PROCESS CONTROL PROGRAM

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 key the salts in solution. The various operations are as described below.

2.1 Waste Feed System

2.1.1 Concentrated and Miscellaneous Liquids

The waste feed system consists of a progressive cavity positive displacement pump mounted on a bed plate and a waste supply line to convey waste to the fill head. The pump takes suction from the liquid waste storage tank and pumps the waste into the liner. The liner is filled until a preset level is reached as detected by a level sensor suspended from the fill head.

2.1.2 Bead Resin, Powdered Resin & Filter Sludge

The waste feed system consists of a progressive cavity positive displacement pump which takes suction from the discharge of the plant installed transfer pump. The pump capacity is adjusted to be lower than the transfer pump with the excess being recirculated to the holdup tank. The pump discharges to the liner and is stopped when the resin level reaches a preset level. A dewatering pump, operating during the fill cycle at a flow rate less than the progressive cavity pump, continues to dewater the liner until loss of flow is detected.

At this time the dewatering pump is stopped and restarted after the pump is restarted. During the time the pump is stopped the plant transfer pump is kept in a recirculation mode. The fill and dewater procedure is repeated until the dewatering cycle no longer brings the resin level down below the preset level. Based on the 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 and filter sludge have special bottom designs to preclude plugging of the dewatering elements.

2.2 Cement Feed Subsystem

Cement and additives are added from bags into the respective hoppers and the material is mixed as it enters the cement metering unit. Air under pressure is supplied to the metering unit from an air compressor. A rotary valve arrangement in the metering unit allows specified amounts of cement and additives to enter into the cement/additive feed line where it is conveyed by air to the fill head. The cement feeder can be up to 150 feet from the cask being filled. The quantity of additive required is determined by the pH of the waste after any waste conditioning or pretreatment.

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[1] and BRW's[2] 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 filter sludge).

3.1.2 For the purposes 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 required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, such as sodium sulfate from regeneration of deep bed resins, where the handling of samples could result in personnel radiation exposures which are inconsistent with the ALARA principle, representative non-radioactive samples will be produced and tested. These samples should be as close to the actual waste in their physical and chemical properties as possible to verify proper solidification parameters.

3.2 Collection of Samples

3.2.1 Radiological Protection

These procedures must be followed during sampling to minimize personnel exposure and to prevent the spread of contamination.

3.2.1.1 All persons involved in the collecting and handling of test samples shall wear adequate protective clothing which at a minimum will include cloth gloves, rubber gloves and apron or lab coat.

3.2.1.2 Any additional requirements established by the plant Health Physics Department must also be followed.

3.2.1.3 Test samples which use actual waste will be disposed of by being solidified in the liner.

3.2.1.4 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 retesting.

3.2.2.1 The Test Sample Data will include, but not 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.

3.2.2.2 The Waste Solidification Data Sheet will include the Batch Number, Batch Volume, and Date Solidified, for each batch solidified based on sample described on the Test Sample Data Sheet.

3.2.3 Collection of Samples

3.2.3.1 Evaporator bottoms are normally stored at elevated temperatures (160° to 180°) and must therefore be collected in insulated containers. It is recommended that stainless steel thermos bottles be used.

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 amalysis. 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

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 wastes it is recommended that sodium hydroxide be used to adjust the pH.

4.1.3 If large quantities of detergents are present, 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, the oil should either be removed by skimming or 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 Solidifications should be conducted using a 1000 ml. disposable 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 Measure into the mixing vessel 400 ml. of the waste to be solidified.

4.2.4 Measure out 400 ml. (590 grams) of loose or uncompacted cement and 40 ml. (60 grams) of uncompacted Metso Beads.

4.2.5 Mix the cement and Metso Beads together and slowly add this mixture to the test sample while it is being stirred.

4.2.6 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 no 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 the 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 caustic solution to the sample to raise the pH above 8.

(3) If the waste only partially solidified, try using lower waste to cement ratios. Try 350 ml. of waste to 400 ml. of cement and 40 ml. of Metso Beads and continue reducing the waste volume by 25 ml. with each test until the acceptability criteria of Section 4.3 are met.

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CALCULATION SHEET FOR RESIN, POWDEX & FILTER SLUDGE (DEWATERED)

Volume of Dewatered Waste Transfered to Liner _____ ft^3 (1)
(the recommended waste volume for each size liner is given below, additional data is on the reverse side).

Quantity of Water to Be Added

Waste Vol_____ ft^3 (from (1))

x_____2.5 gallons of water per ft^3 of waste

_____ gallons of water to be added (2)

Divide the gallons of water in (2) by the flowrate of water into the liner to determine how long the pump should operate:

$$\frac{\_\_\_\_ \text{ gallons of water}}{\_\_\_\_ \text{ gallons per minute}} = \_\_\_\_\_ \text{minutes pumping time}$$

Quantity of Cement to be Added

Waste Vol_____ ft^3 (from (1), if greater than recommended see instruction-removal of excess resin.

x 64.0 lbs. cement per ft^3 of waste

_____ lbs. of cement (3)

The recommended quantity of cement is 64.0 pounds (0.68 bags) per ft^3 of waste.

Maximum Waste Volumes-ft^3

HN-100 Series 1 - 90, HN-100 Series 2 -87 , HN-100S -109,
HN-200 - 56, HN-600 - 56 .

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Liner:	HN-100 Series 1	HN-100 Series 2	HN-100S	HN-200	HN-600
Max. Capacity ft^3:[1]	121	116	145	75	75
Max. Rad Level R/hr:	12	12	5	800	100
Waste Volume-ft^3					
Maximum:	90	87	109	56	56
Water Added - gallons					
at Max. Waste Volume:	225	217.5	272.5	140	140
Cement Added - pounds					
at Max. Waste Volume:	5760 (61)[2]	5568 (59)[2]	6976 (74)[2]	3584 (38)[2]	3584 (38)[2]

1. Based on licensed pay load less weight of liner and mixing blades with a solidified product density of 101.5#/ft^3.

2. Numbers in parenthesis indicate the number of one (1) ft^3 bags to be added rounded off to the nearest whole bag.

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Measurement of Waste Volume

The quantity of waste can be measured using a graduated, metal metering stick. The stick is inserted into the liner until it rests on the settled resin. The volume of the resin in the liner is determined by measuring the distance from the top of the resin to the top edge of the loading flange. The minimum distances which correspond to the maximum waste volume are as follows:

Type of Cask	Maximum Resin Volume (ft^3)	Distance Resin to Top of Flange (in)
HN-100 (Series 1)	90	31.5
HN-100 (Series 2)	87	32.75
HN-100S	109	23.15
HN-200		
HN-600		

If the radiation levels at the top of the liner are high, a horizontal member can be attached to the metering stick to permit remote handling into the liner. If desired, a flat disk can be attached to the bottom of the metering stick so that it will not penetrate into the resins while making measurements.

Excess Resins

In the event that the quantity of resins in the liner exceed the values noted above it will be necessary to remove a portion of the resin prior to solidification. Otherwise, the allowable weight or volume of the liner will be exceeded or it will not be possible to add the required amount of cement.

For removing resins, water should be added to the liner until it covers the resin by 12 to 18 inches. A pump should be used to recirculate the water above the resin and to fluidize the upper portion of the resin bed. This is accomplished by using the return line to agitate the bed and the inlet line to pickup the suspended material. After an upper portion of the bed has been resuspended, the outlet of the pump should be diverted to carry off the excess resin. The water and resin from the liner should be returned to waste hold up tank.