

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION

PROCESS CONTROL PROGRAM

Revision 1

Incontainer Solidification

1.0 Purpose

- 1.1 The purpose of the Process Control Program (PCP) for incontainer solidification is to provide a program which will assure a solidified product with no free liquid prior to transportation for disposal.

The program consists of three major steps, which are:

- a. Procedures for collecting and analyzing samples;
- b. Procedures for solidifying samples;
- c. Criteria for process parameters for acceptance or rejection as solidified waste.

2.0 System Description

The systems described herein are designed to handle the solidification of liquids, evaporator bottoms or other concentrated liquids, spent resin, filter sludge and other miscellaneous wastes. Concentrated liquids are processed at elevated temperatures as required to keep the salts in solution. The various operations are as described below.

2.1 Waste Feed System

2.1.1 Concentrated Waste (Evaporator Bottoms)

The waste feed system consists of a progressive cavity positive displacement pump, that is part of the TMI-1 urea formaldehyde solidification system, and a waste supply line to convey waste to the fill head. The pump takes suction from the concentrated waste recirculation piping and pumps the waste into the liner. The waste pump is manually controlled and flow is discontinued when a predetermined level is reached in the liner.

2.1.2 Bead Resin & Powdered Resin

The waste feed system consists of TMI-1 resin recirculation hoses attached to the resin disposal and dewater return connections on the outside wall of the Auxiliary Building. Resin may be directed either to the disposal liner or back to the resin tank via the

dewater return connection. The resin flow to the liner is stopped when the resin slurry reaches a predetermined level. A dewatering pump operating during the fill cycle dewateres the liner until loss of flow is detected. The dewater pump, a positive displacement air operated diaphragm pump, is stopped. The resin flow is restarted and continued until the predetermined level is reached. The dewater pump is restarted. The fill and dewater procedure is repeated until the dewatering cycle no longer brings the resin level down below the predetermined level. Based on liner size used, a predetermined quantity of water is added back into the liner through the dewatering element to fluff the bed to relieve any bed packing.

Liners used for powdered resin have special bottom designs to preclude plugging of the dewatering elements.

2.2 Cement Feed Subsystem

Cement and chemical additives are batch loaded into the shipping container, where the actual mixing occurs, by means of a screw conveyor. This subsystem consists of:

- a. Cement hopper with discharge adaptor
- b. Screw feeder and drive motor
- c. Container inlet valve

As a function of waste volume and container size, the appropriate amount of cement and additives for a single batch are pre-loaded into the cement hopper which, through the discharge adaptor, meters the cement to the screw feeder. Cement is conveyed through the flexible screw feeder to the top of the container, where it passes through the container inlet valve and falls by gravity into the radwaste while the mixing blades are turning.

Dusting is minimized by pre-loading the cement hopper with a known volume of cement, as determined by the Waste Solidification Data Sheet, and by the use of a dust collector as a feature of the vent air filter subsystem (see 2.4).

The cement container inlet valve and the vent line are an integral part of the container fill head assembly.

2.3 Mixing

Each liner is supplied with an internal mixing device designed to provide thorough mixing of the entire liner contents. A mixing motor mounted on the top of the liner prior to the filling operation is started prior to the addition of cement. Mixing continues for approximately twenty minutes or until the motor automatically trips off due to high resistance to mixing. The mixture will be completely firm within 4 hours and be suitable for transport.

2.4 Vent Air Filter Subsystem

The fill head also includes an elbowed vent line. The vent line is hard piped to the edge of the cask where hoses can be connected to allow the air being vented from the cask to be conveyed to the vent air filter. This unit uses flat fabric filters to remove particulates from the vent air.

3.0 Collection and Analysis of Samples

3.1 General Requirements

- 3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BRW's the PCP shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste (e.g. evaporator bottoms, boric acid solution, sodium sulfate solutions, resin and precoat sludge).
- 3.1.2 For the purpose of the PCP a batch is defined as that quantity of waste required to fill a disposable liner to the waste level indicator.
- 3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.
- 3.1.4 If the initial test specimen from a batch of waste fails to verify solidification then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidifications. The Process Control Program shall be modified as requires to assure solidification of subsequent batches of waste.
- 3.1.5 For high activity wastes, such as spent resin or used precoat, where handling of samples could result in personnel radiation exposures which are inconsistent with the ALARA principle, representative non-radioactive samples will be tested. These samples should be as close to the actual waste and chemical properties as possible. Typical unexpended mixed bed resin shall be used to simulate the spent bead resin and the appropriate mix of anion to cation powdered resin shall be used to simulate used precoat.

- 3.1.6 All Chemicals used to condition or solidify waste or simulated waste in solidification tests shall be representative of the actual chemicals to be used in full scale solidification. If chemicals of a different type or from a different manufacturer are used, the new material shall be tested to verify it produces a solid product prior to full scale solidification.

3.2 Collection of Samples

3.2.1 Radiological Protection

- 3.2.1.1 Comply with applicable Radiation Work Permits.
- 3.2.1.2 Test samples which use actual waste shall be disposed of by solidification in the disposal liner.
- 3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each Data Sheet will contain pertinent information on the test sample and the batch numbers of wastes solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

The Waste Solidification Data Sheet will contain pertinent information on the characteristics of the test sample solidified so as to verify solidification of subsequent batches of similar wastes without re-testing.

