PACIFIC NUCLEAR

SOLIDIFICATION PROCESS

CONTROLLED

CONTROL PROCEDURE

SN-173-009-NS

PT-51-WS

Revision: 10

Effective Date: 5/21/92

Essential Related Pacific Nuclear Documents

The following related Pacific Nuclear/Waste Services Document(s) contain operations or information essential to performance of instructions herein and must be issued in conjunction with this document:

1. OM-104
2.
3.
4.
5.
6.

M. B. Hill Prepared By	5.21.92 Date
G. Wes Caughman Engineering	5-21-92 Date
David Mumaw Customer Service	5/21/92 Date
Joe B Jackson Quality Assurance	5-21-92 Date
N/A by PM 5/21/92 Other	 Date
Pam C. Atchley Document Control	5/21/92 Date

(PT-51-WS 5/21/92)
Procedure No. PT-51 (PT-51-NS 9/24/91) Preparation Date August 15, 1986

TITLE: Solidification Process Control Procedure

RECORD OF REVISIONS

REV	DESCRIPTION	PAGE(S) AFFECTED	DATE	SIGNATURE
7	Added sign-offs on Addendums, added addendum H, revised addendum G, Burial volumes	Annotated by vertical line in right margin	2-10-88	Angela H. Bundick
8	Incorporated customer comments	All	3-10-88	Angela H. Bundick
9	Revised to add the use of cement and to put in NSDI procedure format.	All	9/25/91	Pam C. Atchley
10	Revised to add PCP requirements and to change to Waste Services Group (WSG) procedure number format.	All	5/21/92	Pam C. Atchley

LIST OF EFFECTIVE PAGES

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1.0 PURPOSE AND SCOPE

This document contains the Process Control Procedures for the solidification of various types of waste using the Pacific Nuclear Solidification System and Envirostone or Portland Type I or II Cement. Control of the process parameters involves the solidification of a laboratory sample of each separate type of waste product to be solidified, calculation of the chemical volumes to be added in the specific waste container to be used and logging of the solidification details, while following the solidification operating procedures. Log sheets for each of these three separate tasks are included in this document.

2.0 REFERENCES

2.1 United States Gypsum's Topical Report on Envirostone

2.2 10 CFR 61

2.3 NRC Branch Technical Position on Waste Form

2.4 WSG System Operating Procedure, OM-104

2.5 Pacific Nuclear Quality Assurance Program

2.6 NRC Branch Technical Report, May 1983, Rev. 0

3.0 DEFINITIONS - PROCESS DESCRIPTION

The Pacific Nuclear Solidification System is specifically designed to facilitate solidification of various forms and mixtures of radioactive waste in large scale liners. The waste is effectively immobilized using the specified type of cement which is thoroughly mixed with the waste using the system in-container mixing blades. The final product has proven to be a homogeneously mixed, free standing monolith with no free standing water.

4.0 RESPONSIBILITIES

"Not Applicable"

5.0 PRECAUTIONS/PREREQUISITES

Waste can be solidified using the PNSI solidification Unit and either Envirostone or Portland Type I or II Cement in accordance with the formulas listed in this PCP. Specific waste conditioners are required for some waste forms before solidification. The procedures for solidification of various wastes are included as separate addendums to this procedure.

If the laboratory analysis of the waste solidification shows that the waste setup time will be less than desired, Red Top Retarder can be added in small amounts to extend the setup time to long enough to ensure that the full volume of cement can be thoroughly blended with the waste to form a homogeneous mixture. If the waste/cement mixture exhibits a long setup time, as indicated by laboratory testing, accelerator (Alum or equivalent) can be added to the mixture. The exact amount of retarder or accelerator will be determined during the laboratory solidification and then will be applied in the same proportion in the full scale solidification (within ± 2%).

6.0 PROCEDURE

6.1 System Operation

The Pacific Nuclear Solidification System is operated in accordance with the approved procedures, which ensure reproducibility of the waste product from liner to liner. The process parameters and chemical ratios used in each solidification are specifically calculated for each waste batch and a sample verification satisfactorily performed before attempting a full scale solidification.

6.2 Sample Verification

6.2.1 Prior to full scale solidification of each liner of waste product, a representative sample of each waste product shall be test solidified in the laboratory. Detailed procedures for test solidification for each waste type are attached as addenda to this procedure. A portion of the sample shall be isotopically analyzed to determine the waste class. This test solidification confirms the correct process chemistry ratios to be used in the full scale solidifications of the same waste batch. The sample solidification should verify that the solidified waste product will be a uniform, dry, free-standing monolith. The waste end product shall resist penetration when probed with a firm object.

6.2.2 The operator will number each solidified sample and record the contents of each test solidification on a Sample Verification Worksheet. A Solidification Worksheet will then be prepared for each liner prior to solidification. An Operations Logsheet will be prepared for each liner during solidification. The liner serial number will be recorded on the Operations Logsheet.

6.2.3 The waste batch will be sampled and a PCP performed per the following schedule:

a. Initial sample.

b. After additional waste is added to the holdup tanks.

c. After every seven days.

d. After every tenth batch or 5000 gallons of batch waste, whichever is more frequent.

6.2.4 PCP Failure

6.2.4.1 If any test specimen fails to verify SOLIDIFICATION, the SOLIDIFICATION of 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 alternative SOLIDIFICATION parameters determined by the PROCESS CONTROL PROGRAM.

6.2.4.2 If the initial test specimen from a batch of waste fails to verify SOLIDIFICATION, the PROCESS CONTROL PROGRAM shall provide for the collection and testing of representative test specimens from each consecutive batch of the same type of wet waste until at least three consecutive initial test specimens demonstrate SOLIDIFICATION. The PROCESS CONTROL PROGRAM shall be modified as required to assure SOLIDIFICATION of subsequent batches of waste.

6.2.4.3 If the installed equipment is declared inoperable, restore the equipment to OPERABLE status.

6.3 Full Scale Solidification Calculations

After a laboratory sample has been solidified and it has been confirmed that the waste product will meet the requirements for a satisfactorily solidified end product, the calculations can be made for solidification of the waste form in large containers. Calculations will be made and recorded on the Solidification Worksheet included in each addendum.

7.0 ADDENDA

A. Liner Data Sheets

B. Solidification of CITROX and Bead Resins

C. Solidification of AP and Bead Resins or 100% Cation Bead Resins

D. Solidification of Oil

E. Solidification of Bead Resins and Boric Acid or Class A Granular Activated Carbon and Boric Acid

F. Solidification of Boric Acid

G. Solidification of Bead Resins or Class A Granular Activated Carbon

H. Solidification of Powdered Resins.

ADDENDUM A

LINER DATA SHEETS

LINER DATA SHEET
50 CUBIC FOOT SOLIDIFICATION LINER

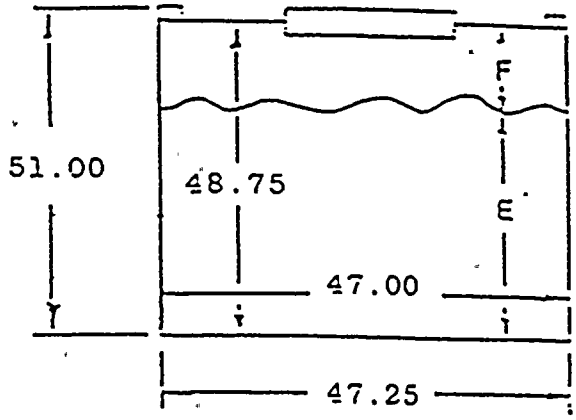
Burial Volume: 52.0 cubic feet

Usable Internal Volume: 46.8 CF
(with 2" of free space in top)

Empty Weight: 600 lbs

Solidified Weight: (Envirostone)

Oil:	4150 lbs
Resin:	4500 lbs
Concentrates:	4850 lbs



Solidification Data:

Sol Eff	Pkging Eff	Waste Vol	Waste Ht (E)	Void Space (F)
40%	36.1%	18.7 CF	18.7 in	30.1 in
45	40.6	21.0	21.0	27.2
50	45.1	23.4	23.4	25.4
55	49.6	25.7	25.7	23.0
60	54.1	28.0	28.0	20.7
65	58.7	30.4	30.4	18.4
70	63.2	32.7	32.7	16.0
71	74.1	33.2	33.2	15.6
72	65.0	33.6	33.6	15.1
73	65.9	34.1	34.1	14.6
74	66.8	34.6	34.6	14.2
75	67.7	35.0	35.0	13.7
76	68.6	35.5	35.5	13.2
77	69.5	36.0	36.0	12.8
78	70.4	36.4	36.4	12.3
79	71.3	36.9	36.9	11.8
80	72.2	37.4	37.4	11.4
81	73.1	37.8	37.8	10.9
82	74.0	38.3	38.3	10.4
83	74.9	38.8	38.8	10.0
84	75.8	39.2	39.2	9.5
85	76.7	39.7	39.7	9.0
100	90.2	46.8	46.8	2.0

Solidification Efficiency = (Waste Volume/Solidified Vol) X 100%

Packaging Efficiency = (Waste Volume/Burial Volume) x 100%

Waste Height (E) and Void Space (F) dimensions are prior to solidification and are used to set the bubble tube level indicator.

