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Revision 0

# Metals/Alloys Material Stabilization Process Plan

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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A-6001-401 (02/98)

# Metals/Alloys Material Stabilization Process Plan

Rev. 0

February 2000

# Table of Contents

# 1.0 Introduction

This Plan outlines the process for brushing metal and alloys in accordance with the path forward discussed in the Integrated Project Management Plan for the Plutonium Finishing Plant Stabilization and Deactivation Project, HNF-3617, and requirements set forth in the Project Management Plan for Materials Stabilization, HNF-3605. This plan provides the basis for selection of the location to process, the processes involved, equipment to be used, and the characterization of the contents of the can.

The scope of the process is from retrieval of metals and alloys from storage to transfer back to storage in a repackaged configuration.

# 2.0 Background

A summary of significant activities is presented below. It is recognized that there have been numerous letters, reports, correspondence, meetings, studies, experiments, evaluations, etc. regarding stabilization of metal and alloys. This section presents a summary of events and is not intended to be comprehensive. Section 5.0 contains further references to actions that have transpired.

In December of 1996 while opening a plutonium metal container, known to be paneled (buckled inward), a sparking, glowing reaction was observed. An occurrence report, PFP-PHMC-1997-0027, was submitted after an initial Unreviewed Safety Question (USQ) screening concluded that the event might not have been bounded by the Plutonium Finishing Plant (PFP) Final Safety Analysis Report (FSAR). This event is unofficially referred to as "Sparky". A USQ Evaluation was completed in September 1997 which concluded the reaction was due to plutonium hydride powder reacting with oxygen in the air as the can was opened and determined that the event was an USQ. The USQ, 97-05, "Pu Metal Reaction Upon Opening Item with Paneled Inner Container" was transmitted to the Department of Energy, Richland Operations Office (RL) in October 1997.

The Plutonium Finishing Plant (PFP) sponsored a workshop on Plutonium Metal Corrosion in the Denver area on November 10 and 11, 1998. The workshop included participants from four Department of Energy sites as well as representatives from other organizations. There was an emphasis on plutonium hydride because of the need to resolve an unreviewed safety question at PFP. The results of the workshop were documented and include 18 consensus items. Among the consensus items were that cans of Pu potentially containing hydride can be opened in air and that sparking and short flames are not unexpected. The 18 consensus items are listed in Attachment 6. HNF-4459, Plutonium Metal Corrosion Products-Denver Workshop, contains the detailed minutes of the workshop.

The Project Management Plan for Material Stabilization, HNF-3605, presents the overall objectives, description, justification and planning for the PFP Materials Stabilization project. The plan describes how Materials Stabilization will be managed and integrated with other facility stabilization and deactivation activities. The work scope includes (1) Metals Stabilization (unalloyed plutonium metals), (2) Alloy Stabilization, (3) Compound Stabilization, and (4) Oxide Stabilization.

In February, 1999, a Kepner-Tregoe (K-T) Decision Analysis for Metals Brushing vs. Oxidation Alternatives was performed to determine whether brushing or thermally stabilizing metal would be the best path forward. The K-T recommendation was that brushing is the preferred path forward. The K-T factors evaluated were cost, schedule, safety risk, technical risk, and programmatic risk. Brushing was favored in all of the categories except programmatic risk, with two categories only slightly favoring brushing over thermal stabilization. The K-T Evaluation Results are attached in Appendix E.

A Hazards Evaluation of Plutonium Metal Opening and Stabilization, HNF-4823 was performed in July 1999 for the opening of containers of Pu Metal, conversion of the metal and corrosion products to plutonium oxide product, and sampling, testing and packaging the product. The Evaluation was based on opening containers of Pu Metal in Glovebox 636, brushing metal in Glovebox 636, and transferring metal that burned and corrosion products to HA-21A, HC-21C, and HC-18M for thermal stabilization operations.

An Integrated Project Management Plan (IPMP) for the Plutonium Finishing Plant Stabilization and Deactivation Project, HNF-3617, was prepared and approved in April 1999. The IPMP sets forth the plans, organization, and control systems for managing the PFP Stabilization and Deactivation Project and includes the top level cost and schedule estimates. The IPMP applies an accelerated planning case, including technical alternatives and cost/schedule summaries, that has not been reflected in Multi-Year Work Plans or in the Defense Nuclear Facilities Safety Board (DNFSB) 94-1 Recommendation Implementation Plan. The Plan includes stabilizing Pu-bearing solids with >30wt% Pu, specifies that Pu metals will be brushed, Pu / uranium alloys will be brushed, Pu metal with other alloys will be thermally stabilized, and Pu alloys with aluminum will be packaged for shipment offsite without further stabilization. Metals will be opened in an inert atmosphere if required, brushed, and repackaged. Brushings, including plutonium metal items that are extensively corroded, will be thermally stabilized. Oxides from the thermal stabilization will be repackaged. Alloys containing uranium will be brushed and repackaged, or sent to the Savannah River Site. Alloys containing aluminum will be packaged for direct shipment to SRS. Remaining alloys will be thermally stabilized and the oxide product dispositioned as part of the Plutonium oxide and MOX inventory.