- 3.2.2.1.a The test sample data for concentrated waste will include, but not necessarily be limited to, the type of waste solidified, major constituents, percent solids, pH, volume of sample, amount of oil in sample and the ratio of the sample volume to the final volume of the solidified product.
- 3.2.2.1.b The test sample data for spent resin and used precoat will include, but not necessarily be limited to, the type of waste solidified, volume of sample and ratio of sample volume to the final volume of the solidified product.
- 3.2.2.2 The Waste Solidification Data Sheet will include the Batch Number, Batch Volume, and Date Solidified, for each batch solidified based on sample described.

3.2.3 Collection of Samples

- 3.2.3.1 Evaporator bottoms shall be kept heated or reheated to 130^oF. prior to testing.
- 3.2.3.2 Two samples shall be taken for analysis. Sample sizes shall be compatible with the standard size sample used for the radioactivity analysis and the second for the chemical analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

- 3.2.3.3 Samples should be drawn at least six hours prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification.
- 3.2.3.4 The tank containing the waste to be solidified should be mixed by recirculating the tank contents for at least one volume change prior to sampling to assure a representative sample.
- 3.2.3.5 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. These samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.2. If the contents of a particular tank represents X% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent X% of the composite samples.

3.3 Analysis of Samples For Concentrated Waste (Evaporator Bottoms)

This document only defines the parameters to be analyzed and not the methodology. This is left to the plant staff.

- a. pH
- b. Boron or Boric Acid
- c. Sulfates
- d. Detergents
- e. Oil
- f. Weight % Solids
- g. Any other suspected major constituent

4.0 Test Solidification and Acceptance Criteria

4.1 Waste Conditioning

- 4.1.1 Prior to the test sample solidification the pH of the sample shall be adjusted to a range of 5 to 8 if Metso Beads are used or a range of 8 to 10 if they are not used.
- 4.1.2 For Boric Acid (including Evaporator Bottoms) wastes it is recommended that sodium hydroxide be used to adjust the pH.
- 4.1.3 If large quantities of detergents are presents, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required should be recorded.
- 4.1.4 If oil is present in quantities greater than 1% by volume, emulsification agents should be used to break up the oil. The quantity of any substance added to the sample for this purpose should be recorded.

4.2 Test Solidification

- 4.2.1 Any sample to be solidified shall be pretreated as specified in Section 4.1.

- 4.2.2 Test solidification should be conducted using a 1000 ml. disposal beaker or similar size container. Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case for less than five (5) minutes.
- 4.2.3 For the test solidification of resin, measure into the mixing vessel 100ml of water and add a sufficient quantity of dewatered resin to yield a 400ml mixture. The degree of compaction of the resin will determine the volume of resin required.
- 4.2.4 For the test solidification of precoat sludge, measure into the mixing vessel 400ml of waste at a maximum of 30 w/o solids.
- 4.2.5 for the test solidification of Concentrated Waste (Evaporator Bottoms), measure into the mixing vessel 400ml of waste.
- 4.2.6 Measure out the required quantities of cement and Metso Beads as shown below. Volumes are for loose, uncompacted material.

<u>Waste</u>	<u>Cement</u>		<u>Metso Beads</u>	
	<u>grams</u>	<u>ml</u>	<u>grams</u>	<u>ml</u>
Resins	362	240	36	24
Filter Sludge	340	226	34	23
Evaporator Bottoms	583	387	58	39

- 4.2.7 Mix the cement and Metso Beads together and slowly add this mixture to the test sample while it is being stirred.
- 4.2.8 After ten (10) minutes of mixing and a homogeneous mixture is obtained allow the waste to stand for a minimum of 30 minutes.

4.3 Solidification Acceptability

The following criteria define an acceptable solidification process and process parameters.

- 4.3.1 The sample solidification is considered acceptable if there is not visual or drainable free water.
- 4.3.2 The sample solidification is considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration by a rigid stick.

4.4 Solidification Unacceptability

- 4.4.1 If the waste fails any of the criteria set forth in Section 4.3, the solidification will be termed unacceptable and a new set of solidification parameters will need to be established under the procedures in Section 4.5.

4.4.2 If the test solidification is unacceptable then the same test procedures must be followed on each subsequent batch of the same type of waste until three consecutive test samples are solidified.

4.5 Alternate Solidification Parameters

4.5.1 If a test sample fails to provide acceptable solidification of waste the following procedures should be followed.

- (1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.
- (2) Add additional sodium hydroxide solution to raise pH above 8.
- (3) If the waste is only partially solidified, use lower waste to cement and Metso ratios. Using the recommended quantities of cement and Metso Beads, reduce the waste sample volume to 375ml and continue reducing the sample volume by 25ml until the acceptability criteria of Section 4.3 are met.

