PROCESS CONTROL PROGRAM FOR SOLIDIFICATION/DEWATERING OF RADIOACTIVE WASTE FROM LIQUID SYSTEMS

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1.0 GENERAL

1.1 Purpose

The purpose of this Process Control Program (PCP) is to detail the means by which the dewatering and/or solidification of radioactive waste from liquid systems can be assured:

1.2 Scope

This PCP includes the following processes:

1.2.1 Solidification of liquid waste concentrates.

1.2.2 Manual solidification of waste liquids.

1.2.3 Manual solidification of wet trash by submersion.

1.2.4 Processing of wet trash by compaction/cementation.

1.2.5 Dewatering of bead resin.

1.2.6 Dewatering of powdered resin.

1.2.7 Dewatering of spent filter elements.

1.2.8 Appendix A - PCP for in-container solidification of bead resin.

1.3 Definitions

1.3.1 Batch - A quantity of liquid waste concentrates (for example, the contents of #121 Waste Concentrates Tank) to be solidified. A batch of waste concentrates can normally be drummed in not more than two days.

1.3.2 Solidification - The conversion of wet radioactive wastes into a form that meets shipping and burial ground requirements.

1.3.3 Dewatering - The process of removing water from a substance to meet specific limits.

1.4 Applicable Tech. Spec. - TS 3.9.C

2.0 SOLIDIFICATION OF LIQUID WASTE CONCENTRATES

2.1 Purpose

To establish the process parameters which provide reasonable assurance of complete solidification of liquid waste concentrates.

2.2 Applicability

This section of the PCP is applicable to solidification of liquid waste concentrates using the Atcor Solidification System and related equipment.

