculation and precipitation) for the removal of metals. This treatment approach is essentially the BDAT for this type waste. Some successful testing has already been accomplished on both the neutralization step and cyanide destruction. The reason this alternative did not receive the highest score for "Effectiveness/Development" is because the existing treatment system in Building 374 is designed for the removal of radioactive metals not for maximum removal of EP Toxic metals. However, discharge limitations on the treatment plant should help ensure that adequate removal efficiency is obtained. This alternative was given a zero on "Secondary Waste" because of the multiple steps necessary. Although waste specific testing is still required, treatment could likely be completed within one to two years. A high score was given for "Efficiency" because the option makes use of existing capabilities and essentially generates no residue since it is combined in the much larger volume of bypass sludge.

Pretreatment, CN Treatment, Cementation - The acid would be pretreated by neutralization, metal precipitation, and cyanide destruction. The liquid would then be decanted off and sent to the evaporator in Building 374 and the sludge would be cemented. This

**Figure 6.14: Evaluation of the Treatment Alternatives For Acid
Need: Neutralization, Precipitation and Stabilization of Metals**

Alternatives	Neutralization, CN Treatment, Discharge to Wastewater Treatment	Pretreat, CN Treatment, Cementation	Pretreat, Vitrification	Pretreat, CN Treatment, Polymer Solidification		
Effectiveness/ Development	9	6	6	6		
Secondary Waste	0	0	2	0		
Availability	4	4	2	2		
Efficiency	3	1	3	2		
TOTAL	16	11	13	10		

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

process should work, but no testing has been performed on steps other than neutralization and cyanide destruction. This alternative received a zero for "Secondary Waste" because of the multiple steps and waste streams generated. The process is, however, made up of relatively simple steps and could be put into a production mode within two years. It received a low score for "Efficiency" because the cemented waste form is much less dense (more porous) than with other techniques identified.

Pretreatment and Vitrification - The pretreatment in this instance is similar to that described above for cementation, but the cyanide destruction step is eliminated. The precipitated sludge is sent to a microwave process for vitrification where the cyanide is also destroyed. This process should work, but no testing has been performed other than neutralization. This alternative was given some benefit under "Secondary Waste" for eliminating one of the process steps. However, the use of the more complicated microwave process does extend the estimated production mode time schedule to beyond two years. A high score was given under "Efficiency" because the resulting vitrified waste is a better form than achieved under the solidification options and the waste volume is less.

Pretreat, CN Treatment, Polymer Solidification - The pretreatment, including cyanide destruction, under this option is identical to that describe above for cementation. In this case the sludge is solidified through the use of a polymer binding agent. This alternative also involves multiple processing steps and waste streams which caused it to receive a zero under "Secondary Waste". It was given a lower score on "Availability" than was cementation because the technology is not in use at RFP. The use of polymer solidification should produce a waste form that is less porous than cementation, so it was given a medium score under "Efficiency".

Pretreatment and discharge to the existing wastewater treatment system received the highest score and will continue to be considered a viable treatment approach. Each of the other alternatives will be tested to determine its effectiveness as backup. Development of the pretreatment process for each of the technologies is, of course, applicable to the first option. A backup alternative is considered necessary in the event that unforeseen regulatory concerns associated with discharging to the wastewater system should arise or if it is determined that the 374 treatment plant is inefficient in removing heavy metals.

6.14.6 Schedule

The schedule for activities associated with treatment of the acid waste are shown in Table 6.14. Although not specifically shown in the schedule, a significant factor in the schedule may be the development of a safe manner to destroy the cyanides in the waste if this is shown to be necessary. As mentioned earlier, the existing analytical results from the electropolishing solution indicate the waste will likely have hydrogen cyanide gas build up in the containers and will present a hazardous situation in any handling operations.

Table 6.14: Schedule for Acid Activities

	FY 90	FY 91	FY 92
1. Characterize the waste to verify the need for cyanide treatment on this waste	▨		
2. Cyanide Treatment, Production Scale Implementation* A.N. 3.7.1.09.0024		▨	
3. Pretreatment Lab Scale Tests A.N. 3.7.1.09.0024	▨	▨	▨
4. Solidification Lab Scale A.N. 3.7.1.09.0012	▨	▨	
5. Vitrification Lab Scale A.N. 3.7.1.09.0021	▨	▨	▨

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project
*If required

6.15 Composite Chips

6.15.1 Generation Process

Metal fabrication activities within Building 444 at RFP include work on composite materials. These composite metals normally consist of stainless steel and depleted uranium; however, in some instances the uranium may be coupled with aluminum, beryllium, or even copper. During machining operations on these composite metals, oils and solvents are applied to the stock material. Cuttings or chips from the composite metal along with residues from the oils and solvents are all mixed as they are caught beneath the machining equipment. This part of the generation process is the same as that described for the metal chip waste, section 6.11. Instead of the drained composite chips being put directly into drums for future disposition as with metal chips, they are taken to Building 447 for cementation. The cementation is necessary because of the pyrophoric nature of the uranium. (The composite chips are not compatible with the roasting process described in section 6.4.) The cementation procedure involves layering chips and a cement/water mix into drums and using a vibrator to mix the contents. The drums are then stored in 4ft by 4ft by 7ft plywood boxes.

As of September 1989, 106 cubic yards (25 full boxes and one half box) of the composite chip waste had been accumulated and future generation rates are expected to be 15.6 cubic yards per year.

6.15.2 Waste Characterization

Characterization of the composite chip waste depends primarily upon process knowledge. The composite metal being machined typically consists of depleted uranium, silver and stainless steel, but the stainless steel is sometimes replaced with aluminum, beryllium, or copper. The chips, also consisting of these metals, are

contaminated with cutting oil and solvents. The cutting oil is not a hazardous material or waste, but the solvents used (1,1,1-trichloroethane and 1,1,2-trichloro-1,2,2-trifluoroethane) are subject to RCRA regulation once they have become a waste. Because of the nature of the waste, leachability of metals may also be a concern.

The cemented composite chips were sampled once as part of the Waste Stream Identification and Characterization effort in 1986. Provided below is a list of compound/parameter categories for which analyses were performed on that sample:

Category of Analytical Data

Semivolatiles
Radiochemistry (tritium only)
RCRA Characteristics
 Ignitability
 EP Toxic Metals

Each of the data categories listed above and the results of the sampling and analysis will be described in the following paragraphs. EPA hazardous waste numbers that are applicable to this waste, based on analytical results and process knowledge are also presented.

6.15.2.1 Semivolatiles

Only one semivolatile compound registered above detection limits (ADL) in the sample. The single compound observed was di-n-butyl phthalate at a concentration of 190 ug/kg (or ppb).

6.15.2.2 Radiochemistry

The radiochemistry results for tritium was 0.11 (+/- 0.22) pCi/ml.

6.15.2.3 RCRA Characteristics

Ignitability - The single test for ignitability was negative showing a flash point greater than 60°C.

EP Toxic Metals - None of the EP Toxic metals were observed at levels above the maximum concentrations set in 40 CFR 261.24. Three metals were observed at detectable levels but did not include silver. However,, from process knowledge the presence of silver should not be discounted based on this single sample. The three metals observed were as follows:

<u>Metal</u>	<u>EP Toxicity Results (mg/l or ppm)</u>	<u>Maximum Concentration</u>
Arsenic	1.80	5.0
Cadmium	0.32	1.0
Lead	1.83	5.0

6.15.2.3 Applicable EPA Hazardous Waste Numbers

The hazardous waste numbers applicable to this waste are based solely on process knowledge. The analyses performed on the single sample did not identify any reasons to consider the waste hazardous, but analyses did not detect silver and were not performed for volatiles which are the other suspected cause of the hazardous designation. The presence of silver and the listed solvents would require the waste to have the following designations:

<u>Hazardous Waste Number</u>	<u>Description</u>
D011 F001	EP Toxic for silver Waste contaminated with halogenated solvents used for degreasing

The composite chip waste is also considered low-level radioactive waste primarily because of the presence of uranium in the composite material.

6.15.3 Regulatory and Waste Form Requirements

6.15.3.1 Waste Form Requirements for Low-Level Waste Disposal

The composite chip waste as currently packaged and stored should meet normal low-level waste disposal facility acceptance criteria. The cementation process appears to adequately treat the pyrophoric problem and leaves a physically stable waste form.

6.15.3.2 Applicable Land Disposal Restrictions (LDR)

LDR Requirements now In-Place - The applicable LDR regulations, now in effect, are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that is applicable bans the land disposal of non liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated organic compounds (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for spent solvents. The standards can be found in the CCWE Table in 40 CFR 268.41 and provide two concentration limits for each of 25 solvents: one applicable to wastewaters and the second for other waste forms. The following identifies only those suspected (from process knowledge) to be of concern for the composite chip waste:

F001-F005 Solvent

CCWE Concentration (ppm)
- nonwastewaters -

1,1,1-trichloroethane	0.41
1,1,2-trichloro-	0.96
1,2,2-trifluoroethane	

Future LDR Requirements - Most restrictions applicable to mixed waste as well as those for the "final third" wastes are scheduled to go into effect May 8, 1990. Included in the "final third" wastes are those associated with RCRA characteristics. Although standards have not yet been set, composite chips could be impacted by the future standards as shown in the following:

<u>Potential Characteristic</u>	<u>Concentration Limit Set by LDR</u>
D011	TBD

6.15.3.3 Impact of Restrictions or Waste Form Requirements

Solvents - Impact uncertain - Knowledge of the process generating the composite chips leads to the conclusion that the current waste form will likely meet disposal requirements. It is unlikely that well drained composite chips will contain significant residues of the listed solvents identified in the previous paragraph. This is due both to the physical act of draining and the evaporation of the more volatile solvent portions of the liquid mixture. However, it may be difficult to show that the LDR standards were achieved without dilution of the cementation process. There should be no doubt that the 1,000 ppm limit for HOCs is not exceeded. The individual limits for solvents are roughly three orders of magnitude smaller and could, therefore, be a concern. Representative

samples should be taken of the stored composite chip wastes and subjected to the TCLP for spent solvents.

RCRA Characteristics (EP Toxic Metals) - Impact uncertain - The LDR standards for this type of waste have not been established and the waste has not yet been adequately characterized to determine which of the criteria would be applicable. Additional sampling and analysis will include these parameters.