In August 1999, DOE-RL directed that the RL declaration of USQ PFP-97-05 be canceled and the associated plant operating restrictions removed. The Hazards Evaluation, HNF-4823, Rev. 0 was included as part of the new authorization basis until the Final Safety Analysis Report is amended to incorporate the evaluation.

DOE-STD-3013-99 "Stabilization, Packaging, and Storage of Plutonium-Bearing Materials" was issued in November 1999. This replaces DOE-STD-3013-96 and provides guidance for the stabilization, packaging, and safe storage of plutonium-bearing metals and oxides containing at least 30 wt.% plutonium plus uranium. Criteria that apply to metals and alloys require that each package shall weigh at least 50 grams and not be foils, turnings or wires, metals shall be visually free of non-adherent corrosion products, liquids, and organic materials, and briquettes made by pressing plutonium turnings shall not be stored under this Standard. Assurance that thermally stabilized materials to be packaged meets criteria must be accomplished by stabilization testing (such as Loss on Ignition) or process qualification. The moisture content (weight loss, if using Loss on Ignition) of oxide to be packaged shall be less than 0.5 wt.% at the time of packaging.

A K-T Analysis for selection of the location for Metal brushing was conducted on January 25 and 28, 2000. The results of that analysis recommended brushing in the BTS glovebox in Building 2736-ZB (W-460 project) as the preferred alternative, although with significant adverse consequences. Appendix 1 of this document justifies the decision to open and thermally stabilize in Building 234-5Z.

## 3.0 Definitions

| | |
|---|---|
| 3013-99 Can | A container assembly that consists of two individually sealed (by welding), nested containers that meets DOE STD-3013-99 criteria. The two cans are referred to as an inner container and an outer container. |
| Brushings | Material from plutonium metal that has been removed by brushing with a soft bristle brush. |
| BTS | Bagless Transfer System, the system that provides the welded 3013-99 inner can that meets the requirements of DOE STD-3013-99. Note: The 3013-99 outer can is provided by a separate outer can welder in 2736-ZB. |
| Corrosion Products | Various forms of oxides, nitrides, and hydrides that may form on Pu metal. |
| USQ | Unreviewed Safety Question, A review and evaluation process established to preserve the authorization basis of a nuclear facility and allow contractors to make physical and procedural changes and to conduct test and experiments without prior DOE approval in order to provide contractors with the flexibility needed to conduct day-to-day operations and to ensure that those occurrences and issues with a potential impact on the authorization basis, and |

| | |
|---|---|
| | therefore the safety of the facility, be brought to the attention of DOE. |
| Repackaging | The process of removing Pu metal and products from existing storage cans and packaging into 3013-99 compliant cans. |
| Thermal Stabilization | The process of heating material in an oxidizing atmosphere to a material temperature of at least 950°C for a time sufficient to meet DOE STD-3013-99 Stabilization Criteria in 6.1.2.3, but not less than 2 hours. |

# 4.0 Process Description

## *4.1 Assumptions*

(1) Brushing will be the method used for Metal Stabilization
(2) A Bagless Transfer System (BTS) will be located in 234-5Z
(3) Pre-screening (radiography, weighing) for determining condition of cans is outside the scope of this process plan
(4) Material will be handled only once, i.e. material that is taken from the vault will be replaced in the vault with 3013-99 compliant containers after processing/packaging. The material will not be placed in the vault with interim containers.
(5) Cans that are bulged, paneled, or have gained weight will be processed with the same requirements as cans that do not exhibit these characteristics.

## *4.2 Processing Pu Metals and Alloys with Uranium*

A Process Flow Diagram is included in Appendix 2 and a partial plan of Building 234-5Z is shown in Appendix 3 of this document and details the following process.

### 4.2.1 Retrieve Can from Vault

Cans of Pu metal and alloys with uranium will be retrieved from the vault in 2736-Z, weighed in preparation to transfer to Building 234-5Z, and placed in transportation wagons.