LINER DATA SHEET
142 CUBIC FOOT SOLIDIFICATION LINER

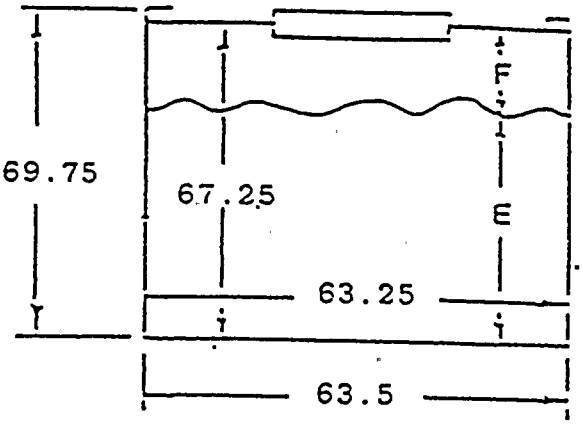
Burial Volume: 128.3 cubic feet

Usable Internal Volume: 118.6 CF
(with 2" of free space in top)

Empty Weight: 1100 lbs

Solidified Weight: (Envirostone)

Oil:	10,125 lbs
Resin:	11,000 lbs
Concentrates:	11,900 lbs



Solidification Data:

Sol Eff	Pkging Eff	Waste Vol	Waste Ht (E)	Void Space (F)
40%	35.1%	47.5 CF	26.1 in	39.2 in
45	39.5	53.4	29.4	35.9
50	43.9	59.3	32.6	32.7
55	48.3	65.3	35.9	29.4
60	52.6	71.2	39.2	26.1
65	57.0	77.1	42.4	22.9
70	61.4	83.1	45.7	19.6
71	62.3	84.2	46.3	19.0
72	63.2	85.4	47.0	18.3
73	64.0	86.6	47.6	17.7
74	64.9	87.8	48.3	17.0
75	65.8	89.0	48.9	16.4
76	66.7	90.2	49.6	15.7
77	67.6	91.4	50.2	15.1
78	68.4	92.5	50.9	14.4
79	69.3	93.7	51.5	13.8
80	70.2	94.9	52.2	13.1
81	71.1	96.1	52.9	12.4
82	71.9	97.3	53.5	11.8
83	72.8	98.5	54.2	11.1
84	73.7	99.7	54.8	10.5
85	74.6	100.8	55.5	9.8
100	87.8	118.6	65.3	2.0

Solidification Efficiency = (Waste Volume/Solidified Vol) X 100%

Packaging Efficiency = (Waste Volume/Burial Volume) x 100%

Waste Height (E) and Void Space (F) dimensions are prior to solidification and are used to set the bubble tube level indicator.

LINER DATA SHEET
190 CUBIC FOOT SOLIDIFICATION LINER

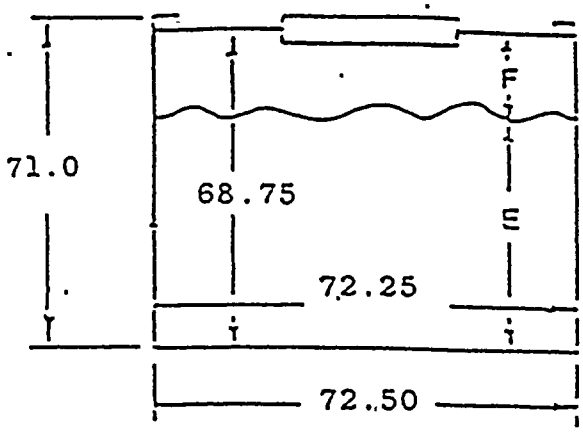
Burial Volume: 170.2 cubic feet

Usable Internal Volume: 158.4 CF
(with 2" of free space in top)

Empty Weight: 1285 lbs

Solidified Weight: (Envirostone)

Oil:	13,350 lbs
Resin:	14,500 lbs
Concentrates:	15,700 lbs



Solidification Data:

Sol Eff	Pkging Eff	Waste Vol	Waste Ht (E)	Void Space (F)
40%	37.3%	63.3 CF	26.7 in	40.1 in
45	42.0	71.3	30.0	38.8
50	46.7	79.2	33.4	35.4
55	51.3	87.1	36.7	32.1
60	56.0	95.0	40.0	28.8
65	60.6	103.0	43.4	25.4
70	65.3	110.9	46.7	22.1
71	66.2	112.5	47.4	21.4
72	67.2	114.0	48.1	20.7
73	68.1	115.6	48.7	20.1
74	69.0	117.2	49.4	19.4
75	70.0	118.8	50.1	18.7
76	70.9	120.4	50.7	18.1
77	71.8	122.0	51.4	17.4
78	72.8	123.6	52.1	16.7
79	73.7	125.1	52.7	16.1
80	74.6	126.7	53.4	15.4
81	75.6	128.3	54.1	14.7
82	76.5	129.9	54.7	14.1
83	77.4	131.5	55.4	13.4
84	78.4	133.0	56.1	12.7
85	79.3	134.0	56.7	12.1
100	93.3	158.4	66.8	2.0

Solidification Efficiency = (Waste Volume/Solidified Vol) X 100%

Packaging Efficiency = (Waste Volume/Burial Volume) x 100%

Waste Height (E) and Void Space (F) dimensions are prior to solidification and are used to set the bubble tube level indicator.

LINER DATA SHEET
210 CUBIC FOOT SOLIDIFICATION LINER

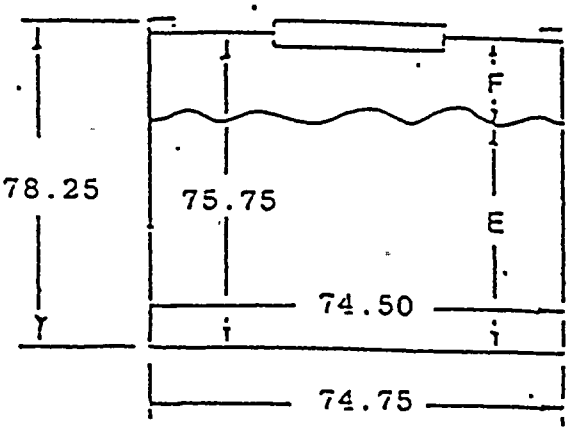
Burial Volume: 199.4 cubic feet

Usable Internal Volume: 185.5 CF
(with 2" of free space in top)

Empty Weight: 1400 lbs

Solidified Weight: (Envirostone)

Oil:	15,500 lbs
Resin:	16,850 lbs
Concentrates:	18,300 lbs



Solidification Data:

Sol Eff	Pkging Eff	Waste Vol	Waste Ht (E)	Void Space (F)
40%	37.3%	74.2 CF	29.5 in	46.3 in
45	42.0	83.5	33.2	42.6
50	46.7	92.8	36.9	38.9
55	51.3	102.0	40.6	35.2
60	56.0	111.3	44.3	31.5
65	60.6	120.6	47.9	27.8
70	65.3	129.9	51.6	24.1
71	66.2	131.7	52.4	23.4
72	67.2	133.6	53.1	22.6
73	68.1	135.4	53.8	21.9
74	69.0	137.3	54.6	21.2
75	70.0	139.1	55.3	20.4
76	70.9	141.0	56.1	19.7
77	71.8	142.8	56.8	19.0
78	72.8	144.7	57.5	18.2
79	73.7	146.5	58.3	17.5
80	74.6	148.4	59.0	16.7
81	75.6	150.3	59.7	16.0
82	76.5	152.1	60.5	15.3
83	77.4	154.0	61.2	14.5
84	78.4	155.8	62.0	13.8
85	79.3	157.7	62.7	13.1
100	93.3	185.5	73.7	2.0

Solidification Efficiency = (Waste Volume/Solidified Vol) X 100%

Packaging Efficiency = (Waste Volume/Burial Volume) x 100%

Waste Height (E) and Void Space (F) dimensions are prior to solidification and are used to set the bubble tube level indicator.

ADDENDUM B

PROCESS CONTROL PROGRAM FOR SOLIDIFICATION OF CITROX AND BEAD RESINS

1.0 PREREQUISITES

1.1 A sample solidification shall be performed before attempting to perform a full scale liner solidification.

1.2 The WSG operator shall ensure that a Radiological Work Permit has been issued for the performance of the sample verification activity and that adequate personnel monitoring and radiation detection equipment is on hand.

1.3 The WSG operator shall ensure that all necessary materials and equipment are on hand prior to beginning the sample verification. Suggested equipment and materials for the test are as listed below:

6 - 300 to 500 ml plastic beakers
6 - mixing spatulas
1 - 500 gram capacity scale
20 g - PNS waste conditioner WC-785
50 g - Calcium Hydroxide
1000 g - Envirostone or Portland Type I or II Cement
100 g - Anhydrous Sodium Metsosilicate (Metso)

NOTE: The waste and chemicals used to solidify the sample waste must be from the same containers or lot numbers to be used in the full scale solidification.