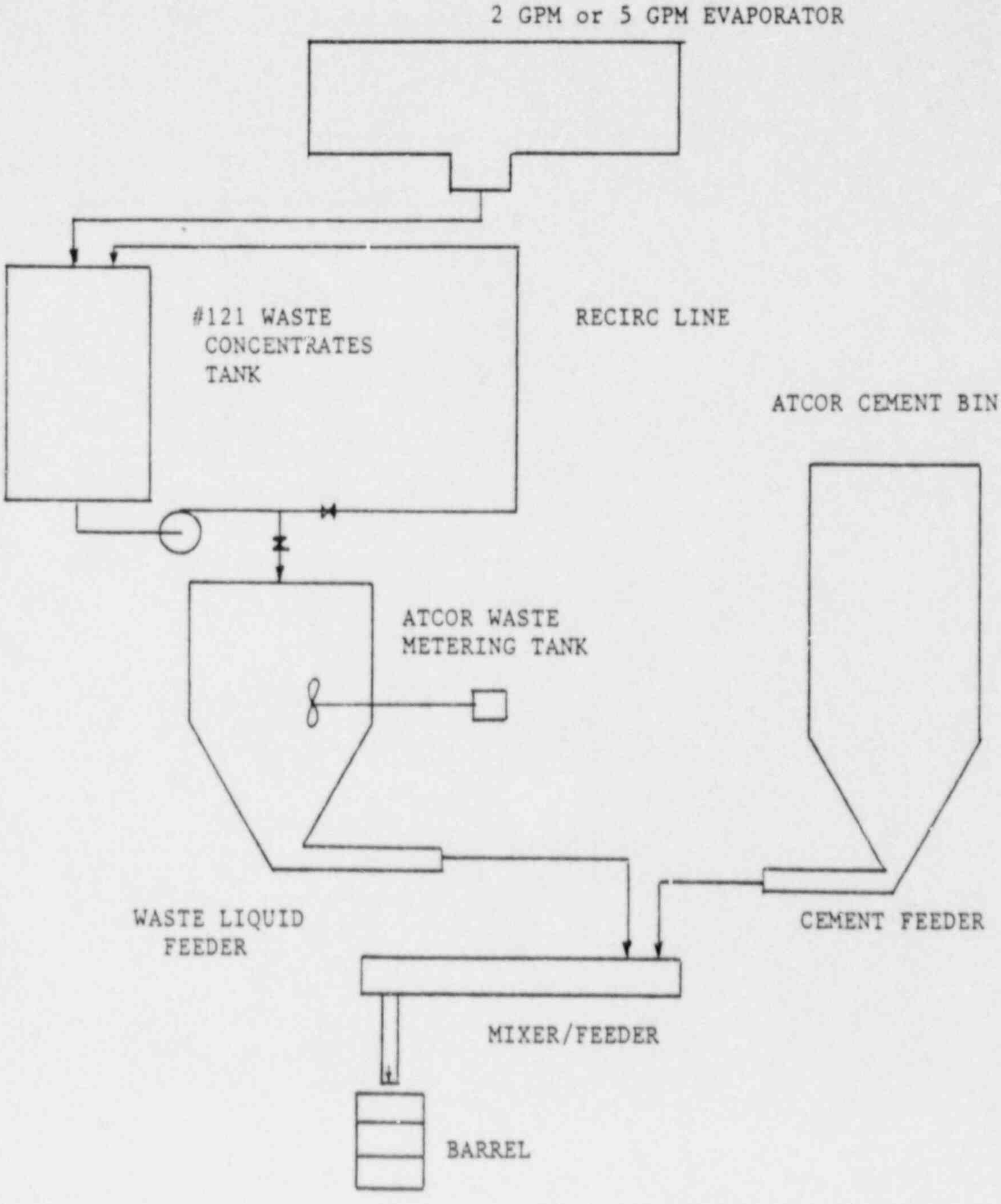
2.3 References

C21.2 Solid Radioactive Waste Operating Procedure

2.4 System Description

General Description

The solidification system for liquid waste concentrates includes #121 Waste Concentrates Tank (WCT), the Atcor Solidification System and related pumps, piping and equipment. Concentrates are accumulated from the 5 GPM ADT evaporator or the 2 GPM waste evaporator and stored in #121 WCT. When a sufficient quantity exists in #121 WCT, the contents are transferred to the Atcor system for solidification in 55 gallon drums. The filled drums are held in the Atcor drum storage aisles until solidification can be confirmed. The drums are then capped, deconned, and surveyed prior to storage for subsequent shipment and disposal. A flow diagram is shown on Figure 2.4.1-1.



SOLID RADWASTE FLOW DIAGRAM

FIGURE 2.4.1-1

2.4.2 Detailed Description

2.4.2.1 #121 Waste Concentrates Tank

#121 WCT is an upright cylindrical, vented tank of approximately 1700 gal. capacity. The tank is electrically heated to keep the contents in solution.

#121 WCT receives concentrates from either the 5 GPM ADT Evaporator the 2 GPM Waste Evaporator or the coagulation tank. The tank is located in a shielded vault for radiation protection and is equipped with a high level alarm to prevent over-filling. A direct reading float-type level gauge provides level indication from outside of the shielded vault.

#121 WCT pump and discharge piping are arranged for recirculation and mixing of the tank contents or for pumping the contents to the Atcor System for solidification. A sample valve is provided near the pump discharge.

2.4.2.2 Atcor Solidification System

The Atcor Solidification System is designed to mix waste liquid concentrates with cement, to convey the blended mass into 55 gal. drums and to store the filled drums in a shielded area for curing. The system consists of the following principle components:

(a) Waste Metering Tank

The waste metering tank is a tank of approximately 700 gal. process capacity. The tank is equipped with heaters to maintain contents in solution and is equipped with an agitator to ensure homogeneity of liquid. The tank is equipped with a positive displacement discharge pump having discharge rate variable up to 10 GPM. The pump discharges directly into the mixer feeder.

(b) Cement Bin

The cement bin is a bin of approx. 100 cu. ft. process capacity. The bin is equipped with a vibrating lower cone to preclude bridging of cement and to ensure uniform flow of material having a consistent bulk density. The cement bin is fitted with a discharge auger having a discharge rate variable from 0.3 to 3.3 CFM. The auger discharges directly into the mixer/feeder.

(c) Mixer/Feeder

The mixer/feeder is a double enveloping screw type mixer which simultaneously blends the liquid waste and cement while conveying the mass to the discharge chute. The discharge chute directs the blended mass into the shipping container by gravity flow.

(d) Controls

Controls for the solidification system are contained on a panel shielded from the waste materials.

Gauges indicating feed rate of cement and waste liquid are located on the control panel.

Rates of cement feed and liquid feed are adjustable from the control panel during processing.

A closed circuit TV camera and monitor are provided for viewing drum movements from the control panel.

(e) Cement Type

Cement normally used is type "M" masonry cement having 50% lime and 50% portland cement, conforming to ASTM-C-91-64 and ASTM-C-270-61T.