6.15.4 Treatment Alternatives

EPA has established incineration as the BDAT for solid waste contaminated with solvents at levels above the LDR standards. However, the LDR has established concentration-based standards for F001 through F005 solvents rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards. If leachable quantities of silver or other EP Toxic metals are present, stabilization would be the likely BDAT.

Although the primary problem identified with the cemented composite chip waste is due to the suspected presence of solvents, any treatment alternative considered must be capable of dealing with the pyrophoric nature of the depleted uranium. The ideal treatment option would be one that destroys the organics and oxidizes the depleted uranium to a non-ignitable form. The alternatives that are being considered include incineration, vitrification, and extraction.

6.15.5 Evaluation of Alternatives

Three treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.15. The treatment approaches and the result of their evaluation are

Figure 6.15: Evaluation of the Treatment Alternatives For Composite Chips

Need: Destruction of Organics

Alternatives	Incineration (not FBI)	Vitrification	Extraction (Followed by Cementation)			
Effectiveness/Development	12	6	12			
Secondary Waste	2	2	0			
Availability	2	2	4			
Efficiency	1	1	2			
TOTAL	17	11	18			

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

discussed in the paragraphs that follow. It will be assumed that for each treatment alternative, the cemented waste form will require a pretreatment of grinding or crushing to be put into a form appropriate for the treatment. For the thermal treatment approaches this will likely be required in order to insure solvent mass transfer into the gas phase. To a lesser extent, it will help control the temperature of the processes; due to the extremely hot temperature of metal fires the amount of metal burning at any given time needs to be controlled. The pyrophoric nature of the metals will also make the grinding activity a difficult task and results in all options being of high complexity. For generations of the composite chip waste after the treatment method is developed, it will be assumed that the cementation step before treatment will be eliminated.

Incineration - Incineration received a high score because it is considered the BDAT for this type waste and has been shown to work on a full scale. Incinerator does produce an ash that would likely require solidification before disposal and was given a two for "Secondary Waste". It is not a technology that could be put into production rapidly, particularly since the existing fluidized bed incinerator (FBI) would not normally be considered appropriate for this type waste. It was, however, given a low score for "Efficiency" because of its high capital costs in comparison to other alternatives.

Vitrification - The plasma arc technology is being considered under this alternative. It should be capable of destroying organics, eliminating the pyrophoric nature of the uranium, and providing a vitrified waste form. However, it has not been developed through bench scale testing for this particular waste. Because destruction efficiency is not known at this time, it is assumed that the off-gas will be of regulatory concern and the alternative was given a two under "Secondary Waste". The technology is fairly complex and

considering the stage of development, could not be put into production scale in less than two years. The "Efficiency" was also scored low because of the high capital costs of this system and because its reliability has not been proven.

Extraction - Two types of treatment are being considered: aqueous washing and supercritical fluid cleaning using liquid carbon dioxide. Aqueous washing has been tested sufficiently on similar types of metal chips to receive a score of 12 on the "Effectiveness/Development" element. Liquid carbon dioxide should work as well but has not been developed. The nature of the treatment approach is such that a secondary waste is produced that will require additional treatment while the treated composite chips retain their designation of a listed waste. The chips would also retain their pyrophoric nature and require cementation. These technologies are considered relatively simple and could be put into production in less than two years. They received a medium score for "Efficiency" because they involve fairly low capital costs and have shown promising results.

The only technology currently being considered for development to treat composite chips at RFP is the extraction technologies. Aqueous cleaning is the favored technology because of experience. However, the extract from the liquid carbon dioxide cleaning may be treatable by one of the thermal treatment technologies to achieve full destruction of listed solvents.

6.15.6 Schedule

The schedule for development activities associated with alternate treatment approaches for composite waste chips are shown in Table 6.15. It should be noted that the first action on the schedule is the characterization of cemented and non-cemented waste to better determine what treatment is really necessary to put it into a disposable form.

Table 6.15: Schedule for Composite Chip Activities

	FY 90	FY 91	FY 92
1. Characterization of composite chip waste, keying on TCLP for solvents and EP Toxic metals*	▨		
2. Extraction and Cementation		▨	

*Due to the pyrophoric nature of the materials involved, it may not be practical to perform leach tests, in which case testing of a simulated waste may be appropriate.

A.N. = Activity Number in 5 Yr Plan

P.N. = Program Number for Current Project

6.16 Absorbed Organic Waste

6.16.1 Generation Process

Scintillation fluids or cocktails are routinely used in radiochemistry performed at the RFP. In addition to the radioactive material involved, the past scintillation material was considered hazardous, hence the resulting waste form being designated a mixed waste. The absorbed organic waste was generated when spent scintillation cocktail was absorbed onto hydrated calcium silicate in polyethylene bottles and then placed into a 55 gallon drum.

The absorbed organic waste is no longer being generated since the scintillation fluids currently being used are not hazardous. The current inventory of the problem mixed waste is 1.4 cubic yards or five drums.

6.16.2 Waste Characteristics

Much of the characterization of the absorbed organic waste is based on process and manufacturer supplied knowledge of the original components of the waste. Since the waste stream differs very little from the manufacturer's original material until it is added to the hydrated calcium silicate, this type characterization provides excellent information. A typical scintillation fluid waste was sampled in 1987 as part of the Plant Waste Stream Identification and Characterization effort which was published in April 1987. However, the single sample was analyzed only for ignitability and radiochemistry. Characterization based on process knowledge and analytical results will be discussed in the following sections; EPA hazardous waste numbers applicable to the waste will also be provided.

6.16.2.1 Process Knowledge

The scintillation fluid used was a PCS brand obtained through the Amersham Corporation. The Material Safety Data Sheet (MSDS) for the fluid identifies xylene and 2-ethoxyethanol as the hazardous constituents making up the original mixture. In a September 1989 telephone conversation with the Technical Support Office of the Amersham Corporation, it was learned that the scintillation fluid as supplied was 60% xylene and 5% 2-ethoxyethanol. Since only a small amount of the radioactive material sample is added to the fluid, this characterization should be indicative of the waste mixture as it is added to the absorbent.

6.16.2.2 Ignitability

The single sample analysis results provided a flash point of less than 25°C (77°F). The MSDS of the original fluid indicates a flash point of about 29°C (85°F). In either case, the material appears to be well within the limit to be considered ignitable by RCRA definition.

6.16.2.3 Radiochemistry

The results of the single set of radiochemistry analyses are as follows:

<u>Analysis</u>	<u>Concentration</u>
Pu-239	71 +/- 18 pCi/g
Am-241	At or near background
U-233,234	At or near background
U-238	At or near background
Tritium	28,000 +/- 1,000 pCi/ml

6.16.2.4 Applicable EPA Hazardous Waste Numbers

RCRA Characteristics - There is no reason to suspect the absorbed organic waste is corrosive, reactive, or EP Toxic for metals or

pesticides. The scintillation fluid does exhibit a very low flash point, but once absorbed onto hydrated calcium silicate it is no longer a liquid, thus it would have to be capable of causing a fire through friction to be considered an ignitable. However, additional sampling or inspection may be required to verify that no free liquids exists. The only RCRA characteristic that could be associated with the waste in liquid form is as follows:

<u>Hazardous Waste Number</u>	<u>Description</u>
D001	Ignitable

RCRA Listed Wastes - Both of the hazardous constituents in the scintillation fluid, xylene and 2-ethoxyethanol, can be listed solvents if their formulations when originally used meet the regulatory definitions. Spent xylene qualifies as an F003 waste if before use, the material is all xylene or all xylene and other F003 solvents. Xylene can also be an F003 waste if it is in a mixture that contains a total of 10% or more of any of the solvents listed in F001, F002, F004 or F005. 2-Ethoxyethanol qualifies as an F005 waste if by itself or in combination with any other F005 solvents or any F001, F002, F004 solvent equals 10% or more of the original material before use. With these qualifications in mind, it can be determined that the scintillation fluid qualifies as neither an F003, nor an F005 waste. The xylene only makes up 60% of the original mixture and it needs to make up essentially all of the material that is not another listed solvent. The 2-ethoxyethanol is only 5% of the original material and it needs to be 10% before the classification is applicable.

6.16.3 Regulatory and Waste Form Requirements

6.16.3.1 Waste Form Requirements for Low-Level Waste Disposal

Excluding any RCRA requirements, the absorbed organic waste would likely be acceptable for disposal as low-level waste as long as the scintillation fluid was adequately absorbed, and free liquids were no longer present.

6.16.3.2 Applicable Land Disposal Restrictions (LDR)

LDR Requirements Now In-Place - The restrictions on California list waste and on F001 through F005 solvents are currently in effect but they are not applicable to the absorbed organic waste.

Future LDR Requirements - Those specific LDR standards or limits not yet established are scheduled to go into effect May 8, 1990. The LDR standard that may be applicable to the absorbed organic waste is that established for ignitability, D001.

6.16.3.3 Impact of Restrictions or Waste Form Requirements

Impact uncertain - The only LDR standard that may be applicable to the absorbed organic waste (that for D001) has yet to be established, even for strictly hazardous waste.

6.16.4 Treatment Alternatives

Assuming it has no free liquids, the absorbed organic waste should no longer qualify as ignitable and the stored inventory should be acceptable for disposal in its present form as low-level waste. Alternatively, if free liquids are present, the waste is ignitable and currently banned from disposal

In summary, the only apparent treatment need for this waste is to eliminate its ignitability characteristic. This could be accomplished through an incineration process, that would also destroy the organics, but the concern over the release of tritium has discounted this option. The only treatment alternative currently being considered is solidification.

6.16.5 Evaluation of Alternatives

The single treatment alternative was evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.16. The treatment approach and the result of its evaluation are discussed in the paragraphs that follow.

Cementation - Cementation would be accomplished with a gypsum cement such as Envirostone which has shown to be relatively successful with organic materials. The alternative was given a high score for effectiveness for this reason. It was also scored high for "Secondary Waste" since no additional waste streams would be created. Because of the form in which the waste currently exists, some development will be required to determine the best method in which to deploy the cementation process, or conversely, the best form in which to put the waste so the cementation process can be deployed. However, the process should still be possible to put into production within two years. The alternative received a low score for "Efficiency" because waste volume is increased and cementation produces a relatively porous waste form. However, it should be noted that treatment options that would generate a better, denser waste form generally involve heat and would increase the potential for release of tritium from the waste during treatment.