1.4 A one-liter sample shall be taken for solidification in the laboratory for each separate batch of waste to be processed. The operator may choose to take the samples from the storage tanks to be solidified in the liner, or may take the sample from the liner directly, after the waste has been transferred to the liner. Due to the importance of obtaining a representative sample for use in the verification procedure, the operator shall confirm that the contents of the waste form to be solidified have been adequately mixed and that the sample is a part of a homogeneously mixed waste batch.

2.0 SAMPLE VERIFICATION

2.1 Record the information obtained during sample verification on the Sample Verification Worksheet.

2.2 Provide a waste sample (size to be specified by the plant) to the plant staff for isotopic analysis.

2.3 Place a sample of the waste in the beaker so that the resins are at the 200 ml level with the liquid solution just covering the resins. This may necessitate pouring off some of the liquid solution.

2.4 Record the initial pH, radiation level and temperature of the waste sample.

2.5 Add Slacked Lime (Calcium Hydroxide) to the waste sample in the quantity as per Table I and mix the sample thoroughly for ten minutes. Record the pH of the sample.

2.6 Add PNS WC-785 to the waste sample in the quantity as per Table I and mix the sample thoroughly for ten minutes. Record the pH of the sample.

2.7 Add Envirostone or Portland Type I or II Cement to the waste sample in the quantity as listed in Table I and mix the sample until the mixture begins to thicken. Record the time from the start of adding the appropriate cement to the time that the mixture thickens such that mixing is no longer required (mix time) and the time from the start of adding the appropriate cement to the time that the waste is firm to the touch (setup time). Additional cement can be added if necessary to achieve a satisfactory end product. However, if additional cement must be added, the waste solidification efficiency must be redetermined and the solidification liner waste volume adjusted.

TABLE I

CITROX/Cation Resin Ratio	Grams Lime	Grams Metso	Grams WC-785	Grams Cement
100% CITROX	4.0	25	1.5	103
75% CITROX/25% Cation	3.0	25	1.1	104
50% CITROX/50% Cation	2.0	25	0.8	105
25% CITROX/75% Cation	1.0	25	0.4	107

NOTE: Metso is Anhydrous Sodium Metsosilicate used in conjunction with Portland Type Cement.

2.8 Continue to mix samples until a satisfactory waste product is produced. The waste setup time should be at least 30 minutes for 50 ft^3 liners, 60 minutes for 142 ft^3 liners, and 90 minutes for larger liners. If the setup time is shorter than specified for the liner to be solidified, add a lesser amount of WC-785 and continue to perform sample testing to verify the setup time. If the setup time is greater than 150 minutes, add a greater amount of WC-785 to the waste sample and continue to perform sample testing until a satisfactory sample is obtained which will set up in less than 150 minutes. If a satisfactory sample cannot be obtained by adjusting the amount of WC-785, the operator can adjust the amount of lime added to the waste sample and continue to test. If a satisfactory sample cannot be obtained, the operator shall refer to Section 6.2.4 and contact the Customer Service Manager before proceeding.

2.9 Remove the solidified sample from the sample container and visually examine it for evidence of soft, porous or unsolidified areas. The solidified samples should be hard, homogeneous and of uniform coloration.

2.10 Set sample(s) aside for future disposal.

3.0 FULL SCALE SOLIDIFICATION

3.1 After a satisfactory sample solidification has been performed, determine the appropriate amount of waste conditioners and cement to be added to the full scale liner solidification using the Solidification Worksheet.

3.2 After determining the appropriate volumes of additives and cement to be added to the Liner, the full scale solidification should be performed using the system operating procedure (Reference 2.4), and the Solidification Operations Logsheet should be filled out.

SAMPLE VERIFICATION WORKSHEET
FOR SOLIDIFICATION OF CITROX AND BEAD RESINS

Operator:_____ Date:_____ No.:_____

Utility/Location: _____

Waste Type: _____

Waste Sample From/By:_____

Waste Temperature:_____F Waste pH:_____Sample Rad Level:_____

Physical Characteristics (viscosity, color, sedimentation, clarity, etc.):

_____

_____

Sample Proportions:

Waste Sample	_____ml
CITROX/Cation Resin Ratio	_____ ml/_____ml
Slacked Lime CA $(OH)_2$	_____gm
pH after Lime Addition	_____pH
WC-785	_____gm
pH After WC-785	_____pH
Chemical Additives	_____
	_____
	_____
Final pH	_____pH
Envirostone	_____gm
Portland	_____gm

Blend the required volume of cement into the waste and record the time the addition starts: _____

Record the time when the mixture viscosity increases to the point when the mixer is secured: _____(1)

Record the time when the mixture is firm to the touch: _____(2)

SAMPLE VERIFICATION WORKSHEET
FOR SOLIDIFICATION OF CITROX AND BEAD RESINS

Sample Results:

Mix time (1): _____ minutes

Setup time (2): _____ minutes

Free Water, if any: _____

Relative set (soft, firm, very hard): _____

Observations: _____

_____

_____

Sample proportions and solidification results acceptable for calculation of large scale solidification ratios: ____ yes ____ no

Isotopic results of sample: _____

_____

_____

Solidification Efficiency (Waste Volume/Solidified Volume): _____

Operator Signature: _____ Date: _____

Utility Representative Signature: _____

Title: _____ Date: _____

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF CITROX AND BEAD RESINS

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Satisfactory Sample Verification No:_____ Date:_____

Solidification Efficiency:_____

Container Model:_____

SEE THE LINER DATA SHEET FOR THE LINER BEING USED

Usable Liner Volume (with 2" safety margin):_____cf

Waste Volume:_____cf

Waste Height:_____in

(Waste Full/Level Bubble Tube to be set at this height)

Weight of Lime to be Added to the Liner (Use the values determined from the Sample Verification Worksheet):

_____gms of lime in sample/_____ml of waste in sample

x 62.38 = _____lbs of lime to be added to the liner

x _____ Actual cf of waste in liner

= _____ lbs of lime to be added to the liner.

Weight of WC-785 to be Added to the Liner (use the values determined from the Sample Verification Worksheet):

_____ gms of WC-785 in sample/_____ml of waste in sample

x 62.38 = _____ lbs of WC-785/cf of waste

x _____ Actual cf of waste in liner

= _____ lbs of WC-785 to be added to the liner.

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF CITROX AND BEAD RESINS

DRY CHEMICAL ADDITIVES

Chemical Additive:_____

Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x _____ lbs cement to be added to the liner

= _____ lbs Chemical Additive

Chemical Additive:_____

Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x _____ lbs cement to be added to the liner

= _____ lbs Chemical Additive

WET CHEMICAL ADDITIVES

Chemical Additive:_____

Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Chemical Additive:_____

Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF CITROX AND BEAD RESINS

Weight of cement to be added to the liner (use the values determined from the Sample Verification Worksheet):

_____ gms of cement in sample/_____ml of Waste in Sample

x 62.38 = _____lbs of cement/cf of waste

x _____ Actual cf of waste in liner

= _____ lbs of cement to be added to the liner.

NOTE: Cement weight may be rounded up to the next 100 pound increment thus allowing full 100 pound bags of cement to be added to container.

Calculate and record the weight percent of CITROX to resin in the liner:

_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION OPERATIONS LOGSHEET

Operator:_____ Date:_____ No._____

Utility/Location:_____

Liner Serial No.:_____

Waste Type:_____

Waste From:_____

Solidification Worksheet No:_____

Waste Volume Added:_____cf:_____ Time Completed:_____

Height of Waste:_____Inches From Inside Bottom of Liner

Time Mixer Started:_____ Hydraulic Press:_____

Wet Chemicals Added (List):
_____ gal_____time completed_____
_____ gal_____time completed_____

Dry Chemicals Added (List):
_____ lbs_____time completed_____
_____ lbs_____time completed_____

Cement Added:_____lbs Time Started:_____Complete:_____

Mixer Hydraulic Pressure	PSI	Time
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Time Mixer Secured:_____

Waste Setup Time:_____

Time Fillhead Removed:_____Time Liner Capped:_____

Only Cap Liner With Utility Representative's Approval:_____

Comments and Observations:_____
_____

Date Liner Shipped/Shipment Number:_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

ADDENDUM C

PROCESS CONTROL PROGRAM

FOR SOLIDIFICATION OF AP AND BEAD RESINS

OR 100% CATION BEAD RESINS

1.0 PREREQUISITES

1.1 A sample solidification shall be performed before attempting to perform a full scale liner solidification.

1.2 The WSG operator shall ensure that a Radiological Work Permit has been issued for the performance of the sample verification activity and that adequate personnel monitoring and radiation detection equipment is on hand.

1.3 The WSG operator shall ensure that all necessary materials and equipment are on hand prior to beginning the sample verification. Suggested equipment and materials for the test are as listed below:

6 - 300 to 500 mL plastic beakers
6 - mixing spatulas
1 - 500 gram capacity scale
10 g - Red Top Retarder or equivalent (if required)
100 g - Anhydrous Sodium Metsosilicate (Metso)
1000 g - Envirostone
20 g - Accelerator, Alum or equivalent (if required)
1000 g - Portland Type I or II Cement

NOTE: The waste and chemicals used to solidify the sample waste must be from the same containers or lot numbers to be used in the full scale solidification.