Batch No: _____

Sample No: _____

Date: _____

WASTE SOLIDIFICATION DATA SHEET

FOR

(Type of Waste - Resin, Powdered Resin, Concentrated Waste
Evaporated Bottoms)

Batch No: _____

Sample No: _____

Sample Volume, ml:

Weight % Solids²:

pH^{1 2}:

Quantity of Oil %²:

Other Major Constituents:

Quantity of Cement Added: _____ Cement Ratio (#/ft³ Waste³) _____

Quantity of Additive Added: _____ Additive Ratio (#/ft³ Waste³) _____

Final Waste to Product Ratio: _____

Product Acceptable: _____ Yes _____ No (If no, refer to Section 4.5 and proceed
as directed)

Radionuclides Present:
(Isotopes & Concentrations)

Additional batches solidified based on this sample solidification:

<u>Batch</u> <u>No.</u>	<u>Batch</u> <u>Vol.</u>	<u>Date</u>	<u>Batch</u> <u>No.</u>	<u>Batch</u> <u>Vol.</u>	<u>Date</u>	<u>Batch</u> <u>No.</u>	<u>Batch</u> <u>Vol.</u>	<u>Date</u>
2			5			8		
3			6			9		
4			7			10		

Notes

¹If pH adjustment is required, note chemical used, quantity used and pH after adjustment.

²Not required for spent resin or used precoat. _

³Multiply the grams of cement (Metso) per ml of waste by 62.4 to convert to pounds of cement (Metso) per cubic foot of waste. For the ratios given in Section 4.2.6, cement-to-waste ratios are 56.4 pounds per cubic foot for resin, 53.1 pounds per cubic foot powdered resin and 911 pounds per cubic foot for boric acid. Note that the cement ratio for resin is per cubic foot of waste; i.e., resin plus water. This is equivalent to 75.3 pounds of cement per cubic foot of dewatered resin.

SOLIDIFICATION DATA TABLES

SUMMARY

For the three waste types investigated in this calculation, bead resin, powdered resin and 12 w/o boric acid and licensed cask payload is limiting in all cases for the HN-100 Series 1, HN-100 Series 2 and HN-100S. Weight is limiting for the HN-100S and the HN-200 only for Concentrated Waste (Evaporator Bottoms). Weight is not a limiting factor for the HN-600.

	<u>BEAD RESIN</u>		HN-100S	HN-200	HN-600
	HN-100 Series 1	Series 2			
Usable Liner Volume, ft ³	149	149	149	64	72
Max. Solidified Waste Volume ft ³	127.2	122.0	149	64	72
Max. Resin Volume Dewatered, ft ³	71.7	68.7	84.0	36.1	40.6
Water Added at Max. Resin Vol, gal	179	172	210	90.3	102
Cement Added Pounds 1 ft ³ bags	5399 57	5173 55	6325 67	2178 29	3057 32
Netso Added Pounds 1 ft ³ bags	540 5.7	517 5.5	633 6.7	272 2.9	306 3.2
Max. Radiation Level R/hr. Contact	12	12	5	800	100

CONCENTRATED WASTE (EVAPORATED BOTTOMS)

	HN-100		HN-100S	HN-200	HN-600
	Series 1	Series 2			
Usable Liner Volume, ft ³	156	156	156	68	79
Max. Solidified Waste Vol. ft ³	105.5	101.2	126.9	65.8	79
Max. Waste Vol, ft ³	74.5	71.4	89.6	46.4	55.8
Cement Added at Max. Waste Vol. Pounds	6783	6501	8158	4225	5080
1 ft ³ bags	72	69	87	45	54
M.B. Added at Max. Waste Vol. Pounds	678	650	816	422	508
1 ft ³ bags	7.2	6.9	8.7	4.5	5.4
Max. Rad. Level R/hr on Contact	12	12	5	800	100

SOLIDIFICATION CALCULATION SHEET

Liner Capacity: _____ (1)

Waste/Product Ratio: _____ (2)

Cement Ratio: _____ #/ft³ (3)

Additive: _____

Additive Ratio: _____ #/ft³ (4)

Volume of Dewatered or Concentrated Waste:

_____ (1) x _____ (2) = _____ (5)

Cement Quantity

_____ (5) x _____ (3) = _____ (6)

Additive Quantity

_____ (5) x _____ (4) = _____ (7)

Quantity of Water to be added - gallons (Resin only)

_____ (5) x 2.5 = _____ (8)

Divide the Quantity of Water to Be added (8) by the supply flowrate (9) to determine how long water should be pumped to the disposal liner.

_____ (8) ÷ _____ gal/min (9) = _____ minutes (10)

POWDERED RESINS

	HN-100		HN-100S	HN-200	HN-600
	Series 1	Series 2			
Usable Liner Volume, ft ³	149	149	149	64	72
Max. Solidified Waste Vol. ft ³	126.8	121.6	149	64	72
Max. Waste Vol. ft ³	98.5	94.5	115.8	49.7	55.9
Cement Added at Max. Waste Vol.					
Pounds	5230	5018	6150	2639	2968
1 ft ³ bags	56	53	65	28	31
M.B. Added at Max. Waste Vol.					
Pounds	523	502	615	264	297
1 ft ³ bags	5.6	5.3	6.5	2.8	3.1
Max. Rad Level R/hr Contact	12	12	5	800	100