6.16.6 Schedule

No activities are currently planned for development of additional treatment for this waste. The absorbed organic waste can be disposed

Figure 6.16: Evaluation of the Treatment Alternatives For Pondcrete

Need: Elimination of Ignitability

Criteria	Alternatives	Cementation			
Effectiveness/Development	12				
Secondary Waste	4				
Availability	4				
Efficiency	1				
TOTAL	21				

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

of in its present form, once it is verified that no free liquid exists and the waste no longer qualifies as ignitable. Additional work will be done in FY 1990 to verify these parameters, and the waste will be shipped as soon as possible after the verification is completed.

Table 6.16: Schedule for Absorbed Organic Waste Activities

FY 92	FY 91	FY 90
		

Ignitability
Determination

6.17 Electrochemical Milling (ECM) Sludge

6.17.1 Generation Process

Building 881 at the RFP is a manufacturing and general support facility and one of the processes taking place in that facility is described as micro-shaping. In this activity various metal parts, including uranium, are shaped through precision mechanical techniques and/or through electrochemical methods. The later approach, referred to as electrochemical milling (ECM), generated a small amount of sludge that accumulated over the years. Clean out of this accumulation was responsible for the generation of the ECM sludge waste.

ECM sludge is no longer generated as a mixed waste. The inventory currently awaiting disposition is only two cubic yards and is being stored in a single "Half-Box" which is being held on the 904 pad. Since this waste is mixed, there are no off-site facilities that take it for additional treatment or disposal.

6.17.2 Waste Characterization

The ECM sludge has not been sampled for radiological or hazardous constituent analysis; its characterization is based primarily on process knowledge. The aqueous waste from the ECM process was sampled and analyzed as part of the Plant Waste Stream Identification and Characterization effort in 1986. These analytical results provide some indication of the contaminants that might be present in the sludge. The ECM wastewater was analyzed for ignitability, corrosivity, reactivity, volatiles, and total metals. The following paragraphs discuss the results of those analyses and how they may relate to the sludge waste. The applicable EPA hazardous waste numbers will be provided at the end of the discussion.

The wastewater was not ignitable (flash point greater than 60°C) and neither would the sludge be expected to be. The wastewater had a high pH (12.1), but not high enough to be considered corrosive; the sludge could be expected to be similar, but should be tested to determine if it qualifies as corrosive. Analysis for reactive cyanide and sulfide (different than total cyanide or sulfide) were performed on the wastewater; cyanides were shown to be present in the water (at 622 ug/g) while sulfides were not. The ECM sludge should be considered as containing cyanides, but needs to be tested for the appropriate forms (total and amenable to chlorination).

The ECM wastewater was analyzed for volatiles, but only acetone was observed at levels above the detection limit (measured at 37 ppb). The sludge could also have trace amounts of volatiles present, but without further characterization it would probably be inappropriate to assume that listed solvents were present.

The analysis of the wastewater for total metals indicated the presence of arsenic and chromium but not at concentrations high enough for the wastewater to be considered EP Toxic for either of the metals. (The arsenic and chromium concentrations were 1200 ppb and 11 ppb, respectively.) It is quite possible that these types of materials could have concentrated in the sludge so tests for toxic metals will be required.

Without further characterization the EPA hazardous waste numbers applicable to the ECM sludge are assumed to be as follows:

<u>Hazardous Waste Number</u>	<u>Description</u>
F006-F009	Wastes from electroplating operations

Further characterization may also determine that EPA waste numbers for some of the EP Toxic metals are also applicable.

6.17.3 Regulatory and Waste Form Requirements

6.17.3.1 Waste Form Requirements for Low-Level Waste Disposal

The ECM sludge as currently packaged and stored would probably meet normal low-level waste disposal facility acceptance criteria. The only potential concern would be the presence of free liquids. Visual inspection of the ECM sludge waste may be necessary to determine if any significant separation of liquid and solid has taken place.

6.17.3.2 Applicable Land Disposal Restrictions (LDR)

Since the ECM sludge waste is mixed and is assumed to involve no organic contaminants, the applicable LDR regulations do not go into effect until May 8, 1990. The restrictions associated with the RCRA characteristics may be applicable depending on the results of additional sampling and analysis. The LDR standards for these wastes have not yet been established.

Restrictions for the electroplating series of EPA hazardous waste numbers have already been set for regular hazardous wastes and it will be assumed that they will remain unchanged for mixed wastes. The applicable limits have been established with some parameters in terms of CCWE and others in CCW. If a nonwastewater exceeds the following limits, it is restricted from land disposal:

F006, F007, F008 and F009	
<u>Category/constituent</u>	<u>Concentration (ppm)</u>
CCWE	
- Cadmium	0.066
- Chromium	5.2
- Lead	0.51
- Nickel	0.32
- Silver	0.072
CCW	
- Cyanides (Total)	590
- Cyanides (Amenable)	30

6.17.3.3 Impact of Restrictions or Waste Form Requirements

Low-Level Waste Disposal Requirements - No impact - Assuming the stored ECM sludge has no significant free liquid content, the waste would likely be acceptable for disposal as low-level radioactive waste.

RCRA Characteristics - Impact uncertain - Until the ECM sludge is sampled and analyzed it will be unknown which, if any, of the RCRA characteristics are applicable. The LDR regulations addressing RCRA characteristics are also unavailable at this time.

Electroplating Standards - Impact uncertain - It is likely that the ECM sludge will not meet the stringent concentration limits established for metals and cyanides in electroplating type wastes. However, until the waste is better characterized, the exact impact is unknown.

6.17.4 Treatment Alternatives

The stored inventory of ECM sludge will likely be unacceptable for disposal as of May 8, 1990 because of its metal and cyanide concentrations. However, this is only speculation at this time

because the waste has not been sampled and analyzed. EPA has not yet published BDAT treatment standards in the LDR regulations for waste that is hazardous because it exceeds EP Toxicity limits for metals. Such waste may simply be banned from disposal which would require the metals to either be removed or stabilized. For F006, F007, F008 and F009 wastes, EPA has established BDAT for treatment as alkaline chlorination followed by precipitation, settling, filtration, and stabilization of metals. However, the LDR establishes concentration-based standards rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards. With the waste already in a sludge form, the only portions of the BDAT still applicable are alkaline chlorination for destruction of cyanides and stabilization of metals.

Three treatment alternatives have been chosen to address possible cyanides and leachable metals in the ECM sludge at concentrations above the LDR standards. The first two alternatives involve pretreatment of the waste to destroy cyanide followed by solidification. The second alternative is use of the Joule melter.

6.17.5 Evaluation of Alternatives

Three treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.17. The treatment approaches and the result of their evaluation are discussed in the paragraphs that follow.

CN Treatment, Cementation - In this process the sludge would be resuspended in water to allow cyanide destruction through alkaline chlorination, dewatered, and finally cemented. This approach should achieve the desired results, but it has not been tested on a bench scale. Because of the multiple steps involved and the introduction of water, this approach was given a zero under "Secondary Waste".

Figure 6.17: Evaluation of the Treatment Alternatives For ECM Sludge

Need: Cyanide Destruction and Metal Stabilization

Alternatives	CN Treatment Cementation	CN Treatment Polymer Solidification	Vitrification			
Effectiveness/ Development	6	6	6			
Secondary Waste	0	0	2			
Availability	2	2	2			
Efficiency	1	2	3			
TOTAL	9	10	13			

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

Because of the stage of development, the alternative would likely take longer than two years to put into a production mode. The option received a low score under "Efficiency" because it increases waste volume and the resulting cemented waste form is still considered to be of poorer quality than forms generated from other options.

CN Treatment, Polymer Solidification - This option is identical to that described above with the exception that a polymer binder is used in lieu of cement. The higher score for "Efficiency" was due to the denser, better quality waste form that is generated.

Vitrification - Use of the Joule melter to achieve a vitrified waste form was evaluated. This process should work, but has not been tested on a bench scale for this waste. This option received the highest evaluation score for two reasons: first, cyanide destruction takes place as part of the melting process so the sludge should not require pretreatment; and second, the resulting waste form is considered to be of better quality than the other options and would likely be of the smallest volume. This earned the alternative higher scores under "Secondary Waste" and "Efficiency" respectively. The vitrification process received only a two under "Secondary Waste" since it is thermal treatment and as such generates an off-gas that could be of concern.

6.17.6 Schedule

The schedule for development activities associated with alternate treatment approaches for the ECM sludge waste are shown in Table 6.17. The key step on the schedule is the characterization effort that is required to determine the actual treatment needs for this waste. Development efforts will follow accordingly.

Table 6.17: Schedule for ECM Sludge Activities

	FY 90	FY 91	FY 92
1. Characterization of waste keying on cyanides (total and amenable), TCLP for metals and possibly for solvents.			
2. Cyanide Treatment Full Scale Test A.N. 3.7.1.09.0024			
<u>Solidification</u>			
3. Polymer Bench Scale Test A.N. 3.7.1.09.0012			
4. Cement Bench Scale Test A.N. 3.7.1.09.0018			
<u>Vitrification</u>			
5. Joule Melter Bench Scale Tests A.N. 3.7.1.09.0018			

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.18 Contaminated Dirt

6.18.1 Generation Process

Excavation of areas that are contaminated with radioactive materials and RCRA hazardous constituents generates contaminated soil as a waste. Twelve (12) cubic yards of contaminated soil waste has been generated through recent investigative drilling activities and is being stored in six 2 ft. by 4 ft. by 7 ft. boxes (referred to as half boxes). For estimation purposes, it is assumed that this waste will continue to be generated at a rate of about 3.6 cubic yards per year. This does not include any major soil excavation projects that may occur as a result of remedial or corrective actions.