1.4 A one-liter sample shall be taken for solidification in the laboratory for each separate batch of waste to be processed. The operator may choose to take the samples from the storage tanks to be solidified in the liner, or may take the sample from the liner directly, after the waste has been transferred to the liner. Due to the importance of obtaining a representative sample for use in the verification procedure, the operator shall confirm that the contents of the waste form to be solidified have been adequately mixed and that the sample is a part of a homogeneously mixed waste batch.

2.0 SAMPLE VERIFICATION

2.1 Record the information obtained during sample verification on the Sample Verification Worksheet.

2.2 Provide a waste sample (size to be specified by the plant) to the plant staff for isotopic analysis.

2.3 Place a sample of the waste in the beaker so that the resins are at the 200 ml level with the liquid solution just covering the resins. This may necessitate pouring off some of the liquid solution.

2.4 Record the initial pH, radiation level and temperature of the waste sample.

NOTE: Step 2.5 applies only if Portland Cement is used. If Envirostone Cement is ~~pbed~~ USED, skip to Step 2.6

2.5 Add 25 g of Anhydrous Sodium Metsosilicate to the 200 ml waste sample, and mix until dissolved.

2.6 Add 108 g of cement to the 200 ml waste sample and mix the sample until the mixture begins to thicken. Record the time from the start of adding the cement to the time that the mixture thickens such that mixing is no longer required (mix time) and the time from the start of adding the cement to the time that the waste is firm to the touch (setup time). Additional cement can be added if necessary to achieve a satisfactory end product. However, if additional cement must be added, the waste solidification efficiency must be redetermined and the waste volume to be added to the solidification liner may have to be adjusted.

NOTE: Step 2.7 applies only if Envirostone is the type of cement used.

2.7 If the waste setup time is less than 30 minutes if a 50 cubic foot liner is being used, is less than 60 minutes if a 142 cu ft liner is being used, or is less than 90 minutes if a larger liner is being used, add Red Top Retarder to the 200 ml waste sample at a rate of Retarder Wt = 0.05% of Envirostone Wt to adjust the waste setup time to the minimum time requirement for the liner size being used. Increase the amount of retarder added to the sample until the desired setup time is achieved.

2.8 If the waste setup time is longer than operationally desired, add accelerator to the 200 ml waste sample at a rate of Accelerator Wt = 1.0% of Envirostone Wt to adjust the waste setup time to the maximum time. Increase the amount of accelerator to the sample until the desired setup time is achieved.

2.9 Continue to mix samples until a satisfactory waste product is produced. If a satisfactory sample cannot be obtained, the operator shall refer to Section 6.2.4 and contact the Customer Service Manager before proceeding.

2.10 Remove the solidified sample from the sample container and visually examine it for evidence of soft, porous or unsolidified areas. The solidified sample should be hard, homogeneous and of uniform coloration.

2.11 Set sample(s) aside for future disposal.

3.0 FULL SCALE SOLIDIFICATION

3.1 After a satisfactory sample solidification has been performed, determine the appropriate amount of Additives and cement to be added to the full scale liner solidification using the Solidification Worksheet.

3.2 After determining the appropriate volumes to be added to the Liner, the full scale solidification should be performed using the system operating procedure (Reference 2.4) and the Solidification Operations Logsheet should be filled out.

SAMPLE VERIFICATION WORKSHEET FOR SOLIDIFICATION OF AP AND BEAD RESINS OR 100% CATION BEAD RESINS

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Waste Sample From/By:_____

Waste Temperature:_____F Waste pH:_____Sample Rad Level:_____

Physical Characteristics (viscosity, color, sedimentation, clarity, etc.):

_____

_____

_____

Sample Proportions:

Waste Sample	_____ml
AP/Cation Resin Ratio	_____ml/_____ml
pH	_____pH
Chemical Additives (if required)	_____ _____ _____
Cement	_____gm
Accelerator (if required)	_____gm

Blend the required chemical additives (if any) thoroughly into the waste before adding the cement.

Blend the required volume of cement into the waste and record the time the addition starts:_____

Record the time when the mixture viscosity increases to the point when the mixer is secured:_____(1)

Record the time when the mixture is firm to the touch:_____(2)

SAMPLE VERIFICATION WORKSHEET
FOR SOLIDIFICATION OF AP AND BEAD RESINS
OR 100% CATION BEAD RESINS

Sample Results:

Mix time (1):_____minutes

Setup time (2):_____minutes

Free Water, if any:_____

Relative set (soft, firm, very hard):_____

Observations:_____

_____

_____

Sample proportions and solidification results acceptable for calculation of large scale solidification ratios:_____yes_____no

Isotopic results of sample:_____

_____

_____

Solidification Efficiency (Waste Volume/Solidified Volume):_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF AP AND BEAD RESINS
OR 100% CATION BEAD RESINS

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Satisfactory Sample Verification No:_____Date:_____

Solidification Efficiency:_____

Container Model:_____

SEE THE LINER DATA SHEET FOR THE LINER BEING USED

Usable Liner Volume (with 2" safety margin):_____cf

Waste Volume:_____cf

Waste Height in Liner:_____in
(Waste Full/Level Bubble Tube to be set at this height)

Weight of cement to be added to the liner (Use the values determined from the Sample Verification Worksheet):

_____gms of cement in sample/_____ml of waste in sample

x 62.38 =_____lbs of cement/cf of Waste

x_____cf of waste to be added to the liner

=_____lbs of cement to be added to the liner.

NOTE: Cement weight may be rounded up to the next 100 pound increment thus allowing full 100 pound bags of cement to be added to container.

DRY CHEMICAL ADDITIVES

Chemical Additive:_____

Weight of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x _____lbs cement to be added to the liner

= _____lbs Chemical Additive

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF AP AND BEAD RESINS
OR 100% CATION BEAD RESINS

Chemical Additive:_____

Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x _____ lbs cement to be added to the liner

=_____ lbs Chemical Additive

WET CHEMICAL ADDITIVES

Chemical Additive:_____

Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Chemical Additive:_____

Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION OPERATIONS LOGSHEET

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Liner Serial No.:_____

Waste Type:_____

Waste From:_____

Solidification Worksheet No:_____

Waste Volume Added:_____cf:_____Time Completed:_____

Height of Waste:_____Inches From Inside Bottom of Liner

Time Mixer Started:_____ Hydraulic Press:_____

Wet Chemical Added (List):
_____gal_____time completed_____
_____gal_____time completed_____

Dry Chemicals Added (List):
_____lbs_____time completed_____
_____lbs_____time completed_____

Waste Conditioner Added:_____Type:_____lbs:_____Time:_____

Cement Added:_____ lbs:_____ Time Started:_____Complete:_____

Mixer Hydraulic Pressure	PSI	Time
	_____	_____
	_____	_____
	_____	_____

Time Mixer Secured:_____

Waste Setup Time:_____

Time Fillhead Removed:_____ Time Liner Capped:_____

Only Cap Liner With Utility Representative's Approval:_____

Comments and Observations:_____
_____

Date Liner Shipped/Shipment Number:_____/_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

ADDENDUM D

PROCESS CONTROL PROGRAM

FOR SOLIDIFICATION OF OIL

1.0 PREREQUISITES

1.1 A sample solidification shall be performed before attempting to perform a full scale liner solidification.

1.2 The WSG operator shall ensure that a Radiological Work Permit has been issued for the performance of the sample verification activity and that adequate personnel monitoring and radiation detection equipment is on hand.

1.3 The WSG operator shall ensure that all necessary materials and equipment are on hand prior to beginning the sample verification. Suggested equipment and materials for the test are as listed below:

6 - 300 to 500 mL plastic beakers
6 - mixing spatulas
1 - 500 gram capacity scale
50 ml - Envirostone Emulsifier
10 g - Envirostone Accelerator or Alum (if required)
10 g - Red Top Retarder or equivalent (if required)
100 g - Anhydrous Sodium Metsosilicate (Metso)
1000 g - Envirostone
50 g - Calcium Hydroxide (Lime)
50 g - Boric Acid
1000 g - Portland Type I or II Cement

NOTE: The waste and chemicals used to solidify the sample waste must be from the same containers or lot numbers to be used in the full scale solidification.

1.4 A one-liter sample shall be taken for solidification in the laboratory for each separate batch of oil to be processed. The operator may choose to take the samples from the storage drums to be solidified in the liner, or may take the sample from the liner directly, after the oil has been transferred to the liner. If the sample is taken from the drums prior to transferring the oil to the liner, the operator will take a sample from each drum and mix the samples together in the same ratio that will be mixed in the liner. The sample will consist of 126.6 ml of oil. [This will produce a total sample size of 200 ml after 59.6 ml of water (or Boric Acid concentrations up to 24 wt%) and 13.8 ml of Emulsifier has been added.] The operator may also choose to transfer the appropriate volume of waste oil, water (or Boric Acid concentrations up to 24 wt%) and Emulsifier to the liner, thoroughly emulsify the waste, then take a 200 ml sample of the waste mixture for sample solidification. This should be done only after it has been established that the oil will solidify using the standard formulas.