### 4.2.2 Transfer Can to 234-5Z

Cans of Pu metal will be transferred from 2736-Z to Building 234-5Z interim storage in Room 175 or will be transferred directly to Room 230B to be sealed into Glovebox HC-21A.

4.2.3 Brushing in HC-21A

The processing steps in glovebox HC-21A are as follows:

4.2.3.1 Seal-in Pu container into Glovebox HC-21A using sphincter port, weigh Pu container and furnace boat. Open can with a can opener (Note: opening can in an inert atmosphere is not required; see section 5.0)

If metal is burning, place can into boat until burning ceases, transfer can contents into a tare-weighed, empty boat. When burning ceases, attempt to brush button and pour contents into a tare-weighed empty boat

4.2.3.2 Separate corrosion products from metal

4.2.3.2.1 Visually inspect button for excessive corrosion, pitting, and for fracturing. If button integrity is suspect, transfer boat with button and corrosion products to HC-21C for thermal stabilization otherwise, brush whole button with soft bristle brush and place brushed button into a convenience can. Transfer brushed button to BTS for packaging

4.2.3.3 Collect brushings and accumulate in a can. Note: The corrosion products from one container up to a total of 2400 grams of Pu may be processed through the furnaces at one time. No more than 150 grams may be collected when corrosion products from multiple cans are collected together for processing. Also, material that will not pass through a ¼ inch screen must be handled as metal.

4.2.3.4 Heat brushings using a hotplate to convert corrosion products to the oxide form.

Note: The time between brushing metal and transfer of the metal to the BTS should be minimized to minimize the formation of additional corrosion products. The process will be optimized to accomplish this.

4.2.4 Canning Metal in HC-21A

After brushing, material will be transferred to a convenience can in HC-21A.

4.2.5 Processing Metal Fragments in HC-21C

Material that cannot reasonable be cleaned by brushing, which could include severely corroded, pitted, or otherwise fragmented material, will be thermally stabilized in muffle furnaces in HC-21C. Material that was observed to be burning and cannot be brushed will also be thermally stabilized. Metal may be required to be processed through the furnace twice.

4.2.6 Processing Collected Corrosion Products in HC-21C

A furnace charge will be generated using accumulated brushings (corrosion products) and will be thermally stabilized.

4.2.7 Transfer Oxides from HC-21C to HC-18M

Thermally stabilized material, either from metal or from corrosion products, will be transferred to HC-18M for sieving, sampling, and canning. Material will be packaged in convenience cans. Batches containing material that do not pass through a sieve will be returned to HC-21C for further stabilization.

4.2.8 Sampling

Material that is thermally stabilized will be sampled for moisture content. After thermal stabilization a sample will be taken prior to packaging with the BTS. A Residual Moisture test will be performed. Material will be canned and temporally stored until the results of the moisture test have been received and are acceptable. Material that does not meet 3013-99 requirements will be returned to HC-21C for further processing.

4.2.9 Transfer to Bagless Transfer System

Material that has been brushed or thermally stabilized will be sent to the Bagless Transfer System in Room 235B. The Bagless Transfer Convenience Can (BTCC) will be placed into a 3013-99 inner can. The 3013-99 inner can atmosphere will be evacuated and replaced with helium, the can welded and leak tested. The can will be weighed and labeled prior to transfer to either interim storage in Room 175 or 225 or transferred to Building 2736-ZB.

4.2.10 Transfer to 2736-ZB

The package will be transferred from interim storage in Room 175 or 225, or from weighing subsequent to canning in the 234-5Z BTS, to 2736-ZB.

4.2.11 NDA

The package with a 3013-99 inner can will have an accountability assay performed in the 2736-ZB NDA lab. These tests typically include calorimetry and isotopic non-destructive analyses (NDA)

4.2.12 Outer 3013-99 Can

The 3013-99 inner can will be placed into a 3013-99 outer can, the atmosphere inerted with helium, and the can welded and leak tested. After leak testing the package will be weighed for accountability purposes.

4.2.13 Transfer to Vault

The final package will be transferred from 2736-ZB to the vault in 2736-Z.

### *4.3 Processing Other Alloys*

Other alloys will be processed similar to Plutonium Metals and Alloys with Uranium, except they will not require the brushing operation. Items in this category will be thermally stabilized using the muffle furnaces.

### *4.4 Processing Alloys with Aluminum*

Alloys with aluminum containing greater than 30% Pu will not require brushing or thermal stabilization. These materials will be repackaged into 3013-99 containers. Material will be transferred from the vaults directly to 2736-ZB. Refer to the Process Flow Diagram. The process follows similar steps as Metals/Alloys.