2.6 Sequence of Operation

2.6.1 Recirculation of #121 WCT

Before beginning the solidification process, the contents of #121 WCT should be recirculated for at least three volume changes to assure complete mixing and homogeneity.

2.6.2 After recirculation, a sample of the #121 WCT is to be drawn and analyzed for isotopic content, pH and % boric acid.

If pH is greater than 5.0, no adjustments need be made. If the pH is less than 5.0 it must be increased to between 5.5 and 7.0 with the addition of lime. Adjustments to pH, if required, should be made to the liquid in #121 WCT. As an alternate, pH adjustments may be made in the Atcor Metering Tank.

2.6.3 After sampling and pH adjustment, if required, the waste liquid is transferred to the Atcor Waste Metering Tank for solidification.

Filled drums are stored in the Atcor Drum Storage Aisles until solidification can be verified.

2.6.4 Flowrates

Normal flowrates with operating tolerance together with the discharge volume are as follows for typical evaporator bottoms:

Waste Liquid Flow	5.0 ± 2% gpm
Masonry Cement	0.8 ± 10% cfm
Product Discharge	1.0 cfm

Other flowrates may be used if demonstrated to result in solidification.

2.6.5 Cure Time

Cure time is variable and depends upon waste pH, Boron concentration, and mix ratios. Normally, a two to three week cure time can be expected for complete solidification.

2.6.6 Verification of Solidification

Representative barrels of each batch are to be inspected to verify solidification and the absence of free water. A drum may be considered solid when the cemented mass offers significant resistance to penetration by a hammer, or similar object. Absence of free water may be determined visually.

If solidification fails to take place, the process shall be suspended until the cause is determined and remedies are defined.

2.6.7 When solidification and absence of free water has been verified, the drums may be capped, deconned and removed from the Atcor Drum Storage Aisles. As an alternate to this sequence and in the interest of minimizing personnel exposure, the drums may be removed individually for capping and deconning.

2.6.8 When the drums are removed from the Atcor Drum Storage Aisles, and after they are capped and deconned, the drum number is recorded together with the batch number, contents and radiation level. The drums are then placed in storage to await shipping and burial.

2.7 Sample Solidification of Liquid Waste Concentrates

2.7.1 Sampling Requirements

If it is not feasible to verify solidification and the absence of free water in the full-scale product, sample solidification shall be conducted for at least every tenth batch of liquid waste concentrates.

2.7.2 Prerequisites

Before drawing a specimen from #121 WCT for sample solidification, the contents must be adequately mixed to achieve a representative mixture.

2.7.3 Sample Preparation

2.7.3.1 Obtain a specimen from #121 WCT in the required volume. The volume required will be approximately 200 ml for each sample mixed plus 10 ml for a boric acid analysis.

2.7.3.2 Remove approximately 10 ml for boric acid analysis. Record % boric acid on Attachment 1A.

2.7.3.3 Place the remaining waste liquid in a beaker. Maintain the temperature of the liquid to prevent precipitation of boron. Record the volume of waste in the beaker on Attachment 1A.

2.7.3.4 Check the mixture pH and record this value on Attachment 1A. If the pH is less than 5.0, slowly add lime to the liquid while continuously stirring until a pH value of 5.5 to 7.0 is achieved. Record the final pH and the weight of lime added on Attachment 1A.

2.7.3.5 Because of the relatively long cure time required three samples should be mixed from the initial test specimen using different liquid/cement ratios. One sample will be mixed at the recommended full scale operating mix ratio. The other two samples should have more and less liquid than recommended for full scale mixing.

Additional samples may be mixed from the initial test specimen at the discretion of the Rad Waste System Engineer using additional mix ratios or using different pH values. The following table defines the mix ratios which should be used:

VOLUME OF WASTE LIQUID (ml)	VOLUME CEMENT (ml) (Note #1)	WT OF CEMENT (gm)	LIQUID/CEMENT RATIO (volume)
176	200	218	0.88
166	200	218	0.83 (Note #2)
156	200	218	0.78

Note #1: Cement volume is theoretical and is listed for reference only. For accurate sample preparation, cement must be measured by weight.

Note #2: Liquid/cement ratio (volume) recommended by Atcor for full scale mixing.

2.7.3.6 Place the required amount of cement in a beaker. Measure out the correct amount of waste liquid for the sample. Thoroughly mix the liquid and cement together to ensure homogeneity.

2.7.3.7 Cover the sample and store in a shielded area.

2.7.3.8 Observe the sample immediately after mixing and intermittently thereafter as appropriate till solidification is complete. Record the results in the space provided on Attachment 1B.