6.18.2 Waste Characterization

The contaminated dirt waste has not been sampled for radiological or hazardous constituent analysis. However, based on knowledge of past plant operations, solvent contamination is anticipated. The primary solvents which have been seen in remedial investigations are carbon tetrachloride and trichloroethylene. Other solvents, as well as plutonium contamination, are also expected. Without further characterization, the EPA waste designations applicable to this waste are assumed to be:

<u>Waste</u>	<u>Hazardous Waste Number</u>
Contaminated dirt	F001 through F005

6.18.3 Regulatory and Waste Form Requirements

6.18.3.1 Waste Form Requirements for Disposal

The contaminated soil would likely be acceptable for disposal as low-level waste in its current form. Neither free liquids nor

fine particulate, the most common problems, should be issues with this waste.

6.18.3.2 Applicable Land Disposal Restrictions (LDR)

The applicable LDR regulations, now in effect, are those established for the California List wastes and for the F001 through F005 solvents. The California List restriction that is applicable bans the land disposal of non liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated Organic Compounds (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for spent solvents. The standards can be found in the CCWE Table in 40 CFR 268.41 and provide two concentration limits for each of 25 solvents: one applicable to wastewaters and the second for other waste forms. Process knowledge of the waste does not allow the list of 25 solvents to be significantly narrowed. In referring to the CCWE Table, the concentrations for waste forms other than wastewater is the applicable category.

6.18.3.3 Impact of Restrictions or Waste Form Requirements

Impact uncertain - Sampling and analysis may indicate that concentrations of solvents in the contaminated dirt will be high enough that land disposal will be unacceptable. It is doubtful that the 1,000 ppm limit for HOCs will be exceeded, but the limits for individual solvents could definitely be an issue.

6.18.4 Treatment Alternatives

If solvent levels in the contaminated dirt are above the LDR limits, EPA has established incineration as the BDAT for this type of waste. However, the LDR specify concentration-based standards for F001 through F005 solvents rather than requiring a specific technology. Therefore, any technology not specifically prohibited (such as dilution) may be used to meet the applicable standards.

Assuming that radiological and solvent contamination are the only problems with this waste, the treatment need is either destruction, stabilization, or removal of the organic contaminants. The treatment alternatives being considered include incineration, two types of vitrification, several types of extraction to remove the solvent contamination, and ultra-violet (UV) ozonation.

6.18.5 Evaluation of Alternatives

Five treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.18. The treatment approaches and the result of their evaluation are discussed as follows.

Incineration - Incineration received the highest score of the alternatives being evaluated because it is considered the BDAT for this type waste and has been shown to work on a full scale. Incineration was given a two for "Secondary Waste" because it produces an ash that may require solidification before disposal. It is not a technology that could be put into production rapidly, particularly since the existing fluidized bed incinerator (FBI) would not normally be considered appropriate for this type waste. It was given a medium score for "Efficiency" because there would be little volume reduction, but it is a proven, reliable technology.

Figure 6.18: Evaluation of the Treatment Alternatives For Contaminated Dirt

Need: Destruction of Organics

Alternatives	Incineration (not FBII)	Vitrification	Extraction	UV Ozonation	Cementation
Effectiveness/Development	12	6	6	9	6
Secondary Waste	2	2	0	0	4
Availability	2	2	2	2	6
Efficiency	2	2	1	1	1
TOTAL	18	12	9	12	17

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

Vitrification - The vitrification approaches being pursued include both the Joule melter and microwave treatment. This treatment alternative received the second highest score. Bench scale testing of the microwave system on radioactively contaminated waste has been accomplished at the RFP with promising results, but it has not been tested on the contaminated dirt. Development of the Joule melter is at a similar stage. A concern with this technology is whether volatiles will be destroyed or released to the off-gas. It was assumed that the off-gas would not be a significant problem and vitrification was given a two for "Secondary Waste". This alternative produces a better waste form than incineration, but because of the questionable reliability in destroying organics it was also given a medium score under "Efficiency". A production scale microwave or Joule melter would likely take longer than two years.

Extraction - Four types of extraction were considered under this alternative: steam stripping, air sparging, aqueous wash, and supercritical fluid using CO₂. In each case the treatment would be designed to remove the solvent contamination from the dirt. By definition, the dirt would remain a listed waste (unless formally delisted) and the extraction media would then require additional treatment. Each of the techniques has promise, but none have been tested on the specific waste. As stated, each would involve a secondary waste stream that would require treatment thereby earning a zero for that element. Since testing has not been initiated and the technology would require the necessary permits, it is estimated that no production scale operation could be in place in less than two years. Because of the increased waste volume and the questionable reliability in getting the contaminated dirt below LDR standards, extraction received a low score for "Efficiency".

UV Ozonation - This treatment approach would require the dirt to be suspended in water prior to oxidation of organics through the use of UV ozonation. This treatment approach has been tested with success

and received a nine for the "Effectiveness/Development" element of the evaluation. The dirt would have to be dewatered prior to disposal and unless delisted, both the water and the dirt would still be considered listed waste under RCRA. For these reasons the option was given a zero under "Secondary Waste". As with most full treatment processes, it is assumed that it would take longer than two years to reach a production scale. The alternative receive a low score for "Efficiency" because the waste volume is increased and the multiple steps and waste streams would appear to reduce the reliability in achieving the desired waste form.

Cementation - The use of cement to achieve the desired waste form received a high evaluation score. This technology would normally be considered the appropriate technology for stabilization of loose material such as dirt, but no testing has been performed on this particular waste to determine its effectiveness on organic contaminants. However, until characterization is performed, the extent of organic contamination is also unknown; if LDR standards are already being met, cementation may be appropriate, as necessary, to achieve a disposable waste form. This alternative scored higher than others evaluated for the "Availability" criterion because treatment is already being performed at the RFP under RCRA interim status on other wastes and improved techniques could likely be put into operation in less than a year. Cementation does have limitations as noted by its receiving the lowest score under "Efficiency". It increases the waste volume significantly and may be sensitive to changes in the waste characteristics.

The technologies for treatment of the contaminated dirt waste currently being considered for additional testing at the RFP are cementation, both types of vitrification, supercritical fluid extraction using CO₂, and UV ozonation. At the present time, the possibility of developing another incinerator for use at the RFP is considered small and is not identified in the schedule.

6.18.6 Schedule

The schedule for development activities associated with alternate treatment approaches for the contaminated dirt are shown in Table 6.18. No development specific to this waste is planned until characterization indicates treatment is needed. Cementation scored highest among treatment alternatives being considered for RFP operation, and will be considered first. Should more robust treatment be required as a result of TCLP analysis, development will proceed expeditiously.

Table 6.18: Schedule for Contaminated Dirt Activities

	FY 90	FY 91	FY 92
1. Characterization of waste, keying on TCLP for solvents and possibly for EP Toxic metals	▨		
<u>Vitrification</u>			
2. Microwave Bench Scale Tests A.N. 3.7.109.0004			▨
3. Joule Melter Bench Scale Test A.N. 3.7.109.0018			▨
<u>Extraction</u>			
4. Supercritical Fluid (CO ₂ Decon) Bench Scale Tests A.N. 3.7.109.0016 P.N. 970007			▨
<u>VOC Destruction</u>			
5. UV Ozonation Lab Scale Tests A.N. 2.5.109.0001			▨
<u>Solidification</u>			
5. Cementation Bench Scale Tests A.N. 3.7.109.0012		▨	

A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.19 Cutoff Sludge

6.19.1 Generation Process

Building 889 has served as a decontamination facility for cleaning (primarily steam cleaning) radiologically contaminated equipment at RFP. Equipment was brought into Building 889 from various locations in the plant and during the cleaning process, wastewater drained to a floor drain and then to a sump for eventual conveyance to the wastewater treatment facility. Cutoff sludge waste is material that was found under decontamination equipment in Building 889 when the equipment was removed.

During decommissioning activities on Building 889, cleaning equipment was removed and sludge material which accumulated over a period of time, was found in the collection system. Cement was added to the sludge to absorb free liquid and the mixture was placed in plywood boxes with other clean up debris (concrete and piping). These boxes are being stored awaiting final disposition. The estimated volume of waste is 10 cubic yards. Cutoff sludge is not expected to be generated in the future.

6.19.2 Waste Characterization

The sludge is made of materials washed off of equipment brought into Building 889 for decontamination. The type of equipment cleaned varied greatly but included such items as motors and lathes. In addition to radiological contaminants, the equipment cleaned could be expected to contain oils, greases, rust, metal chips and grindings. Items such as laths likely contained cutting oils and listed solvents. During the Waste Stream Identification and Characterization effort in 1986 and 1987, the sump where cleaning water was collected was sampled and analyzed. The results indicated reasonably high levels of organic solvents. Cutoff sludge, treated with cement, was sampled and analyzed

for total metals, volatiles, radiochemistry and pH in January 1988. The results of that sampling event will be presented in the following sections and the applicable EPA hazardous waste numbers are also presented.

6.19.2.1 Metals

The single sample analyzed for metals provided the following results:

<u>Metal</u>	<u>Concentration (ppm)</u>
Aluminum	6,016.0
Antimony	41
Arsenic	6.8
Barium	176.2
Beryllium	8,900
Cadmium	31
Calcium	14,731.7
Chromium	306.4
Cobalt	Not Detected
Copper	205.3
Iron	26,448.9
Lead	1,500
Magnesium	2,727.5
Manganese	227.8
Mercury	1.0
Molybdenum	27.8
Nickel	238.6
Potassium	3,600
Selenium	<1.0
Silver	6.2
Sodium	2,394.4
Strontium	46.0
Titanium	<1.0
Vanadium	Not Detected
Zinc	463.8

6.19.2.2 Volatiles

cut off
The ~~bypass~~ sludge sample was analyzed for 34 different volatile compounds. Only 12 of those compounds were observed at levels

above detection. The volatiles observed and their concentrations are as follows:

<u>Analyte</u>	<u>Concentration (ppb)</u>
Acetone	38
2-Butanone	11
Carbon Tetrachloride	9
1, 1-Dichloroethene	17
1, 2-Dichloropropane	357
Ethylbenzene	11
Methylene Chloride	32
Tetrachloroethane	331
Toluene	44
1, 1, 1-Trichloroethane	19
Trichloroethene	11
Total Xylenes	34

6.19.2.3 Radiochemistry

The single sample of bypass sludge was analyzed for gross alpha with a result of $(3.9 \pm 0.2) \times 10^3$ pCi/g.

6.19.2.4 pH

The sample was measured to have a pH of 8.86.