4.4.1 Open Cans

The cans containing alloys with aluminum will be opened, and the contents placed into a screw lid Bagless Transfer Convenience Can (BTCC).

4.4.2 Welding

The BTCC will be placed into a 3013-99 inner can in a helium atmosphere, welded, and leak tested.

4.4.3 Weighing

The package will be weighed prior to transfer to 2736-ZB Room 641.

4.4.4 Outer Can Welding

The package will be placed into a 3013-99 outer can in a helium atmosphere, welded, and leak tested.

4.4.5 NDA

The package will have an accountability assay performed.

4.4.6 Transfer to Vault
The package will be transferred to 2736-Z for storage in the vault.

# 5.0 Hazards

This section provides a more detailed description of specific operations involving potential hazards associated with the metals/alloys brushing operations.

## *5.1 Opening Cans*

The Denver Workshop concluded that pyrophoric activity should be expected when opening cans of plutonium, regardless of atmosphere. Sparking and short flames are expected. Approximately 10 percent of the cans in the inventory are expected to be paneled, based on radiograph inspection of approximately 60 cans. The expected composition of material in a can is shown in Appendix D. Operational pre-jobs need to address the possibility of pyrophoric activity and how to respond to this activity (i.e. place item into a furnace boat, remove hands from gloves, and prevent combustibles from coming in contact with burning button). A plutonium metal button will not burn fast enough to cause a safety problem and should be allowed to continue as long as glovebox containment is not jeopardized. No credible mechanism exists for the reactive species in the can to cause over-pressurization by cloud dispersion.

### *5.2 Brushing Metal*

The brushing operation consists of using a soft bristle brush to remove loosely adhering oxides, in order to meet DOE STD-3013-99 requirements. It is anticipated that some of the metal buttons will not be brushable, due to significant corrosion, pitting, fragmenting, or other reasons. The metal will be inspected prior to brushing to determine if it should be brushed or sent to thermal stabilization.

The calculated maximum amount of hydride that can form on a metal button is 150 grams. Up to 150 grams of brushings from separate Pu cans may be collected for hotplating in a separate can. If one Pu can contains more than 150 grams of brushings that material may be processed as a unit without separating into 150 gram lots. However, it may not be combined with material from other cans.

### *5.3 Hotplating Brushings*

Up to 150 grams of brushings will be hotplated to 400°C to oxidize the corrosion products. The potential exists for pyrophoric activity due to the presence of hydride that may not have reacted when the corrosion products were exposed to air.

After the brushings have been hotplated they will be collected into cans to await thermal stabilization. The can may contain up to 2400 grams of hotplated brushings. These brushings will be sent to HC-21C for thermal stabilization.

## 6.0 Interfaces

### *6.1 Magnesium Hydroxide Project*

The Magnesium Hydroxide (MgOH) Project is located in Building 234-5Z Room 230C and is scheduled to be processing solutions in the beginning of Fiscal Year 2001 and end midyear in FY02. Construction activity is ongoing and is scheduled to be completed in September 2000.

The MgOH project has been anticipated to use all five available furnaces (two furnaces in HC-21C and three furnaces in HA-21I). In addition, conveyors HC-1, HC-2, HC-3, HC-2/3, HC-4, HA-28 will be used. Bag-out operations planned in HC-12S, handling of stabilized material in HC-18M and HC-18BS, and the Control Room in 230B will also be used. Bag-out operations will use HC-2 and HC-12 until the BTS systems are available.

Once available, the MgOH will also utilize the Bagless Transfer Systems in 234-5Z and in 2736-ZB to package the stabilized plutonium oxide product.

### *6.2 Cementation Project*

Cementation Project utilizes conveyor HA-28 for access to the port used to bag-in feed and supplies and bag-out cemented billets and glovebox waste.

### *6.3 W-460 Project*

The W-460 Project is scheduled for completion in January 2001. The W-460 contains the Bagless Transfer System used for packaging alloys with aluminum into 3013-99 compliant containers, and the outer can welder used for packaging 3013-99 inner cans containing metals and thermally stabilized materials. The outer can welding system is schedule for completion at the end of October 2000.

The BTS is required to be operational prior to processing metals or alloys.

### *6.4 Other*

Other interfaces that may affect the process include installation of the Supercritical Fluid Extraction equipment in Room 235B, installation of a Bagless Transfer System in Room 235B, Pipe and Go in Room 235B, and Sieve and Sample in Room 235B. These projects have not been finalized but potentially would change the Metals/Alloys Process or one of the projects that interfaces with Metals/Alloys.