NOTE: Some water may appear on the surface and be re-absorbed during solidification.

2.7.3.9 Set the sample aside for future disposal.

2.7.3.10 Complete Attachment 1A before proceeding with full scale solidification.

2.7.4 Sample Acceptance Criteria

2.7.4.1 Visual inspection after mixing will confirm that the sample is homogeneous.

2.7.4.2 Visual inspection of the sample after curing will confirm that no free water exists on the surface of the sample.

2.7.4.3 Physical inspection of the sample after curing will confirm that the end product is a uniform, liquid free, free standing solid that resists penetration when probed with a pencil-sized probe.

2.7.4.4 If test samples from the initial specimen fail to produce a mixture which will solidify, additional specimens shall be drawn and mixed to determine the proper solidification parameters before full scale solidification can commence.

Additionally, if test samples from the initial specimen fail to produce a mixture which will solidify, sample solidification of specimens from successive batches shall be conducted until at least three samples from consecutive batches demonstrate solidification.

SAMPLE VERIFICATION FORM

RPS ______________________________ Date__________ Time_________

Waste Type ____

PRETREATMENT

P1 Initial pH _______ Initial Temp _______°F % Boric Acid ______

P2 Specimen Volume ________________ml

P3 Lime Added ________________gm

P4 Final pH __________________

$$\text{Lime Ratio} = \frac{P3}{P2} \times 8.34 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \frac{\text{lbs}}{\text{gal}}$$

SAMPLE PROPORTIONS

Sample No. ___________________

S1 Sample Waste Liquid Vol ________ml

S2 Sample Cement wt _______________gm

$$\text{Liquid/Cement Ratio (vol)} = \frac{S1}{S2} \times 1.089^{*} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

*Density correction factor.

ATTACHMENT 1A

SAMPLE VERIFICATION FORM

Sample No. ______________________

Describe sample appearance, water amount, hardness, etc.

CURE TIME	CONDITIONS NOTED
0 HRS	

Sample is/is not solid ____________________________ Date ____________
RPS Signature

ATTACHMENT 1B

3.0 MANUAL SOLIDIFICATION OF WASTE LIQUIDS

3.1 Purpose

To establish parameters which provide reasonable assurance of complete solidification of waste liquids when mixed manually.

3.2 Applicability

This section of the PCP is applicable to manual solidification of waste liquids with masonry cement. Manual solidification may include the use of a portable, power-operated mixer.

Waste liquids which are normally solidified manually include:

- 1 Laundry sludge
- 2 Decon solutions, etc. not suitable for evaporation

3.3 Sequence of Operation

3.3.1 Place desired amount of liquid in 55 gal. drum (normally 1/2 to 2/3 full).

3.3.2 Commence mixing.

3.3.3 Add cement while continuing to mix at the rate of 1 ft^3 (1 bag) per 6.25 gal. of liquid or until mixture begins to thicken. Continue to mix until all of the cement is incorporated and the mixture is smooth.

Remove the mixer. (If applicable).

3.4 Cure Time

Solidification can normally be expected within two to three days.

3.5 Verification of Solidification

Each drum of manually solidified waste liquid shall be inspected to verify solidification and the absence of free water. A drum may be considered solid when the cemented mass offers significant resistance to penetration by a hammer or similar object. Absence of free water may be determined visually.

If solidification fails to take place, the process shall be suspended until the cause is determined and remedies are defined.

3.6 When solidification and absence of free water has been verified, the drum may be capped and deconned. The drum number is recorded together with the batch number, contents and radiation level. The drum is then placed in storage to await shipment and burial.

4.0 MANUAL SOLIDIFICATION OF WET TRASH BY SUBMERSION

4.1 Purpose

To establish parameters which provide reasonable assurance of complete solidification of liquid contained in wet trash.

4.2 Applicability

This section of the PCP is applicable to solidification of wet trash with masonry cement.

Wet trash includes contaminated material such as mopheads, wet rags, paper towels, etc.

4.3 Sequence of operation

4.3.1 Place desired amount of liquid in 55 gal drum (normally 1/2 to 2/3 full).

NOTE: Contaminated liquids may be used for this purpose.

4.3.2 Commence mixing.

4.3.3 Add cement while continuing to mix at the rate of 1 cu. ft. (one bag) per 6.25 gal of liquid or until the mixture begins to thicken. Continue to mix until all of the cement is incorporated and the mixture is smooth. Remove the mixer (if applicable).