6.19.2.5 Applicable EPA Hazardous Waste Numbers

The cutoff sludge waste is an accumulation of materials cleaned off of many kinds of equipment from various plant processes. As such, the waste could be contaminated with various types of hazardous constituents. Based on the activities involved at the RFP and the way the waste was generated, the RCRA characteristics suspected are EP Toxic metals and solvents are the RCRA listed wastes that may be present. The results of the single sampling event support these suspicions. The specific EPA hazardous waste

numbers that may be applicable to the cutoff sludge waste are described in the paragraphs that follow.

RCRA Characteristics - Cutoff sludge will qualify as a characteristic hazardous waste depending on the results of analytical tests performed on the material. The specific analytical test required, the EP Toxicity test, has not been performed, but based on total metals analyses, the following EPA hazardous waste numbers may be applicable:

<u>Hazardous Waste Number</u>	<u>Description</u>
D004	EP Toxic for Arsenic
D005	EP Toxic for Barium
D006	EP Toxic for Cadmium
D007	EP Toxic for Chromium
D008	EP Toxic for Lead
D009	EP Toxic for Mercury
D011	EP Toxic for Silver

It is very unlikely that arsenic, barium, mercury, and silver will exceed the maximum concentrations, considering the EP Toxicity analysis method and the dilution that occurs when testing solid samples. However, sampling and analysis for the above metals, using the Extraction Procedure (EP), will be necessary to make the final determination.

RCRA Listed Wastes - The types of solvents used within the RFP in addition to the possibility of small amounts of electroplating bath residues being cleaned off of equipment, causes the following listed wastes to be suspect:

<u>Hazardous Waste Number</u>	<u>Description</u>
F001	Spent halogenated solvents used in degreasing
F002	Spent halogenated solvents
F003	Spent non-halogenated solvents
F005	Spent non-halogenated solvents
F007	Spent cyanide plating bath solutions from electroplating
F008	Plating bath residues from electroplating where cyanides are used
F009	Spent stripping and cleaning bath solutions from electroplating where cyanides are used.

All but two of the volatiles detected in the cutoff sludge are solvents listed under F001, F002, F003, or F005. Since the exact source of those hazardous constituents are unknown, the conservative approach is to assume they are from listed sources. The presence of F007, F008 or F009 waste is speculative at best. If cyanide is not detected in the sludge, it can probably be assumed that none of the F007 through F009 listed wastes are present.

6.19.3 Regulatory and Waste Form Requirements

6.19.3.1 Waste Form Requirements for Low-Level Waste Disposal

Cutoff sludge would likely be acceptable in its present form for disposal as low-level waste. This presumes that the addition of cement eliminated all free liquids and left no unacceptable quantity of fine particulate. Should either factor present a problem to the ultimate disposal facility's criteria, additional conditioning of the waste may be required.

6.19.3.2. Applicable Land Disposal Restrictions (LDR)

LDR Requirements Now In-Place - The applicable LDR regulations now in effect are those established for the California List of wastes and for the F001 through F005 solvents. The California List restriction that applies, bans the land disposal of non-liquids that exceed the following standard:

<u>Component</u>	<u>Concentration Limit (mg/kg or ppm)</u>
Halogenated Organic Compound (HOC)	1,000

The applicable F001 through F005 standards are set in terms of CCWE for specific spent solvents and can be found in 40 CFR 268.41. The regulation provides two concentration limits for each of 25 solvents: one applicable to wastewaters and the second to other waste forms. Solvents detected in the single cutoff sludge samples are shown with their applicable LDR limits as follows:

<u>F001-F005 Solvent</u>	<u>CCWE Concentration (ppm) - non wastewater -</u>
Acetone	0.59
2-Butanone (or Methyl Ethyl Ketone)	0.75
Carbon Tetrachloride	0.96
Ethylbenzene	0.053
Methylene Chloride	0.96
Tetrachloroethane	0.05
Toluene	0.33
1, 1, 1-Trichloroethane	0.41
Trichloroethene	0.091
Xylene	0.15

Future LDR Requirements - Most restrictions applicable to mixed waste as well as those for the "final third" wastes are scheduled to go into effect May 8, 1990. Included in the "final third" wastes are those associated with RCRA characteristics. Although

standards have not yet been set, cutoff sludge could be impacted by these future standards as shown in the following:

<u>Potential Characteristic</u>	<u>Concentration Limit Set by LDR</u>
D004	TBD
D005	TBD
D006	TBD
D007	TBD
D008	TBD
D009	TBD
D011	TBD

Another set of LDR standards that may be applicable to the cutoff sludge are those associated with electroplating activities. These standards have already been set in the form of CCW and CCWE for regular hazardous waste. Assuming the numerical standards will remain the same for mixed waste, wastes exceeding the following standards are prohibited from land disposal:

<u>F007, F008 and F009 Category/Constituent</u>	<u>Concentration (ppm) - non wastewater -</u>
CCWE	
Cadmium	0.066
Chromium (Total)	5.2
Lead	0.51
Nickel	0.32
Silver	0.072
CCW	
Cyanides (Total)	590
Cyanides (Amenable)	30

6.19.3.3 Impact of Restrictions or Waste Form Requirements

Low-Level Waste Disposal Requirements - Impact unlikely - In its current form, cutoff sludge would likely be suitable for disposal as low-level waste. Respirable fines should not be a problem considering the manner in which the waste was generated and the addition of cement should eliminate the free liquid problem.

Solvents - Impact unlikely - The cutoff sludge must be sampled and analyzed using the TCLP method to determine for certain whether the F001 through F005 solvent standards can be met. Total volatile analyses indicated only tetrachloroethane at levels higher than the LDR's CCWE limit and this is comparing a total analysis to an extraction method (TCLP in this case). Therefore, LDR limits for individual solvents should not be exceeded and the 1,000 ppm limit for HOCs should also be met quite easily. But again, to be certain, the waste should be analyzed for halogenated semi-volatiles.

Electroplating Waste - Impact uncertain - Until the cutoff sludge is analyzed for cyanides, it will be uncertain whether these standards are even applicable. Should cyanides be present, the waste will undoubtedly exceed the allowable concentration for metals.

RCRA Characteristics (EP Toxic Metals) - Impact uncertain - The LDR standards for this type of waste have not been established, and the waste has not yet been characterized to determine which of the criteria would be applicable. However, it is assumed that the sludge will exceed the EP Toxicity limits for some metals.

6.19.4 Treatment Alternatives

Analyses for CCWE solvents and total semi-volatiles would be required to determine if cutoff sludge is now acceptable for land disposal. However, in the future cutoff sludge will possibly be unacceptable because of concentrations of EP Toxic metals. EPA has not yet published BDAT treatment standards in the LDR regulations for waste that exceeds EP Toxicity for metals. It's possible that land disposal of RCRA characteristic waste in general will be prohibited. As another possibility, based on BDATs for similar wastes, a limit may be set and

stabilization of metals may be the recommended approach to achieve the limit.

Until further characterization is accomplished, it will be assumed that stabilization of metals and destruction of organics are needed for the cutoff sludge waste. The treatment alternatives to be considered include two solidification methods (cementation and polymer solidification), two vitrification methods (Joule melter and microwave), and incineration.

6.19.6 Evaluation of Alternatives

Four treatment alternatives were evaluated against the criteria described in section 5.0 and the results are shown in Figure 6.19. The treatment approaches and the result of their evaluation are discussed as follows.

Cementation - The use of cement to solidify the cutoff sludge waste would appear to be a viable approach except for the possible presence of organics in the waste. Cementation is not considered a reliable method to tie up organic materials into a non-leachable form. It does however eliminate any secondary waste streams and scores high in that area. Since treatment of this waste is of relatively low priority because of its small volume, even this simple process is assumed to take over two years to reach a production mode. The option received a low score for "Efficiency" because it increases the waste volume, and has questionable reliability in satisfactorily preventing the leaching of organic solvents.

Polymer Solidification - Use of a polymer binding agent scored higher in "Effectiveness/Development" because it is considered to have better potential for reducing leachability of organics, but it has not been tested on the specific waste. It was given a zero for "Secondary Waste" because the process temperature may volatilize organics. Like

Figure 6.19: Evaluation of the Treatment Alternatives For Cutoff Sludge

Need: Stabilization of Metals

Criteria	Alternatives	Cementation	Polymer Solidification	Vitrification	Incineration		
Effectiveness/Development		3	6	6	12		
Secondary Waste		4	0	2	0		
Availability		6	2	2	2		
Efficiency		1	1	2	3		
TOTAL		14	9	12	17		

Effectiveness and Stage of Development

(Weighting Factor = 3)

- 4 = BDAT or equivalent as demonstrated in full scale testing
- 3 = Bench scale testing complete, BDAT or encouraging results of equivalency
- 2 = In theory should be BDAT or equivalent, but no testing on waste
- 1 = Low effectiveness, not expected to be equivalent to BDAT

Availability for Production

(Weighting Factor = 2)

- 3 = Production ready in less than 1 year
- 2 = Production ready in 1 to 2 years
- 1 = Production ready in greater than 2 years

Secondary Waste Stream

(Weighting Factor = 2)

- 2 = None generated or, at least, none hazardous
- 1 = Hazardous, but within LDR
- 0 = Hazardous and exceeds LDR (treatment needed)

Efficiency*

(Weighting Factor = 1)

- 3 = High
- 2 = Medium
- 1 = Low

*Subjective score taking into consideration its volume reduction capability, quality of final waste form, its capital cost, and its overall reliability.

cementation, it is estimated that it would take longer than two years to get to a production level operation. The alternative was given a low score for "Efficiency" because the volume is increased and because of the potential need for off-gas control.

Vitrification - Both the Joule melter and the microwave are technologies being considered under this alternative. Both should be capable of destroying organics and providing a vitrified waste form for the stabilization of metals. However, neither technology has been tested with cutoff sludge. Because the destruction efficiency of organics is not known at this time, it is assumed that the off-gas will be of some concern and the alternative was given a two under "Secondary Waste". In both cases the technology is reasonably complex and could not be put into production in less than two years. The "Efficiency" was given a medium score because the reliability of destroying organics is uncertain, but the resulting waste form is of high quality.