Laboratory equipment for performing moisture content analysis and isotopic and calorimetry equipment for performing assays will be required to support the process.

## 7.0 References

1. Letter, R. D. Redekopp, BWHC, to L. J. Olguin, FDH, "Potential Unreviewed Safety Question PFP-97-05 "Plutonium Metal Reaction Upon Opening Item With Paneled Inner Container", BWHC-9755047, dated October 7, 1991.

2. USQ Evaluation 97-05 "Pu Metal Reaction Upon Opening Item with Paneled Inner Container"

3. HNF-4829, Rev. 0, "Technical Documentation to Support the Evaluation of Handling of Plutonium Metal"

4. HNF-4823, Rev. 0, "Hazards Evaluation of Plutonium Metal Opening and Stabilization"

5. HNF-3605, Rev. 0, "Project Management Plan for Material Stabilization"

6. DOE/RL-96-79, Radioactive Air Emissions Notice of Construction for Stabilization of Plutonium Metal and Oxides in the Muffle Furnaces at the Plutonium Finishing Plant, October 1996, and Update to Notice of Construction

7. HNF-3617, Rev. 0, "Integrated Project Management Plan for the Plutonium Finishing Plant Stabilization and Deactivation Project", April 1999

8. Letter, K. A. Klein, DOE-RL, to R. D. Hanson, Fluor Daniel Hanford, Contract No. DE-AC06-96RL132000 –Closure of Unreviewed Safety Question (USQ) Regarding Plutonium Metal Reactions, August 13, 1999

9. DOE-STD-3013-99 Stabilization, Packaging, and Storage of Plutonium-Bearing Materials, November 1999

10. Interoffice Correspondence, M. W. Gibson to D. R. Speer, Decision Analysis for Metal Processing Location, February 2, 2000

## Appendix A

# Metals/Alloys Brushing Location Decision

# Metals/Alloys Brushing Location Decision

## Summary

This Location Decision recommends that metals and alloys be brushed in Glovebox HC-21A. Although the Kepner-Tregoe® (K-T) for Metal Processing Location Decision recommended that brushing be performed in a glovebox in the W-460 Project other factors outweighed this recommendation. The next recommendation was brushing in HC-21A or processing in a new glovebox in 2736-ZB (Alternatives 2,3, and 8). The location for packaging, stabilization, and oxide processing will be determined during process planning and by design requirements.

## Background

The Kepner-Tregoe® Analysis for Brushing vs. Metal Stabilization was performed in February 1999 and is Appendix 5. The analysis compared brushing metal in either HC-21A or a BTS, with thermal stabilization occurring in HC-21C. The K-T Analysis recommended brushing as the preferred method for metal stabilization.

The Integrated Project Management Plan (IPMP) for the Plutonium Finishing Plant Stabilization and Deactivation Project (HNF-3617 Rev. 0) incorporates brushing as the path forward. The Hazards Evaluation of Plutonium Metal Opening and Stabilization (HNF-4823) is based on opening cans and brushing metal in Glovebox 636 and thermal stabilization of metal and oxides in HC-21C. The Hazards Evaluation was reviewed by DOE and was the basis for canceling USQ PFP-97-05 ("Sparky"). It is expected that a Hazards Evaluation for opening cans and brushing metal in HC-21A would result in similar hazards results.

The Final Environmental Impact Statement (EIS) PFP Stabilization May 1996 (EIS-0244F) considers that "Any loose oxide would be brushed from the metal and collected in a slip lid container." (reference Paragraph. 3.2.1.3).

A K-T Analysis for selection of the location for Metal brushing was conducted on January 25 and 28, 2000 and is documented in Interoffice Correspondence, M. W. Gibson to D. R. Speer, "Decision Analysis for Metal Processing Location", February 2, 2000. The results of that analysis recommended brushing in the BTS glovebox (W-460 project) as the preferred alternative. Adverse consequences were listed. The next group of alternatives (with scores virtually the same) was brushing in HC-21A (with or without the inert atmosphere containment) and in a new glovebox installed in 2736-ZB.

Metal brushing was originally part of the BNFL design for the W-460 Project. In August 1999 a decision was made to remove brushing from the project. One of the reasons for removal was the forecasted schedule impact to completion and approval of the Supplemental Analysis (SA).

**Assessment**

Although W-460 scored the highest in the K-T analysis it had adverse consequences. Any impact to the effort to obtain approval of the Supplemental Analysis (SA) would impact the ability to complete the W-460 on schedule. The SA is part of a process to evaluate compliance with NEPA documentation. The W-460 SA is nearing completion and potential changes to the W-460 scope would require the SA to be reviewed and/or revised. The SA is required to be approved prior to additional procurement of material for construction of the project. This would cause a delay in procurement resulting in a delay of construction.