NOTE: Emulsifier is added only if Envirostone is the type solidification agent used.

2.0 SAMPLE VERIFICATION

2.1 After the materials and equipment, as listed in the prerequisites to this procedure, are verified available, a sample of the waste will be taken. The operator shall take the sample, as described above. When the operator chooses to take the sample directly from the liner, the liner should be filled to the normal level for solidification of oil (see the appropriate Liner Data Sheet) and the oil mixed for five minutes before sampling. The sample can then be drawn directly from the liner. After the operator has confirmed that the waste oil will solidify in accordance with the normal formulas, the water (or Boric Acid) and emulsifier (if applicable) can be added to the waste oil in the liner and mixed prior to taking the sample for solidification verification. The waste oil and the chemicals used to solidify the waste oil must be from the same batches as will be used in the full scale solidification. Record the information obtained during sample verification on the Sample Verification Worksheet.

2.2 Provide a waste sample (size to be specified by the plant) to the plant staff for isotopic analysis.

2.3 If the oil, water (or Boric Acid), and emulsifier (if applicable) have already been blended together, obtain a 200 ml sample of the mixture and skip to Step 2.7.

2.4 Obtain a 126.6 ml sample of the oil to be solidified.

2.5 Add 59.6 ml of tap water (or Boric Acid) to the waste oil. If Boric Acid is used, it may be necessary to adjust the pH using calcium hydroxide (lime) such that the pH is between 2 and 6. Allow approximately 10 to 15 minutes for reaction time before further additions.

NOTE: Step 2.6 applies only if Envirostone is used as the solidification agent. Skip to Step 2.7 if Portland Cement is to be used.

2.6 Add 13.8 ml of emulsifier to the waste/water (or Boric Acid) mixture and mix until emulsified as indicated by uniform coloration without streaking.

2.7 Add 125 grams of cement to the waste mixture and mix with a small spatula until the waste begins to thicken. Record the time that mixing was required (mix time) and the time from the addition of the cement until the waste becomes firm to the touch (setup time). Additional cement can be added if necessary to achieve a satisfactory end product. However, if additional cement must be added, the waste solidification efficiency must be redetermined and the waste volume to be added to the solidification liner may have to be adjusted.

NOTE: Steps 2.8 and 2.9 apply only if Envirostone is the solidification agent to be used. If Portland Cement is to be used, skip to Step 2.10.

2.8 If the setup time is less than desired, add 0.05 grams of Red Top Retarder to the 200 ml emulsified waste mixture, to adjust the waste setup time to at least 30 minutes for solidification in 50 cubic foot liners. The setup time should be adjusted to at least 60 minutes for 142 cubic foot liner solidifications and to at least 90 minutes for larger liners. Adjust the weight of retarder added to the sample and continue to perform sample solidifications until the desired setup time is obtained.

2.9 If the waste setup time is longer than is operationally desired, the operator may add Envirostone Accelerator or Alum in quantities up to 2.0% of the weight of the Envirostone added. The Accelerator or Alum should be added after the waste mixture and Envirostone have been thoroughly blended for a minimum of 5 minutes.

2.10 Remove the solidified sample from the sample container and visually examine it for evidence of soft, porous or unsolidified areas. The solidified samples should be hard, homogeneous and of uniform coloration.

2.11 Set sample(s) aside for future disposal.

2.12 If a satisfactory sample solidification cannot be obtained using the waste oil/water(or Boric Acid)/emulsifier/cement mixture for 50% solidification efficiency, as listed in Steps 2.4 through 2.7 above, repeat the sample solidification using the formulas for 45% solidification efficiency as listed below:

114 ml of oil
59.6 ml of water (or Boric Acid)
12.7 ml of emulsifier
146 gms of cement

2.13 If a satisfactory sample solidification cannot be obtained, the operator shall refer to Section 6.2.4 and contact the Customer Service Manager before proceeding.

3.0 FULL SCALE SOLIDIFICATIONS

3.1 After a satisfactory sample solidification has been performed, determine the appropriate amount of Retarder (if applicable) and cement to be added to the full scale liner solidification using the Solidification Worksheet.

3.2 After determining the appropriate volumes of chemicals and cement to be added to the Liner, the full scale solidification should be performed using the system operating procedure (Reference 2.4), and the Solidification Operations Logsheet should be filled out.

SAMPLE VERIFICATION WORKSHEET FOR SOLIDIFICATION OF OIL

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Waste Sample From/By:_____

Waste Temperature:_____F Waste pH:_____Sample Rad Level:_____

Physical Characteristics (viscosity, color, sedimentation, clarity, etc.):

_____

_____

_____

Sample Proportions:

Waste Oil Sample	_____mL
Water (or Boric Acid concentrations up to 24 wt%) Added to Sample	_____mL
Emulsifier Added to Sample	_____mL
Chemical Additives	_____
	_____
	_____
Cement	_____gm

If applicable, blend the oil, water (or Boric Acid) and emulsifier together thoroughly before adding cement. Retarder and other chemical Additives should be added, if needed, and thoroughly blended in before adding cement. Accelerator, if needed, should be added after the waste and cement have been thoroughly mixed for a minimum of 5 minutes.

Blend the required volume of cement into the waste and record the time the addition starts: _____

Record the time when the mixture viscosity increases to the point when the mixer is secured: _____(1)

Record the time when the mixture is firm to the touch:_____(2)

SAMPLE VERIFICATION WORKSHEET
FOR SOLIDIFICATION OF OIL

Sample Results:

Mix time (1):_____minutes

Setup time (2):_____minutes

Free Water (or Boric Acid), if any:_____

Relative set (soft, firm, very hard):_____

Observations: _____

_____

_____

Sample proportions and solidification results acceptable for calculation of large scale solidification ratios:_____ yes _____ no

Isotopic results of sample:_____

_____

_____

Solidification Efficiency (Waste Volume/Solidified Volume:_____

_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION WORKSHEET FOR SOLIDIFICATION OF OIL

Operator:_____Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Satisfactory Sample Verification No:_____ Date:_____

Solidification Efficiency:_____

Container Model:_____

SEE THE LINER DATA SHEET FOR THE LINER BEING USED

Usable Liner Volume (with 2" safety margin):_____cf

Oil Volume to be Added to Liner:_____cf

Oil Height in liner:_____in

Water (Boric Acid) to be added to the Liner (Use the values determined from the Sample Verification Worksheet):

_____ml of water (or Boric Acid) in sample/_____ml of oil in sample

x _____ inches of oil to be added to the liner

= _____ inches of Water (or Boric Acid) to be added to the Liner.

Oil Height _____ in. ÷ Inches of Water (or Boric Acid)_____ in.

= _____ in. Hgt of Water (and Oil) in Liner (Water Level Setpoint)

Emulsifier to be Added to the Liner (use the values determined from the Sample Verification Worksheet)

_____ml of Emulsifier in Sample/_____ml of Oil in Sample

x _____ cf of oil to be Added to the Liner x 7.48

= _____ Gallons of Emulsifier to be added to the Liner

DRY CHEMICAL ADDITIVES

Chemical Additive:_____
Weight of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner = _____lbs Chemical Additive

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF OIL

Chemical Additive:_____
Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____lbs Chemical Additive

WET CHEMICAL ADDITIVES

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____gallons Chemical Additive

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Weight of cement to be Added to the Liner:

_____gms of cement in sample/_____ml of Oil in sample

x 8.34 = _____lbs of cement/gallon of Oil

x _____ gallons of Oil to be added to the Liner

= _____lbs of cement to be added to the Liner

NOTE: Cement weight may be rounded up to the next 100 pound increment thus allowing full 100 pound bags of cement to be added to container.

SOLIDIFICATION OPERATIONS LOGSHEET
OIL SOLIDIFICATION

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____
Waste From:_____

Solidification Worksheet No:_____

Oil Volume Added to Liner:_____ Time Completed:_____
Height of Oil:_____Inches from Inside Bottom of Liner
Water (or Boric Acid) Volume Added to Liner:_____
Time Completed:_____

Height of Water (or Boric Acid) and Oil:_____Inches from Inside Bottom of Liner

Emulsifier Volume Added to Liner:_____Time Completed:_____

Time Mixer Started:_____ RPM:_____

Wet Chemicals Added (List):
_____gal_____time completed_____
_____gal_____time completed_____

Dry Chemicals Added (List):
_____lbs_____time completed_____
_____lbs_____time completed_____

Cement Added:_____lbs:_____Time Added:_____Complete:_____
Accelerator Added:_____lbs:_____Time Added:_____

Mixer Hydraulic Pressure:	PSI	Time
	_____	_____
	_____	_____
	_____	_____

Time Mixer Secured:_____
Waste Setup Time:_____
Time Fillhead Removed:_____Time Liner Capped:_____

Only Cap Liner With Utility Representative's Approval:_____

Comments and Observations:_____

Date Liner Shipped/Shipment Number:_____/_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

ADDENDUM E

PROCESS CONTROL PROGRAM

FOR SOLIDIFICATION OF BEAD RESINS AND BORIC ACID

OR CLASS A GRANULAR ACTIVATED CARBON AND BORIC ACID

1.0 PREREQUISITES

1.1 A sample solidification shall be performed before attempting to perform a full scale liner solidification.

1.2 The WSG operator shall ensure that a Radiological Work Permit has been issued for the performance of the sample verification activity and that adequate personnel monitoring and radiation detection equipment is on hand.