Incineration - Incineration was given the highest evaluation score because it is considered the BDAT for destruction of organics and is a proven technology. However, it was also given a zero for "Secondary Waste" because generates a residue that will undoubtedly require additional treatment to stabilize the heavy metals. It is assumed that incineration of cutoff sludge could be done in the existing fluidized bed incinerator (FBI), although wastes such as this have not been incinerated in the past at RFP. As with the other technologies, it is still assumed that full production would be at least two years away. Incineration received a high score for "Efficiency" because it is a proven, reliable technology that can put the waste into a form that should be easily solidified.

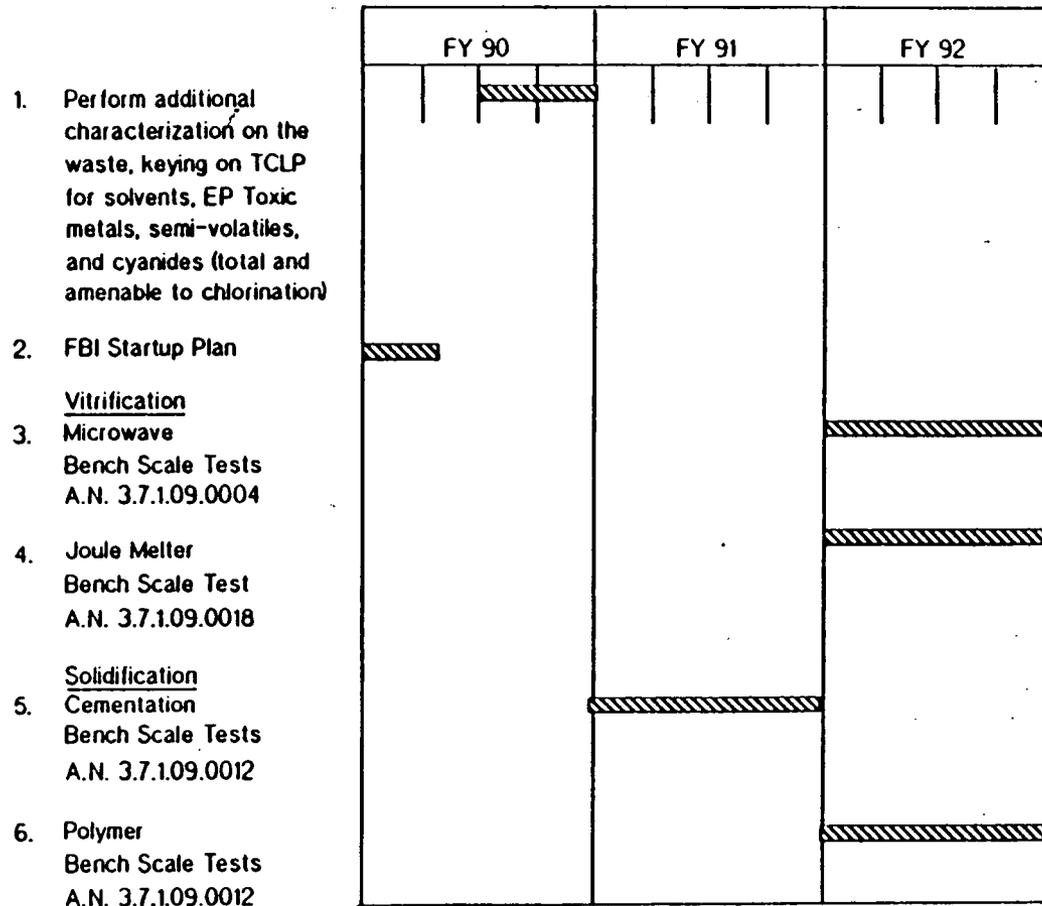
The results of the evaluation scored incineration the highest although it does have some limitations and the FBI has not normally been considered for this type of waste. There are also no current plans to develop other incineration capabilities at RFP. Therefore,

treatment alternatives that did not score as high as incineration must also be evaluated. Both types of vitrification and both types of solidification will be considered for future testing at the RFP.

6.19.6 Schedule

The schedule for development activities associated with alternate treatment approaches for cutoff sludge are shown in Table 6.19. No development is planned pending characterization results. Cementation scored very high and will be developed as required. Should the cemented form prove unacceptable for disposal, vitrification and polymer solidification technologies will be developed in FY 1992.

**Table 6.19: Schedule for Cutoff
Sludge Activities**



A.N. = Activity Number in 5 Yr Plan
P.N. = Program Number for Current Project

6.20 Summary of Waste Streams

Table 6.20 provides a summary of pertinent information for each of the individual wastes streams discussed in this chapter. As can be seen in the table, several RCRA Hazardous Waste Numbers are involved in the waste streams, but the treatment needs can be summarized, for the most part, as destruction of organics and stabilization of metals.

TABLE 6.20

SUMMARY OF WASTE STREAM INFORMATION

Waste	Generation Rate (Cu Yd/Yr)	Amount in Storage (Cu Yd)	Applicable RCRA HW Numbers	Treatment Needs to Achieve a Disposable Waste Form		
				Destruction of Organics	Stabilization of Metals	Other
1. Pond Sludge and Pondcrete	3,396* ¹	9,452	D002, D006, F001, F002, F003, F005, F006, F007, F009		X	
2. Nitrate Salt and Saltcrete	600* ²	2,204	D001, F001, F002, F003, F005, F006, F007, F009		X	Nitrate destruction
3. Bypass Sludge	216	483	D004, D006, D007, D008, D009, D011, F001, F002, F003, F005		X	
4. Roaster Oxide	None	107	F001			None anticipated
5. FBI Oil	23 (4,704 gal)	143 (28,965 gal)	D001, D008, F001, F002, F003, F005	X		Possible stabilization of residue
6. Combustible	41	153	F001, F002, F003, F005	X		
7. Lead	20.4	30.4	D008		X	Recycling

*¹ Rate of generation through October, 1991.

*² This only includes new generations of nitrate salt, the rate of generation goes up to 2,484 if the amount of saltcrete scheduled to be reworked is included.

TABLE 6.20

SUMMARY OF WASTE STREAM INFORMATION

Waste	Generation Rate (Cu Yd/Yr)	Amount in Storage (Cu Yd)	Applicable RCRA HW Numbers	Treatment Needs to Achieve a Disposable Waste Form		
				Destruction of Organics	Stabilization of Metals	Other
8. PCB Waste	None	38	F001, F002	X		
9. FBI Ash	None	11.5	F001-F005, D004-D011		X	
10. Beryllium Dust	1.0	0.8	P015		X	
11. Metal Chips	0.3	3.0	F001	X		
12. Filters	0.3	3.0	F001-F005	X		
13. Fluorescent Lights	0.4	0.3	D009		X	
14. Acid	0.6	8.0	D002-D004, D006-D008, D011, F006, F009		X	Neutralization, cyanide destruction, and pretreatment by flocculation and precipitation
15. Composite Chips	15.6	106	F001	X		
16. Absorbed Organic Waste	None	1.4	D001			Elimination of ignitability

TABLE 6.20

SUMMARY OF WASTE STREAM INFORMATION

Waste	Generation Rate (Cu Yd/Yr)	Amount in Storage (Cu Yd)	Applicable RCRA HW Numbers	Treatment Needs to Achieve a Disposable Waste Form		
				Destruction of Organics	Stabilization of Metals	Other
17. ECM Sludge	None	2	F006-F009		X	Cyanide destruction
18. Contami- nated Dirt	3.6	12	F001-F005	X		
19. Cutoff Sludge	None	10	D004-D009, D011, F001-F003, F005-F009		X	

7.0 CONCLUSIONS/SUMMARY

The preceding section presented a waste-by-waste description of the problem low-level mixed wastes, their characteristics, the disposal criteria applicable to them, treatment alternatives to meet that criteria, and an evaluation of those treatment alternatives. Each waste section concluded with a description and schedule of events that represent the next step in working towards the implementation of successful treatment technologies. As a summary of those individual findings the results will be presented in terms of the steps that are scheduled. The wastes applicable to each of the actions will then be shown.

7.1 Waste Currently Meeting Disposal Requirements

Several of the low-level mixed waste streams have already been accepted for disposal by NTS; others appear to meet applicable LDR and waste form requirements in their current condition. In most cases, the latter situation needs additional characterization to verify the assumptions that support that conclusion. The additional LDR standards that go into effect on May 8, 1990 will also change the acceptability of a number of the wastes streams, or, in cases where standards have not yet been promulgated, make their acceptability unknown. This information is summarized by waste stream as follows:

<u>Waste Stream</u>	<u>Currently Acceptable</u>	<u>Provisions^{*1} on Acceptance</u>	<u>After 5/8/90</u>
1. Pondcrete	Yes	1	No
2. Saltcrete	Yes	1	Unknown
3. Bypass Sludge	Yes	1,2	Unknown
4. Roaster Oxide	Yes	2	Unknown
5. FBI Oil	No		No
6. Combustibles	No		No
7. Lead	Yes		Unknown
8. PCBs	No		No
9. FBI Ash	Yes	1,2	Unknown
10. Beryllium Dust	Yes	1	Unknown
11. Metal Chips	Unknown		Unknown
12. Filters	Unknown		Unknown
13. Fluorescent Lights	Yes	1	Unknown

14. Acid	No		No
15. Composite Chips	Unknown		Unknown
16. Absorbed Organic	Yes	1,2	Yes
17. ECM Sludge	Yes	2	Unknown
18. Contaminated Dirt	Unknown		Unknown
19. Cutoff Sludge	Yes	1,2	Unknown

- *1 Provisions: 1. No free liquids and/or no fine particulate
 2. Additional analytical characterization supports assumptions made

7.2 Waste Characterization Requirements

Several of the low-level mixed waste streams had inadequate waste characterization to be certain of the applicable disposal criteria. Assumptions were made, but sampling and analysis is required to verify those assumptions or to determine if other criteria must be considered. The waste streams requiring additional characterization and the minimum analyses that appear necessary are as follows:

Waste	Required Analyses				
	TCLP Metals	TCLP Solvents	EP Toxic Metals	Free Liquids	Total & Amenable Cyanides
Pondcrete	X	X			
Saltcrete	X				
Bypass Sludge *1		X	X	X	
Roaster Oxide		X			
Combustibles		X	X		X
FBI Ash			X		
Metal Chips		X		X	
Filters		X		X	
Acid					X
Composite Chips		X	X		
Absorbed Organic*2			X		
ECM Sludge	X	X			X
Contaminated Dirt		X	X		
Cutoff Sludge *3		X	X		X

- *1 Bypass sludge should also be inspected/ analyzed for fine particulate
 *2 A determination of ignitability must also be made for this waste
 *3 Cutoff sludge should also be analyzed for semi-volatile contaminants

The analyses shown are those that appeared to be necessary to complete or finalize the waste form requirements for disposal. Schedules for the individual waste stream activities indicated the above analyses being performed for the existing inventory of stored waste before the end of FY 1990. Other parameters should also be considered to provide a better overall description of the waste. Waste streams that continue to be generated should periodically be sampled and analyzed to insure the existing characterization data remains applicable.