4.3.4 Immerse items of wet trash into the cemented mass using a stick or similar device. Attempt to put as many items of trash as possible into the barrel within the limits of ALARA.

4.4 Cure Time

Solidification can normally be expected within two to three days.

4.5 Verification of Solidification

Each drum shall be inspected to verify solidification and the absence of free water. A drum may be considered solid when the cemented mass offers significant resistance to penetration by a hammer or similar object. Absence of free water may be determined visually.

If solidification fails to take place, the process shall be suspended until the cause is identified and remedies are determined.

4.6 Disposition

When solidification and the absence of free water has been verified, the drum may be capped and deconned. Record the drum number together with the batch number, contents, and radiation level. The drum is then placed in storage to await shipment and burial.

5.0 PROCESSING OF WET TRASH BY COMPACTION/CEMENTATION

5.1 Purpose

To establish parameters which provide reasonable assurance that wet radioactive trash is packaged safely and with an absence of free water.

5.2 Applicability

This section of the PCP is applicable to the compaction of wet trash using the trash compactor while concurrently absorbing any free water with masonry cement.

Wet trash includes contaminated material such as mop heads, wet rags, paper towels, etc.

5.3 Sequence of Operation

5.3.1 Place approximately 2" of masonry cement in the bottom of a 55 gal. drum.

5.3.2 Place a layer of wet trash items into the drum while integrating cement into each item of trash. Add a small amount of cement to fill voids between items.

5.3.3 Compress the wet trash using the compactor. Add cement as required to incorporate any free water thus produced.

5.3.4 Repeat the preceding two steps until the drum is filled.

5.4 Cure Time

Absence of free water can normally be determined visually immediately following the final compaction cycle.

5.5 Verification of Absence of Free Water

Each drum of processed wet trash shall be inspected to verify the absence of free water. If free water is detected, additional cement shall be added to solidify the free water.

5.6 Disposition

When the absence of free water has been verified, the drum shall be capped and deconned. The drum number is recorded together with the batch number, contents, and radiation level. The drum is then placed in storage to await shipment and burial.

6.0 DEWATERING OF BEAD RESIN

6.1 Purpose

To describe the process used to provide reasonable assurance that bead resin is dewatered to meet applicable burial site criteria.

6.2 Applicability

This section of the PCP is applicable to all radioactively contaminated bead resin which is intended to be shipped dewatered (not solidified) for disposal.

6.3 Dewatering Procedure

The dewatering procedure varies with the supplier of the resin liner, with the type of liner, whether a steel liner or a high integrity container (HIC), and with the dewatering requirement of the burial site. Individual shipping procedures unique to the particular container and burial site refer to the appropriate dewatering procedure.

In general, however, the dewatering process normally consists of the following steps after the liner has been filled:

(a) Initial pumpdown with the diaphragm pump until suction is lost.

(b) A waiting period (twenty hours, for example).

(c) Final dewatering consisting of one or more pumpdowns using a diaphragm pump or a vacuum pumping system.

6.4 Verification of Dewatering

Preceding shipment, connect and operate the dewatering pump as before. If no water is present, the dewatering process is complete.

If water is found, pump until vacuum is lost. Repeat the pump/wait cycle as required. When no more water can be removed, the dewatering process is complete.

7.0 DEWATERING OF POWDERED RESIN

7.1 Purpose

To describe the process used to provide reasonable assurance that powdered resin is dewatered to meet applicable burial site criteria.

7.2 Applicability

This section of the PCP is applicable to all radioactively contaminated powdered resin which is intended to be shipped for burial.

7.3 System Description

Contaminated powdered resin originates in the Condensate Polishing System Filter Demineralizers of both units.

Spent resin is purged from the Filter Demineralizers to the Backwash Waste Receiving Tank where it awaits the dewatering/drying process.

The dewatering/drying process takes place in the Clamshell Backwash Waste Filter ("Clamshell").

There are two Clamshells to serve the needs of both units, each capable of being aligned to either unit. It is the function of the clamshells to filter the powdered resin out of the water-resin slurry that is pumped from the Backwash Waste Receiving Tank, thru the Clamshells. When a cake of resin develops in the Clamshell to a predetermined thickness, the filtering process automatically switches to a purge phase followed by a forced air drying phase. The duration of the air drying phase can be adjusted. Experience, however, has demonstrated that a drying cycle of approximately 12 minutes produces a product sufficiently dry to meet burial site requirements yet not so dry as to create an air-borne contamination hazard.