1.3 The WSG operator shall ensure that all necessary materials and equipment are on hand prior to beginning the sample verification. Suggested equipment and materials for the test are as listed below:

6 - 300 to 500 mL plastic beakers
6 - mixing spatulas
1 - 500 gram capacity scale
50 g - pH Adjustment Additive (Example: Boric Acid, Calcium Hydroxide, etc.)
100 g - Anhydrous Sodium Metsosilicate (Metso)
10 g - Red Top Retarder or equivalent
1000 g - Envirostone
20 g - Accelerator, Alum or equivalent (if required)
1000 g - Portland Type I or II Cement

NOTE: The waste and chemicals used to solidify the sample waste must be from the same containers or lot numbers to be used in the full scale solidification.

1.4 A one-liter sample shall be taken for solidification in the laboratory from the bead resin tank and from the boric acid tank. Due to the importance of obtaining a representative sample for use in the verification procedure, the operator shall confirm that the contents of the waste form to be solidified have been adequately mixed and that the sample is a part of a homogeneously mixed waste batch.

2.0 SAMPLE VERIFICATION

2.1 Record the initial pH, radiation level and temperature of the waste samples.

2.2 Provide a waste sample (size to be specified by the plant) to the plant staff for isotopic analysis.

2.3 Place a 200 ml sample of dewatered bead resins or granular activated carbon in the beaker.

NOTE: If the ratio of Boric Acid to bead resin or carbon is to be increased, calculate the proper ratios on the work sheet included in this addendum.

2.4 Add 24 wt% (max.) boric acid at 180°F until the liquid level is at or slightly above the resin or activated carbon level.

2.5 Add the appropriate chemical additive, if required, to adjust the pH to between 2 and 6.

2.6 Add 0.1 grams retarder (Red Top), if required.

2.7 Thoroughly blend the waste and record the time when finished.

2.8 Add 25 g of Anhydrous Sodium Metsosilicate to the waste sample and mix until dissolved.

2.9 Add 117 g of cement to the 200 ml waste sample and mix the sample until the mixture begins to thicken. Record the time from the start of adding the cement to the time that the mixture thickens such that mixing is no longer required (mix time) and the time from the start of adding the cement to the time that the waste is firm to the touch (setup time). Additional cement can be added if necessary to achieve a satisfactory end product. However, if additional cement must be added, the waste solidification efficiency must be redetermined and the waste volume to be added to the solidification liner may have to be adjusted.

NOTE: Steps 2.10 and 2.11 apply only if Envirostone cement is the solidification agent used. If Portland Cement is used, skip to Step 2.12.

2.10 If the waste setup time is less than 30 minutes if a 50 cubic foot liner is being used, is less than 60 minutes if a 142 cu ft liner is being used, or is less than 90 minutes if a larger liner is being used, add 0.05 g of Red Top Retarder to the 200 ml waste sample to adjust the waste setup time. Vary the amount of retarder added to the sample until the desired setup time is achieved.

2.11 If the waste setup time is longer than operationally desired, add accelerator to the 200 ml waste sample at a rate of Accelerator Wt = 1.0% of Envirostone Wt to adjust the waste setup time to the maximum time. Increase the amount of accelerator to the sample until the desired setup time is achieved.

2.12 Remove the solidified sample from the sample container and visually examine it for evidence of soft, porous or unsolidified areas. The solidified samples should be hard, homogeneous and of uniform coloration.

2.13 Set sample(s) aside for future disposal.

2.14 Continue to mix samples until a satisfactory waste product is produced. If a satisfactory sample cannot be obtained, the operator shall refer to Section 6.2.4 and contact the Customer Service Manager before proceeding.

3.0 FULL SCALE SOLIDIFICATIONS

3.1 After a satisfactory sample solidification has been performed, determine the appropriate amount of additives and cement to be added to the full scale liner solidification using the Solidification Worksheet.

3.2 After determining the appropriate volumes to be added to the Liner, the full scale solidification should be performed using the system operating procedure (Reference 2.4), and the Solidification Operations Logsheet should be filled out.

SAMPLE VERIFICATION WORKSHEET
FOR SOLIDIFICATION OF BORIC ACID AND BEAD RESINS

Operator:_____ Date:_____ No.:_____

Utility/Location: _____

Waste Type:_____

Waste Sample From/By:_____

Waste Temperature:_____F Waste pH:_____Sample Rad Level:_____

Physical Characteristics (viscosity, color, sedimentation, clarity, etc.):

_____

_____

_____

Sample Proportions:

Bead Resin or Granular Activated Carbon - Dewatered	_____mL
Boric Acid - 24 wt %	_____mL
Chemical Additives	_____
	_____
	_____
Final pH	_____
Cement	_____gm
Accelerator (if required)	_____gm

Blend the waste thoroughly (with pH adjustment additives, retarder, or conditioners, if required) and record the time when finished:
_____

Blend the required volume of cement into the waste and record the time when finished:_____

Record the time when the mixture viscosity increases to the point when the mixer is secured:_____(1)

Record the time when the mixture is firm to the touch:_____(2)

SAMPLE VERIFICATION WORKSHEET
FOR SOLIDIFICATION OF BORIC ACID AND BEAD RESINS

Sample Results:

Mix time (1):_____minutes

Setup time (2):_____minutes

Free Water, if any:_____

Relative set (soft, firm, very hard):_____

Observations:_____

_____

_____

Sample proportions and solidification results acceptable for calculation of large scale solidification ratios:_____ yes _____ no

Isotopic results of sample:_____

_____

_____

Solidification Efficiency (Waste Volume/Solidified Volume):_____

_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF BORIC ACID AND BEAD RESIN

Operator:_____ Date:_____No.:_____

Utility/Location:_____

Waste Type:_____

Satisfactory Sample Verification No.:_____Date:_____

Solidification Efficiency:_____

Container Model:_____

SEE THE LINER DATA SHEET FOR THE LINER BEING USED

Usable Liner Volume (with 2" safety margin):_____cf

Volume - Bead Resin or Activated Carbon:_____cf

Volume - Boric Acid (43% Bead Vol.):_____cf

Waste Height in Liner:_____in

Total Waste Volume added to Liner:_____cf
(Bead Resin Volume & Boric Acid Volume)

Weight of cement to be Added to the Liner (Use the values determined from the Sample Verification Worksheet):

_____gms of cement in sample/_____ml of waste in sample

x 62.38 = _____lbs of cement/cf of Waste

x _____ cf of waste to be Added to the Liner

= _____ lbs of cement to be added to the liner.

NOTE: Cement weight may be rounded up to the next 100 pound increment thus allowing full 100 pound bags of cement to be added to container.

DRY CHEMICAL ADDITIVES

Chemical Additive:_____
Weight of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____lbs Chemical Additive

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF BORIC ACID AND BEAD RESIN

Chemical Additive:_____
Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____ lbs Chemical Additive

WET CHEMICAL ADDITIVES

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____gallons Chemical Additive

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION OPERATIONS LOGSHEET

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Liner Serial No.:_____

Waste Type:_____

Waste From:_____

Solidification Worksheet No:_____

Waste Volume Added:_____ cf:_____ Time Completed:_____

Height of Waste: _____In. From Inside Bottom of Liner

Time Mixer Started:_____ Hydraulic Press:_____

Wet Chemicals Added (List):
_____gal_____time completed_____
_____gal_____time completed_____

Dry Chemicals Added (List):
_____lbs_____time completed_____
_____lbs_____time completed_____

Waste Conditioner Added:_____Type:_____lbs:____Time:_____

Cement Added:_____ lbs:_____Time Started:_____Complete:_____

Mixer Hydraulic Pressure	PSI	Time
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Time Mixer Secured:_____

Waste Setup Time:_____

Time Fillhead Removed:_____Time Liner Capped:_____

Only Cap Liner With Utility Representative's Approval:_____

Comments and Observations:_____

Date Liner Shipped/Shipment Number:_____/_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

ADDENDUM F

PROCESS CONTROL PROGRAM

FOR SOLIDIFICATION OF BORIC ACID

1.0 PREREQUISITES

1.1 A sample solidification shall be performed before attempting to perform a full scale liner solidification.

1.2 The WSG operator shall ensure that a Radiological Work Permit has been issued for the performance of the sample verification activity and that adequate personnel monitoring and radiation detection equipment is on hand.