In addition, the PFP may need the ability to open and potentially process metal in cans that are paneled, gaining weight or are bulging as soon as feasible. W-460 is not scheduled to be fully operational until January 2001. The ability to open and process metal in a suspect can is desired at the earliest possible time. Processing in HC-21A will provide opportunity to open cans and thermally stabilize metal in suspect cans by September 2000.

Brushing in a new glovebox (Alternative 8) requires use of the furnaces in W-460. The same reasons for not selecting W-460 for brushing apply to this Alternative.

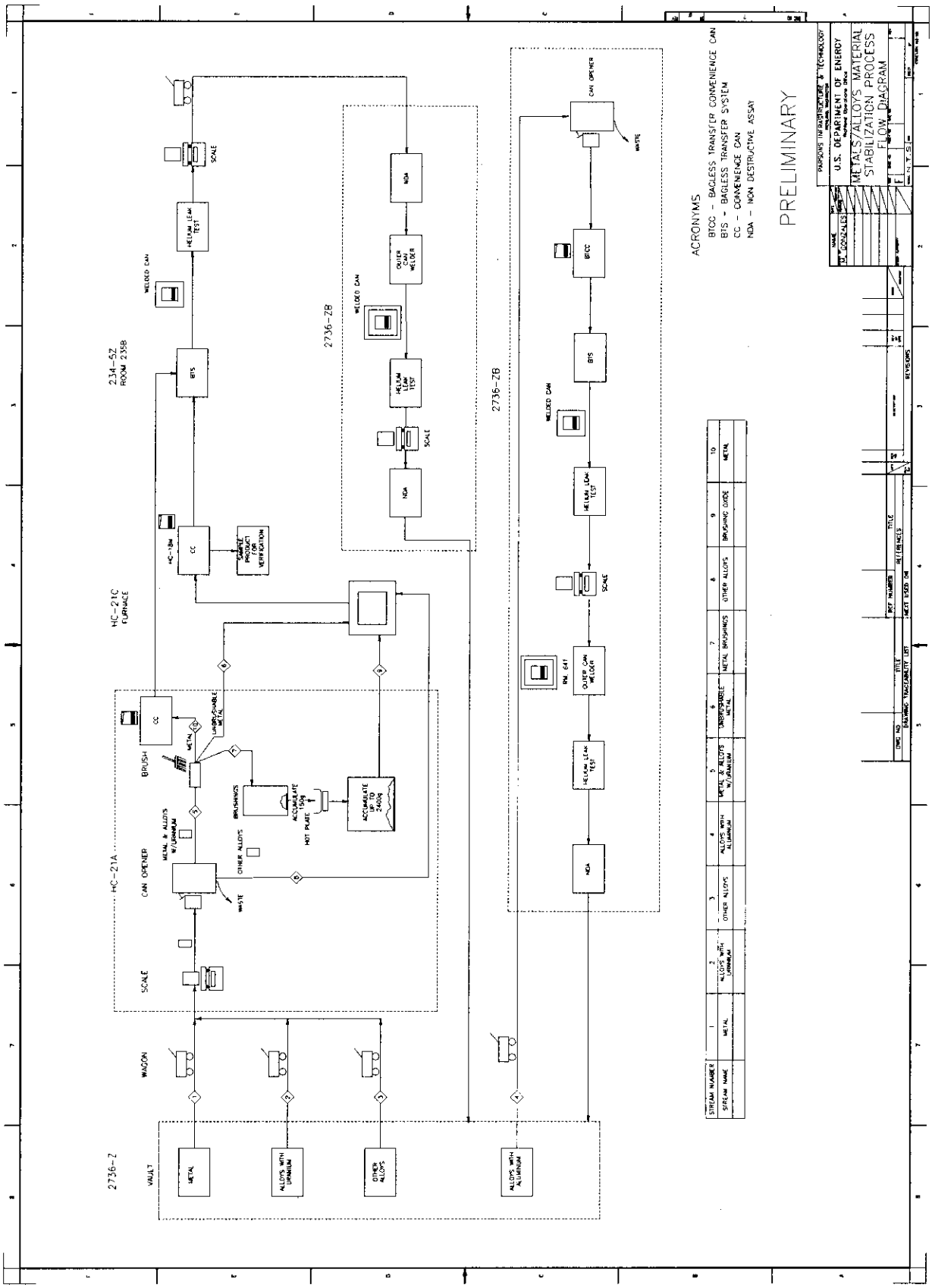
Subsequent to the K-T Analysis a change order was submitted to DOE-RL that would allow the Bagless Transfer System being procured for the W-460 Project to be installed in 234-5Z. Installation of a BTS in 234-5Z would simplify the brushing operation by eliminating the need to store and transfer material to another building and would minimize the time from brushing to repackaging in a welded container.