When the air-dry cycle is completed, the resin is dumped from the Clamshell into a hopper from which it is conducted down an enclosed chute to a container below. If the resin is insufficiently dried it will not flow freely down the chute.

7.4 Disposal

Powdered resin which has been process thru the Clamshell system does not normally receive further dewatering treatment. Powdered resin may, therefore, be shipped in a container not fitted with dewatering equipment such as a steel drum or box. Because processed powdered resin is sufficiently dry to flow freely, and because powdered resin is normally very low in specific activity, it may be used to fill interstitial space in shipments of non-compatible trash or to fill voids in other shipping containers where they occur.

8.0 DEWATERING OF SPENT FILTER ELEMENTS

8.1 Purpose

To describe the process used to provide reasonable assurance that spent filter shipments are dewatered to meet applicable burial site criteria.

8.2 Applicability

This section of the PCP is applicable to all radioactively contaminated filter elements intended for shipment for burial in the dewatered state (not solidified). Normally a High Integrity Container (HIC) is used for this purpose. Procedures specific to the appropriate type of container shall be employed.

8.3 Description of Filling Process

8.3.1 Verify that the container to be used is approved by the manufacturer for disposal of filter elements.

8.3.2 Install dewatering element with attached hose in the container. The dewatering elements must be compatible with the dewatering pump (normally a vacuum pump). Conduct hose to outside of container for later attachment to dewatering pump.

8.3.3 Allow filter elements to drain of excess water prior to placing in container.

8.3.4 Place a layer of processed powdered resin or similar material on the bottom of the container if required.

8.3.5 Place a layer of filter elements into the container while attempting to avoid bridging of filters and observing the principles of ALARA.

8.3.6 Fill voids with processed powdered resin or similar material if required.

NOTE: Powdered resin may be used to fill voids between filter elements while observing principles of ALARA even if not required to be used as packing material by the container manufacturer.

8.3.7 Repeat the preceding two steps until the container is full.

8.4 Dewatering

The dewatering process may vary with type and manufacture of container and with requirements of the burial site. Typically, however, the dewatering process consists of the following steps:

8.4.1 Allow wait period (typically 20 to 24 hours) for water if present to migrate to the bottom of the container.

8.4.2 Connect the dewatering pump to the dewatering element hose. Conduct the pump discharge hose to a container to enable monitoring of discharge volume.

8.4.3 Start the dewatering pump. If no water is found, the container may be considered to be dewatered.

If water is found, pump until vacuum is lost, stop the pump and begin another wait period.

Repeat the pump/wait cycle until no more water can be removed.

8.5 Verification of Dewatering

Preceding shipment, connect and operate the dewatering pump as before. If no water is present, the dewatering process is complete.

If water is found, pump until vacuum is lost. Repeat the pump/wait cycle as required. When no more water can be removed, the dewatering process is complete.

APPENDIX A

Process Control Program for In-Container Solidification of Bead Resin

GENERAL:

Bead resin is normally shipped in the bulk dewatered form. However, high activity resin may be solidified if desired.

Following a brief system description, the Hittman Nuclear and Development Corp. PCP for In-Container Solidification of Bead Resin is appended.

This document is proprietary and is reproduced in its entirety as an appendix to the Prairie Island Process Control Program for Solidification/Dewatering of Waste From Liquid Systems.

Certain plant specific exceptions to the Hittman document are noted in the system description.

SYSTEM DESCRIPTION:

The resin disposal system for the purposes of this PCP consists of 121 Spent Resin Tank, #122 Spent Resin Pump, a portable dewatering pump and related piping, hoses and valves. In addition are included those items furnished by the resin disposal contractor including a shipping cask, shipping liner, solidification equipment and related controls and appurtenances.

Resin is pumped in a water slurry from #121 Spent Resin Tank to the shipping liner in the proper amount. The water is then pumped out to the drains system, after which the solidification process will begin in accordance with the contractor's procedures.

Because of the high activity of the resin requiring solidification, sample solidification using nonradioactive resin is normal. References in the PCP to sampling the spent resin tank therefore do not apply.

NOTE: Because of its proprietary nature, the Hittman Nuclear and Development Corporation Process Control Program for In-Container Solidification of Bead Resin #STD-P-05-004 is retained in the Rad Protection Files for reference.