1.3 The WSG operator shall ensure that all necessary materials and equipment are on hand prior to beginning the sample verification. Suggested equipment and materials for the test are as listed below:

6 - 300 to 500 mL plastic beakers
6 - mixing spatulas
1 - 500 gram capacity scale
50 g - pH Adjustment Additive (Example: Boric Acid, Calcium Hydroxide, etc.)
100 g - Anhydrous Sodium Metsosilicate (Metso)
10 g - Red Top Retarder or equivalent
1000 g - Envirostone
20 g - Accelerator, Alum or equivalent (if required)
1000 g - Portland Type I or II Cement

NOTE: The waste and chemicals used to solidify the sample waste must be from the same containers or lot numbers to be used in the full scale solidification.

1.4 A one-liter sample shall be taken for solidification in the laboratory from the boric acid tank. Due to the importance of obtaining a representative sample for use in the verification procedure, the operator shall confirm that the contents of the waste form to be solidified have been adequately mixed and that the sample is a part of a homogeneously mixed waste batch.

2.0 SAMPLE VERIFICATION

2.1 Record the initial pH, radiation level and temperature of the waste samples.

2.2 Provide a waste sample (size to be specified by the plant) to the plant staff for isotopic analysis.

2.3 Place a 200 ml sample of 24 wt% (max.) boric acid at 180°F in the beaker.

2.4 Add the appropriate chemical additive, if required, to adjust the pH to between 2 and 6.

2.5 Add 0.1 grams retarder (Red Top), if required.

2.6 Thoroughly blend the waste and record the time when finished.

2.7 Add 162 g of cement to the 200 ml waste sample and mix the sample until the mixture begins to thicken. Record the time from the start of adding the cement to the time that the mixture thickens such that mixing is no longer required (mix time) and the time from the start of adding the cement to the time that the waste is firm to the touch (setup time). Additional cement can be added if necessary to achieve a satisfactory end product. However, if additional cement must be added, the waste solidification efficiency must be redetermined and the waste volume to be added to the solidification liner may have to be adjusted.

NOTE: Steps 2.8 and 2.9 apply only if Envirostone cement is used as the solidification agent. If Portland cement is used, skip to Step 2.10.

2.8 If the waste setup time is less than 30 minutes if a 50 cubic foot liner is being used, is less than 60 minutes if a 142 cu ft liner is being used, or is less than 90 minutes if a larger liner is being used, add 0.05 g of Red Top Retarder to the 200 ml waste sample to adjust the waste setup time to the minimum time requirement for the liner size being used. Vary the amount of retarder added to the sample until the desired setup time is achieved.

2.9 If the waste setup time is longer than operationally desired, add accelerator to the 200 ml waste sample at a rate of Accelerator Wt = 1.0% of Envirostone Wt to adjust the waste setup time to the maximum time. Increase the amount of accelerator to the sample until the desired setup time is achieved.

2.10 Remove the solidified sample from the sample container and visually examine it for evidence of soft, porous or unsolidified areas. The solidified samples should be hard, homogeneous and of uniform coloration.

2.11 Set sample(s) aside for future disposal.

2.12 Continue to mix samples until a satisfactory waste product is produced. If a satisfactory sample cannot be obtained, the operator shall refer to Section 6.2.4 and contact the Customer Service Manager before proceeding.

3.0 FULL SCALE SOLIDIFICATIONS

3.1 After a satisfactory sample solidification has been performed, determine the appropriate amount of additives and cement to be added to the full scale liner solidification using the Solidification Worksheet.

3.2 After determining the appropriate volumes of additives and cement to be added to the Liner, the full scale solidification should be performed using the system operating procedure (Reference 2.4), and the Solidification Operations Logsheet should be filled out.

SAMPLE VERIFICATION WORKSHEET FOR SOLIDIFICATION OF BORIC ACID

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Waste Sample From/By:_____

Waste Temperature:_____F Waste pH:_____Sample Rad Level:_____

Physical Characteristics (viscosity, color, sedimentation, clarity, etc.):

_____

_____

_____

Sample Proportions:

Boric Acid - 24 wt %	_____mL
Chemical Additives	_____
	_____
	_____
Final pH	_____
Cement	_____gm
Accelerator (if required)	_____gm

Blend the waste thoroughly (with pH adjustment additives, retarder, or conditioners, if required) and record the time when finished:_____

Blend the required volume of cement into the waste and record the time when finished:_____

Record the time when the mixture viscosity increases to the point when the mixer is secured:_____(1)

Record the time when the mixture is firm to the touch:_____(2)

SAMPLE VERIFICATION WORKSHEET
FOR SOLIDIFICATION OF BORIC ACID

Sample Results:

Mix time (1):_____minutes

Setup time (2):_____minutes

Free Water, if any:_____

Relative set (soft, firm, very hard):_____

Observations:_____

_____

_____

Sample proportions and solidification results acceptable for calculation of large scale solidification ratios:_____yes _____no

Isotopic results of sample:_____

_____

_____

Solidification Efficiency (Waste Volume/Solidified Volume):_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF BORIC ACID

Operator:_____ Date:_____No.:_____

Utility/Location:_____

Waste Type:_____

Satisfactory Sample Verification No.:_____Date:_____

Solidification Efficiency:_____

Container Model:_____

SEE THE LINER DATA SHEET FOR THE LINER BEING USED

Usable Liner Volume (with 2" safety margin):_____cf

Waste Volume:_____cf

Waste Height in Liner:_____in

Weight of cement to be Added to the Liner (Use the values determined from the Sample Verification Worksheet):

_____gms of cement in sample/_____ml of waste in sample

x 62.38 = _____lbs of cement/cf of Waste

x _____ cf of waste to be added to the liner

= _____ lbs of cement to be added to the liner.

NOTE: Cement weight may be rounded up to the next 100 pound increment thus allowing full 100 pound bags of cement to be added to container.

DRY CHEMICAL ADDITIVES

Chemical Additive:_____
Weight of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____lbs Chemical Additive

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF BORIC ACID

Chemical Additive:_____
Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____ lbs Chemical Additive

WET CHEMICAL ADDITIVES

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____gallons Chemical Additive

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION OPERATIONS LOGSHEET

Operator:_____Date:_____ No.:_____

Utility/Location:_____

Liner Serial No.:_____

Waste Type:_____

Waste From:_____

Solidification Worksheet No:_____

Waste Volume Added:_____ cf:_____ Time Completed:_____

Height of Waste: _____In. From Inside Bottom of Liner

Time Mixer Started:_____ Hydraulic Press:_____

Wet Chemicals Added (List):
_____gal_____time completed_____
_____gal_____time completed_____

Dry Chemicals Added (List):
_____lbs_____time completed_____
_____lbs_____time completed_____

Cement Added:_____ lbs:_____Time Started:_____Complete:_____

Mixer Hydraulic Pressure	PSI	Time
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Time Mixer Secured:_____

Waste Setup Time:_____

Time Fillhead Removed:_____Time Liner Capped:_____

Only Cap Liner With Utility Representative's Approval:_____

Comments and Observations:_____

Date Liner Shipped/Shipment Number:_____/_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

ADDENDUM G

PROCESS CONTROL PROGRAM

FOR SOLIDIFICATION OF BEAD RESINS

OR CLASS A GRANULAR ACTIVATED CARBON

1.0 PREREQUISITES

1.1 A sample solidification shall be performed before attempting to perform a full scale liner solidification.

1.2 The WSG operator shall ensure that a Radiological Work Permit has been issued for the performance of the sample verification activity and that adequate personnel monitoring and radiation detection equipment is on hand.

1.3 The WSG operator shall ensure that all necessary materials and equipment are on hand prior to beginning the sample verification. Suggested equipment and materials for the test are as listed below:

6 - 300 to 500 mL plastic beakers
6 - mixing spatulas
1 - 500 gram capacity scale
50 g - pH Adjustment Additive (Example: Boric Acid, Calcium Hydroxide, etc.)
100 g - Anhydrous Sodium Metsosilicate (Metso)
10 g - Red Top Retarder or equivalent (if required)
1000 g - Envirostone
20 g - Accelerator, Alum or equivalent (if required)
1000 g - Portland Type I or II Cement

NOTE: The waste and chemicals used to solidify the sample waste must be from the same containers or lot numbers to be used in the full scale solidification.

1.4 A one-liter sample shall be taken for solidification in the laboratory from the storage tank or solidification liner. Due to the importance of obtaining a representative sample for use in the verification procedure, the operator shall confirm that the contents of the waste form to be solidified have been adequately mixed and that the sample is a part of a homogeneously mixed waste batch.

2.0 SAMPLE VERIFICATION

2.1 Record the initial pH, radiation level and temperature of the waste samples.

2.2 Provide a waste sample (size to be specified by the plant) to the plant staff for isotopic analysis.

2.3 Place a 200 ml sample of dewatered bead resins or granular activated carbon in the beaker.

2.4 Add water until the liquid level is at or slightly above the resin or activated carbon level.

2.5 Add the appropriate chemical additive, if required, to adjust the pH to between 2 and 6.

2.6 Add 0.1 grams retarder (Red Top), if required.

2.7 Add 25 g of Anhydrous Sodium Metsosilicate, if required.

2.8 Thoroughly blend the waste and record the time when finished.

2.9 Add 117 g of cement to the 200 ml waste sample and mix the sample until the mixture begins to thicken. Record the time from the start of adding the cement to the time that the mixture thickens such that mixing is no longer required (mix time) and the time from the start of adding the cement to the time that the waste is firm to the touch (setup time). Additional cement can be added if necessary to achieve a satisfactory end product. However, if additional cement must be added, the waste solidification efficiency must be redetermined and the waste volume to be added to the solidification liner may have to be adjusted.