7.3 Stabilization/Solidification

Many of the problem low-level mixed waste streams can possibly be put into a disposable form by solidifying the waste into a less leachable matrix. The non-thermal methods being considered to accomplish this are through the use of cement or polymer binders. (The use of polymer binders does involve heating, but for these purposes is not considered a thermal treatment.) Development of these treatment capabilities invariably require testing samples of the waste with various recipes of the binding agents and then measuring their leachabilities. Hopefully, an optimum recipe will meet the necessary waste form requirements. The waste streams that are being considered for such an approach and the time frames in which the lab or bench scale testing will be done are provided in the following:

<u>Waste</u>	<u>Binder to be Tested</u>		<u>Date Bench Scale Testing Completed</u>	
	<u>Cement</u>	<u>Polymer</u>	<u>Cement</u>	<u>Polymer</u>
Pondcrete	X	X	9/90	3/91
Saltcrete	X	X	9/90	3/91
Bypass Sludge	X	X	9/90	9/91
Combustibles		X		9/91
Lead	X	X	9/91	9/92
FBI Ash	X	X	6/91	9/91
Beryllium Dust	X	X	9/91	9/92
Filters	X	X	9/91	9/92
Fluorescent Lights	X	X	8/91	9/92
Acid	X	X	6/91	(both-lab scale)
ECM Sludge	X	X	9/92	9/92
Contaminated Dirt	X		9/91	
Cutoff Sludge	X	X	9/91	9/92

It should be noted that the results of solidification testing should be evaluated through use of both the EP and the TCLP methods. EPA has proposed to eliminate the EP in favor of the TCLP. This may make the required standards more difficult to meet with traditional solidification techniques (cement and polymer); thereby making processes like vitrification more necessary.

7.4 Incineration

Many of the problem low-level mixed waste streams appear to be amenable to treatment through incineration; in fact, for many of the wastes EPA has established incineration as the Best Demonstrated Available Technology (BDAT). This fact should provide justification for pursuing the start up of the existing fluidized bed incinerator at the RFP. For one waste, the FBI oil, activities are on-going to negotiate incineration off-site, at the Idaho National Engineering Laboratory (INEL). A plan is now being prepared (to be completed by the end of CY 1989) to detail actions needed to put the existing fluidized bed incinerator into an operational mode. Once that plan has been prepared and reviewed, the decision will be made whether or not to implement the plan. At the present time, the possibility of developing another incinerator for use at the RFP is considered small and is not identified in the schedule. Mixed wastes that were identified as potentially appropriate for incineration are as follows:

<u>Incinerable Wastes</u>	<u>Appropriate for FBI</u>	<u>Other than FBI</u>
FBI Oil	X	
Combustibles	X	
PCB Solids/Capacitors		X
PCB Liquids	X	
Metal Chips		X
Filters	X	
Composite Chips		X
Contaminated Dirt		X
Cutoff Sludge	X	

7.5 Melting/Vitrification

Melting techniques to solidify or vitrify waste are being considered as potential treatment technologies for a several of the low-level mixed wastes where traditional cementation has not provided a consistent quality waste form. This type treatment may also be beneficial in destroying listed organics. Waste streams being considered, the corresponding melting technique to be tested, and the date bench scale testing is to be completed are provided as follows:

<u>Waste</u>	<u>Melting/Vitrification Technique</u>		<u>Bench Scale Testing Completed</u>
	<u>Joule Melter</u>	<u>Microwave</u>	
Pondcrete		X	9/90
Saltcrete* ¹	X	X	9/91 (both)
Bypass Sludge		X	9/91
FBI Oil	X		9/93
Combustibles	X		9/91
FBI Ash	X	X	9/92-J 9/91-M
Beryllium Dust	X	X	3/92 (both-lab scale)
Filters	X		9/92
Fluorescent Lights		X	9/92 (lab scale)
Acid		X	3/92 (lab scale)
ECM Sludge	X		9/92
Contaminated Dirt	X	X	9/92 (both)
Cutoff Sludge	X	X	9/92 (both)

*¹ In this case, these treatment technologies are also being considered for their ability to destroy nitrates.

7.6 Extraction

Techniques to remove hazardous components from the waste may be feasible in some instances. This approach is primarily being considered for removal of organics, but in one instance extraction of metal contaminants is proposed. The extract will likely still require additional treatment after the extraction process, as may the original waste. However, if two wastes streams are generated which are relatively easy to deal with versus the original difficult waste, then the process may be worth while. Waste streams to be considered, the corresponding extraction process

being considered, the type action proposed and the completion date for that action are provided as follows:

<u>Waste</u>	<u>Types of Extraction</u>			<u>Action</u>	<u>Completion Date</u>
	<u>Supercritical CO₂</u>	<u>Aqueous Wash</u>	<u>For Metal</u>		
Pondcrete			X	Study	9/91
Combustibles	X	X		Bench Scale	9/92 (both)
PCBs (solids/capacitors)	X			Bench Scale	9/92
Metal Chips	X	X		Bench Scale	9/92 (both)
Filters	X			Bench Scale	9/92
Composite Chips	X	X		Bench Scale	9/92 (both)
Contaminated Dirt	X			Bench Scale	9/92

7.7 Wet Oxidation

Wet oxidation will be tested for treatment of several waste streams consisting of solid materials that are contaminated with organic solvents. The testing will involve the use of sulfuric acid and hydrogen peroxide at elevated temperatures to decompose the waste. The low-level mixed wastes being considered for the testing and the dates lab scale testing is to be completed are as follows:

<u>Wastes Considered for Wet Oxidation</u>	<u>Lab Study Testing Completed</u>
FBI Oil	6/93
Combustibles	6/92
Filters	9/92

7.8 Biodegradation

Biodegradation will be considered for the destruction of organics in some of the mixed wastes. Because of the necessity to develop bacteria strains specific to the waste, these lab scale tests are expected to extend to the end of FY 1994. The waste to be addressed in these studies are as follows:

Wastes Considered
for Biodegradation

FBI Oil
PCBs (liquids)

7.9 Metal Precipitation Pretreatment

Lab scale testing is scheduled to be completed by the end of CY 1991 on the ability to flocculate and precipitate metals from one waste stream. The precipitate would then require additional treatment.

Waste to be Tested for Metal Precipitation: Acid

7.10 Cyanide Destruction

Pending the results of needed sampling and analysis, two wastes may require treatment for the destruction of cyanides. Full scale treatment equipment is scheduled to be in place by the end of the end of FY 1991. The waste to be treated is:

Wastes Considered for
Cyanide Destruction

Acid
ECM Sludge

7.11 Decontamination of Lead

Lab scale testing is scheduled on the development of capabilities to decontaminate lead through the use of smelting and removal of radiological contamination in the dross. Lab scale testing of this decontamination process is scheduled to be completed by the end of FY 1991.

7.12 Ultra-violet (UV) Ozonation

Tests will be performed to determine the feasibility of treating one of the wastes through UV ozonation to destroy organics. Lab scale tests are scheduled to be completed by the end of FY 1992. The waste to be tested is as follows:

Waste to be Tested by UV Ozonation: Contaminated Dirt

7.13 Plasma Arc

The plasma arc furnace is being pursued on a DOE-wide basis as a potential alternative for the treatment of mixed waste. A demonstration model is currently being tested at the DOE facility in Butte, Montana, and is being monitored by RFP personnel. The wastes that are considered to be potential candidates for treatment by the plasma arc are as follows:

Wastes Considered Appropriate for the Plasma Arc

PCB Solid
PCB Capacitors
Metal Chips
Composite Chips

7.14 Scale Up of Technology Development

The preceding sections have summarized the first steps to be taken in the development of treatment technologies for RFP low-level mixed waste. Completion of these steps should result in reaching the point where pilot or full scale technologies can be pursued. At that time, economic commitment increases significantly. As a point of reference, rough order of magnitude (ROM) cost estimates were generated for full-scale versions

of the major technologies being considered for the RFP wastes. The costs were based roughly on published information and experience gained at the INEL. The cost estimates and a brief description of the process are provided as follows:

<u>Technology</u>	<u>ROM Cost Estimate</u>	<u>Description</u>
Incinerator	\$10M	One ton/hr capacity. Modified controlled air type, to enable limited alpha contamination control (even though its low-level waste)
Joule Melter	\$10-15M	500 lb/hr capacity. It is assumed that an afterburner would not have to be included to treat many of the wastes considered.
Microwave	\$5-10M	500 lb/hr capacity. It is assumed no afterburner is required for the type of wastes considered.
Solidification	\$1-5M	One ton/hr capacity. Large enough for pondcrete and saltcrete waste streams. Would include some type of preconditioning process such as a shredder/grinder.
Plasma Arc	\$10-20M	One ton/hr capacity. Includes off-gas system and limited alpha control.

The above ROM estimates do not include the construction of facilities needed to house any equipment, but they do give consideration to reasonable start up costs such as permitting, performance of a trial burn, operator training, etc. It should be noted that "reasonable" assumes a fairly simple permitting and public involvement scenario, which may not be probable for some of these treatment alternatives.

7.15 Recommendations for Future Activities

The activities described by the plan can be summarized as the development of specifications for well established technologies and performing bench scale testing of those not so well established. As was noted in section 7.10, the costs to install full scale treatment technologies are significant to say the least. Therefore, it is suggested that once bench

scale testing has been completed, the treatment alternatives be reevaluated based on the results of those tests. At that time, only the technologies considered to be fully affective should be evaluated and the capability of a technology to treat multiple waste streams should be given a high weighting.