**Path Forward**

As stated in this document metal brushing will be performed in HC-21A. A determination of a location to perform the packaging (HC-18M or HC-21A) and thermal stabilization of metal and oxides (HC-21C and/or HA-21I) needs to be made. Design requirements and process considerations will drive the locations. A Process Flow Diagram will be prepared as part of the Process Plan and will identify the equipment/systems to be used. A Design Requirements document will be prepared for equipment and systems used in the process. The EIS will need to be evaluated once a Process Flow Diagram is completed and locations of operations are determined. This will be the basis for comparison with the original EIS. It is not expected that a SA will be required, however, approval/concurrence will still be required from DOE-RL that a SA is not required.

## Appendix B

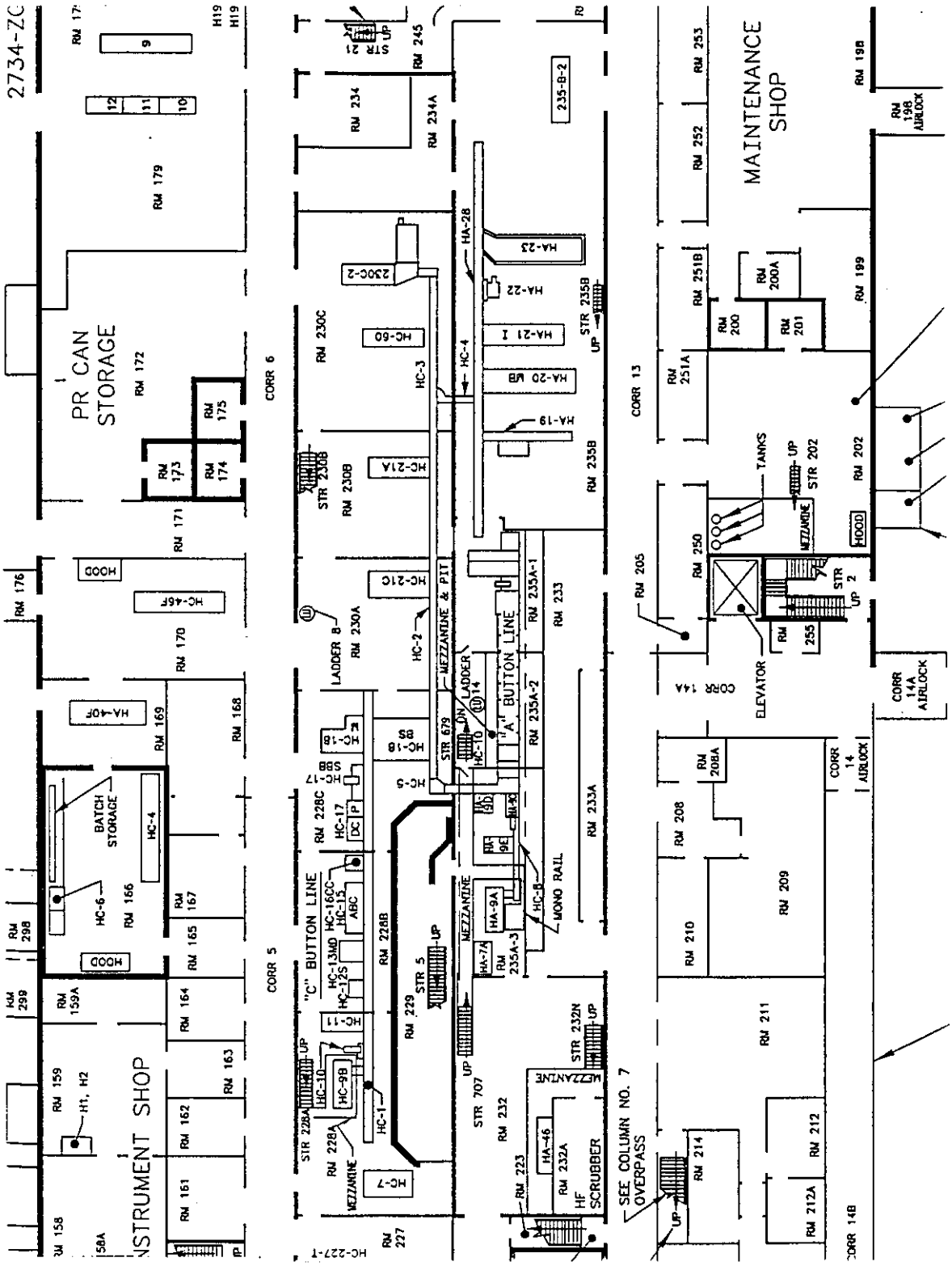
# Process Flow Diagram


PRELIMINARY
ACRONYMS
BTCC - BAGLESS TRANSFER CONVENIENCE CAN
BTS - BAGLESS TRANSFER SYSTEM
CC - CONVENIENCE CAN
NDA - NON DESTRUCTIVE ASSAY
METALS/ALLOYS MATERIAL STABILIZATION PROCESS FLOW DIAGRAM
U.S. DEPARTMENT OF ENERGY
2736-Z
VAULT
METAL
ALLOYS WITH URANIUM
OTHER ALLOYS
ALLOYS WITH ALUMINUM
WAGON
SCALE
HC-21A
CAN OPENER
BRUSH
CC
HELIUM LEAK TEST
OUTER CAN WELDER
BTS
BTCC
NDA
WELDED CAN
WASTE
HC-21C FURNACE
234-5Z ROOM 2358
2736-ZB

## Appendix C

# Facility Layout

# Partial Plan of Building 234-5Z



## Appendix D

# Material Composition

Characterization data for corrosion products within a Pu metal can has not been completed.

A limited number of cans in the vault have been radiographed. From the radiographs it is apparent that some cans have or may have substantial amounts of oxide. A preliminary estimate has been made that approximately 10% of the cans contain metal that will be unbrushable, due to severe corrosion, cracks, fragmented pieces or other reasons. The composition, as shown in the following table, is expected to all be converted to oxide upon exposure to air. The quantity of hydride is the calculated maximum value that can form on a metal ingot. The oxide and nitride are derived values based on expected reaction rates.

QUANTITY AND COMPOSITION OF CORROSION PRODUCTS PER CAN[1]

| | Oxide | Nitride | Hydride |
|---|---|---|---|
| | ($Pu_2O_2$) | (PuN) | ($PuH_2$) |
| Total | 307 g | 461 g | 150 g |

1. The composition and quantity are expected bounding values and are based on HNF-4829 Rev. 0, pp. A-3 and A-7.

## Appendix E

# Metals Stabilization Options Evaluation

Note: See Correspondence Number FH-0002536 for this document.

## Appendix F

# Denver Workshop Consensus Items

Below are the 18 Consensus Items that were a result of the workshop.

1. Opening one can of plutonium metal at a time in air or inert atmosphere is acceptable. Each method has advantages and disadvantages.
2. Open all cans expecting pyrophoric activity regardless of atmosphere.
3. Sparking and short flames are expected when opening plutonium storage containers.
4. Preplans need to discuss the response to pyrophoric activity.
5. Procedures need to contain controls to reduce the likelihood of and the consequences of pyrophoric activity.
6. Glovebox gloves are to be protected by procedural controls.
7. Operators and other facility personnel must have an understanding of what to expect (trained/qualified/certified in the expected).
8. Plutonium corrosion products collection will have a specific limit. (Corrosion products from one storage container or the accumulation is limited to that specified by safety assessment.)
9. Sealed cans bound leaky cans for reactive corrosion products in air atmosphere.
10. No credible mechanism exists for the reactive species in the can to cause glovebox over-pressurization by cloud dispersion.
11. A source of hydrogen to form hydride ($PuH_2$) is generated from both thermal and radiolytic degradation of plastic.
12. The thermal degradation of plastic material in plutonium storage containers dominates over radiolytic degradation when plastic is not in direct contact with plutonium materials.
13. When $PuH_2$ oxidation occurs at a low temperature (not burning) the $H_2$ will be diluted by glovebox airflow.
14. When burning plutonium hydride, the hydrogen will oxidize as it is evolved in an atmosphere that is not oxygen limited.
15. "Massive" plutonium metal button will not burn fast enough to cause safety problem.
16. In an oxidizing atmosphere glovebox, there is no way to burn through the bottom of the glovebox due to burning plutonium. (Oxygen prevents alloy formation).
17. Plutonium ignition can be allowed to continue as long as glovebox containment is not jeopardized.
18. Discussion occurred about the increased dose rate because of plutonium oxidation due to both americium and alpha-neutron reactions compared to storing plutonium metal.

The participants in the Denver Workshop were as follows:

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Major Thompson, WSRC
John Ward, LANL