APPENDIX A
Brief Description of
Treatment Technologies

Air Stripping

Air stripping is the mass transfer of VOCs from a liquid to a gas (air) phase. The transfer continues until an equilibrium is established between the two phases. The mass transfer rate is limited by the amount of liquid surface area exposed to the air, because diffusion occurs at the air-liquid interface only. Within an air stripping column, liquid flows, from top-to-bottom, over packing material creating a broad surface area. At the same time, air (several times the volume of liquid) passes from bottom-to-top (countercurrent) over the liquid. The VOCs enter the passing air which is then emitted to the atmosphere or treated (e.g., vapor phase carbon absorption) and then emitted.

Air Sparging - This process is similar to the air stripping process, but in this plan is used to refer to the mass transfer of the VOCs from a porous solid waste to the air. The transfer continues until an equilibrium is established between the two phases.

Alkaline
Chlorination
(for Cyanides)

? NH₃
wet
bond ch₂

This process utilizes chlorine gas in combination with caustic, chlorine dioxide, or hypochlorite (sodium or calcium) to destroy cyanide by converting it to nitrogen and carbon dioxide. This process is specifically designed to treat wastes containing cyanide or complex cyanides. Toxic volatiles may be released if the pH is not carefully controlled to (pH 7.5 to 9).

Aqueous Wash

In this process wastes are fed into a washing unit where water or a water solution is used to extract contaminants. The washing fluid is then treated to remove the contaminants. Solutions may include water and chelating agents or water and surfactants. Types of contaminants that can potentially be removed include heavy metals, halogenated solvents, aromatics, gasoline, fuel oils, PCBs, and chlorinated phenols. Variable composition wastes complicate the selection of a suitable cleaning solution. For example, trying to remove two or more types of contaminants simultaneously with the same cleaning solution may be difficult.

Biodegradation

Biodegradation is a biological treatment that uses microorganisms to degrade hazardous organic compounds to non hazardous constituents. Two classes of biological processes are of general interest for treating hazardous wastes, aerobic, with oxygen and anaerobic, without

oxygen. Biological reactors have long been used for the treatment of wastewater (particular sanitary wastewater), and have more recently been considered for hazardous wastes. In situ processes have also been used for decontaminating soils. Microorganisms in the soil degrade the organic contaminants to derive by-products needed for growth. Additional nutrients, oxygen, and/or microorganisms may be injected into the soil, if needed, to assist in expanding the organism population. Biodegradation is likely applicable to any organic compounds, but at much slower rates for some than others, and can be sensitive to environmental changes.

Cementation

Cementation involves the addition of portland cement, water and, possibly, other additives to a waste to form a solidified product. In general, solidification processes are designed to improve the handling and physical characteristics of the waste and/or limit the solubility of hazardous constituents. The process is normally tested on a lab or bench scale to develop an optimum recipe for producing a solidified product. With cementation it can be difficult to produce a uniform waste on a production basis if the chemical or physical (such as amount of liquid present) characteristics of the waste stream being solidified changes with time. Also, material such as oils, grease, and soft fines do not lend themselves to forming a good stabilized product.

High Temperature Fluid Wall Reactor

In this process, also known as an advanced electric reactor, wastes are converted to nonhazardous compounds such as carbon, carbon monoxide, and hydrogen by thermolysis (i.e., pure heating). Destruction of the wastes takes place in an electrically-heated, porous-carbon core reactor. The wastes are added at the top of the reactor and are decomposed at temperatures of approximately 2,200°C while passing through the reactor; thermal energy is transferred to the wastes by means of radiation rather than conduction or convection. Off-gases pass through a secondary combustion chamber to ensure complete combustion of organic substances. This process is limited to liquid wastes atomized to droplets no larger than 1,500-microns and solid wastes no larger than 35 mesh. Sludges cannot be handled by this process.

Incineration

Incineration is one of many thermal processes that are destructive technologies when used for wastes containing organic compounds. Because of the potential for generating off-gases containing particulates, acids, and other undesirable constituents, it is expected that an off-gas system may be required with components usually including an after-burner, a scrubber, a filter bank, or a combination of these. The paragraphs that follow

described specific types of incinerators pertinent to this plan.

Fluidized Bed Incinerator (FBI) - Fluidized bed incineration utilizes a bed of inert material which is heated and expanded using forced air. The wastes are injected into the expanded bed material and are burned, with the heat being transferred back to the bed. A secondary combustion chamber containing an oxidation catalyst ensures complete combustion of the pyrolyzed gases. Inorganic wastes will collect in the bed requiring occasional replacement of the bed material. The FBI does not accommodate large, bulky wastes and depending on the specific configuration, may not handle wastes well that yield high volumes of ash generation. The existing waste incinerator at the RFP is an FBI.

Controlled Air Incinerator (CAI) - Controlled air incineration is a variation of conventional incineration practices. Wastes enter the primary combustion chamber and are heated to approximately 870°C in an oxygen poor atmosphere. The wastes are broken down into gases and ash. By minimizing the oxygen flow rate, turbulence in the chamber is restricted and ash dispersion reduced. Off-gases then enter a secondary combustion chamber and are oxidized in an oxygen rich atmosphere. Limitations on the types of wastes appropriate for the CAI are very similar to the FBI. The WERF incinerator at the Idaho National Engineering Laboratory (INEL) is a CAI.

Joule Melter

The Joule melter process is based on the principle that molten glass is a conducting solution because of its ionic composition. Therefore, it is possible to pass an alternating current through electrodes at either end of a refractory vessel to directly generate heat within the molten glass pool. The Joule-heated glass melting process generally uses an electric furnace to melt the waste feed material and glass formers. The feed material and glass formers are added directly to the Joule-heated glass melter. Once inside the melter, a cold cap of feed material forms on top of the molten glass. The feed material can be wet sludge, dry sludge, or combustibles. The glass formers can be soda-ash, lime or glass frit. At atmospheric pressures, temperatures in excess of 1200°C are required to maintain the proper viscosity of the molten glass. At the elevated temperatures, both nitrate salts and volatile organics are destroyed. The molten glass is drawn from the bottom of the melter into drums.

Microwave Melting

Glass melters in general are used for processing wastes by trapping inorganic and metallic constituents in a glass matrix while destroying the organic constituents. Wastes

are first mixed with glass formers and then introduced into the cavity of a glass melter. Microwave melters are similar to glass melters except for the method used to heat the wastes. Wastes, in the form of dried sludges, are introduced into the cavity of the microwave melter, and melted at temperatures between 700-1,300°C. Organic substances, air and moisture are driven off, and metallic and inorganic substances are trapped in the glass matrix. Microwave melters may reduce the volume (up to 80%) of certain types of wastes, while at the same time forming a solidified, glass-like mass. When the glass is removed from the chamber, the waste is in a form that is appropriate for shipment and disposal. As described, a disadvantage of the microwave melter is that it would not be expected to provide a high efficiency for destruction of organics without additional off-gas control.

Plasma Arc

The plasma arc process consists of a low pressure air flow being passed through an electric arc, which ionizes the air molecules. As the molecules return to a lower energy state, intense ultraviolet radiation is emitted. The process is used to reduce atomized wastes into their constituent elements. A cooling zone permits the recombination of the elements into nonhazardous molecules such as hydrogen, carbon, carbon monoxide and hydrogen chloride. The off-gases then pass through pollution control devices to remove particulates, acid gases, and combustible gases.

Polymer Solidification

In this process, sometimes referred to as thermoplastic microencapsulation, waste is dried then mixed with a plastic material to form a malleable solid. A commonly used material is asphalt, but other materials used include polyethylene, polypropylene, wax, or elemental sulfur. A problem that may develop is softening of the solid, if solvents or greases are present in the wastes.

Solvent Extraction

This is the transference of various substances from one solvent to another. This process is applicable to solvents containing both metallic and organic substances. The solvents treated are generally an aqueous solution containing the substances to be extracted and a second solvent, usually organic. The extraction may be performed in a mixer-settler, centrifugal contactor, or a packed tower. The solvent passes countercurrent to the aqueous stream where the exchange is made. After the exchange, the now contaminated solvent is sent to a regeneration process (e.g., distillation, extraction, evaporation, chemical reactor) to reclaim the solvent.

Supercritical Extraction

Fluids at certain critical temperatures and pressures act as exceptional solvents and are superior to distillation and conventional extraction procedures. The paragraph that follows addresses the specific fluid being considered at RFP for use in supercritical extraction.

CO₂ - Supercritical carbon dioxide extraction is a process used to extract organic hazardous constituents from waste. The process, which operates at or above the critical temperature (31.1°C) and pressure (7.5 MPa) of carbon dioxide, has been used to remove hazardous organic compounds from soils, recover oil from sludge, and recover solvents from slurries. Additional processing steps are required if destruction of the solvents and waste oils is required.

UV Ozonation

The ultraviolet (UV)/ozone process uses a strong oxidizing agent, ozone (O₃), in the presence of UV light to decontaminate aqueous waste streams containing hazardous organic compounds. The ozone is added to the wastewater, which is then irradiated with UV light. The UV light converts the O₃ into hydroxyl radicals (OH·); decontamination occurs by the organic contaminants reacting with the hydroxyl radicals to form nonhazardous compounds: carbon dioxide, chlorides, and water. The efficiency of the process is dependent upon the quantity of oxidants applied to the waste stream, the UV dosage, and the residence time in the UV reactor. The efficiency would also be impacted by the suspended solids present as they would limit the amount of light entering the solution, reducing the production of hydroxy radicals, and consequently reducing the overall effectiveness of the treatment.

Wet Oxidation

Wet oxidation may refer to any of several technologies, but for purposes of this plan, refers to acid digestion. In this process, combustible waste is added to sulfuric acid heated to 230-300°C. This causes carbonization of the organic material, after which hydrogen peroxide is added to oxidize the carbon. Sulfur dioxide produced from sulfuric acid degradation can react with additional hydrogen peroxide (the oxidant) to regenerate sulfuric acid. Most solid and liquid organic materials carbonize readily, although lower boiling materials tend to volatilize to varying degrees, and others, particularly halogenated materials, tend to react more slowly. In all cases off-gas scrubbing is necessary, and sulfuric acid is regenerated and reused.