NOTE: Steps 2.10 and 2.11 apply only if Envirostone is the solidification agent used. If Portland Cement is used, skip to Step 2.12.

2.10 If the waste setup time is less than 30 minutes if a 50 cubic foot liner is being used, is less than 60 minutes if a 142 cu ft liner is used, or is less than 90 minutes if a larger liner is being used, add 0.05 g of Red Top Retarder to the 200 ml waste sample to adjust the waste setup time to the minimum time requirement for the liner size being used. Vary the amount of retarder added to the sample until the desired setup time is achieved.

2.11 If the waste setup time is longer than operationally desired, add accelerator to the 200 ml waste sample at a rate of Accelerator Wt = 1.0% of Envirostone Wt to adjust the waste setup time to the maximum time. Increase the amount of accelerator to the sample until the desired setup time is achieved.

2.12 Remove the solidified sample from the sample container and visually examine it for evidence of soft, porous or unsolidified areas. The solidified samples should be hard, homogeneous and of uniform coloration.

2.13 Set sample(s) aside for future disposal.

2.14 Continue to mix samples until a satisfactory waste product is produced. If a satisfactory sample cannot be obtained, the operator shall refer to Section 6.2.4 and contact the Customer Service Manager before proceeding.

3.0 FULL SCALE SOLIDIFICATIONS

3.1 After a satisfactory sample solidification has been performed, determine the appropriate amount of additives and cement to be added to the full scale liner solidification using the Solidification Worksheet.

3.2 After determining the appropriate volumes of additives and cement to be added to the Liner, the full scale solidification should be performed using the system operating procedure (Reference 2.4), and the Solidification Operations Logsheet should be filled out.

SAMPLE VERIFICATION WORKSHEET FOR SOLIDIFICATION OF BEAD RESINS OR GRANULAR ACTIVATED CARBON

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Waste Sample From/By:_____

Waste Temperature:_____F Waste pH:_____Sample Rad Level:_____

Physical Characteristics (viscosity, color, sedimentation, clarity, etc.):

_____

_____

_____

Sample Proportions:

Bead Resin or Activated Carbon	_____mL
Chemical Additives	_____
	_____
	_____
Final pH	_____
Cement	_____gm
Accelerator (if required)	_____gm

Blend the waste thoroughly (with pH adjustment additives, retarder, or conditioners, if required) and record the time when finished:_____

Blend the required volume of cement into the waste and record the time when finished:_____

Record the time when the mixture viscosity increases to the point when the mixer is secured:_____(1)

Record the time when the mixture is firm to the touch:_____(2)

SAMPLE VERIFICATION WORKSHEET FOR SOLIDIFICATION OF BEAD RESINS OR GRANULAR ACTIVATED CARBON

Sample Results:

Mix time (1):_____minutes

Setup time (2):_____minutes

Free Water, if any:_____

Relative set (soft, firm, very hard):_____

Observations:_____

_____

_____

Sample proportions and solidification results acceptable for calculation of large scale solidification ratios:_____yes _____no

Isotopic results of sample:_____

_____

_____

Solidification Efficiency (Waste Volume/Solidified Volume):_____

_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION WORKSHEET FOR SOLIDIFICATION OF BEAD RESINS OR GRANULAR ACTIVATED CARBON

Operator:_____ Date:_____No.:_____

Utility/Location:_____

Waste Type:_____

Satisfactory Sample Verification No.:_____Date:_____

Solidification Efficiency:_____

Container Model:_____

SEE THE LINER DATA SHEET FOR THE LINER BEING USED

Usable Liner Volume (with 2" safety margin):_____cf

Waste Volume Beads or Carbon:_____cf

Waste Height in Liner:_____in

Weight of cement to be Added to the Liner (Use the values determined from the Sample Verification Worksheet):

_____gms of cement in sample/_____ml of waste in sample

x 62.38 = _____lbs of cement/cf of Waste

x _____ cf of waste to be added to the liner

= _____ lbs of cement to be added to the liner.

NOTE: Cement weight may be rounded up to the next 100 pound increment thus allowing full 100 pound bags of cement to be added to container.

DRY CHEMICAL ADDITIVES

Chemical Additive:_____
Weight of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____lbs Chemical Additive

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF BEAD RESINS
OR GRANULAR ACTIVATED CARBON

Chemical Additive:_____
Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____ lbs Chemical Additive

WET CHEMICAL ADDITIVES

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____gallons Chemical Additive

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION OPERATIONS LOGSHEET

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Liner Serial No.:_____

Waste Type:_____

Waste From:_____

Solidification Worksheet No:_____

Waste Volume Added:_____ cf:_____ Time Completed:_____

Height of Waste: _____In. From Inside Bottom of Liner

Time Mixer Started:_____ Hydraulic Press:_____

Wet Chemicals Added (List):
_____gal_____time completed_____
_____gal_____time completed_____

Dry Chemicals Added (List):
_____lbs_____time completed_____
_____lbs_____time completed_____

Cement Added:_____ lbs:_____Time Started:_____Complete:_____

Mixer Hydraulic Pressure	PSI	Time
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Time Mixer Secured:_____

Waste Setup Time:_____

Time Fillhead Removed:_____Time Liner Capped:_____

Only Cap Liner With Utility Representative's Approval:_____

Comments and Observations:_____

Date Liner Shipped/Shipment Number:_____/_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

ADDENDUM H

PROCESS CONTROL PROGRAM

FOR SOLIDIFICATION OF POWDERED RESINS

1.0 PREREQUISITES

1.1 A sample solidification shall be performed before attempting to perform a full scale liner solidification.

1.2 The WSG operator shall ensure that a Radiological Work Permit has been issued for the performance of the sample verification activity and that adequate personnel monitoring and radiation detection equipment is on hand.

1.3 The WSG operator shall ensure that all necessary materials and equipment are on hand prior to beginning the sample verification. Suggested equipment and materials for the test are as listed below:

6 - 300 to 500 mL plastic beakers
6 - mixing spatulas
1 - 500 gram capacity scale
100 g - Anhydrous Sodium Metsosilicate (Metso)
10 g - Red Top Retarder or equivalent (if required)
1000 g - Envirostone
20 g - Accelerator, Alum or equivalent (if required)
1000 g - Portland Type I or II Cement

NOTE: The waste and chemicals used to solidify the sample waste must be from the same containers or lot numbers to be used in the full scale solidification.

1.4 A one-liter sample shall be taken for solidification in the laboratory for each separate batch of waste to be processed. The operator may choose to take the samples from the storage tanks to be solidified in the liner, or may take the sample from the liner directly, after the waste has been transferred to the liner. Due to the importance of obtaining a representative sample for use in the verification procedure, the operator shall confirm that the contents of the waste form to be solidified have been adequately mixed and that the sample is a part of a homogeneously mixed waste batch.

2.0 SAMPLE VERIFICATION

2.1 Record the information obtained during sample verification on the Sample Verification Worksheet.

2.2 Provide a waste sample (size to be specified by the plant) to the plant staff for isotopic analysis.

2.3 Place a 200 ml sample of waste in a the beaker so that the resins are at the 200 ml level with the liquid solution just covering the resins. This will necessitate allowing the resins to settle, then pouring off some of the liquid solution.

2.4 Record the initial pH, radiation level and temperature of the waste sample.

2.5 Add tap water in order to bring the waste sample volume up to 253 ml.

2.6 Add 25 g of Anhydrous Sodium Metsosilicate and mix until dissolved, if Portland Cement is to be used as the solidification agent.

2.7 Add 93 g of cement to the 253 ml waste sample and mix the sample until the mixture begins to thicken. Record the time from the start of adding the cement to the time that the mixture thickens such that mixing is no longer required (mix time) and the time from the start of adding the cement to the time that the waste is firm to the touch (setup time). Additional cement can be added if necessary to achieve a satisfactory end product. However, if additional cement must be added, the waste solidification efficiency must be redetermined and the waste volume to be added to the solidification liner may have to be adjusted.

NOTE: Steps 2.8 and 2.9 apply only if Envirostone Cement is used. If Portland Cement is used, skip to Step 2.10.

2.8 If the waste setup time is less than 30 minutes if a 50 cubic foot liner is being used, is less than 60 minutes if a 142 cu ft liner is being used, or is less than 90 minutes if a larger liner is being used, add Red Top Retarder to the 200 ml waste sample at a rate of Retarder Wt = 0.05% of Envirostone Wt to adjust the waste setup time to the minimum time requirement for the liner size being used. Increase the amount of retarder added to the sample until the desired setup time is achieved.

2.9 If the waste setup time is longer than operationally desired, add accelerator to the 200 ml waste sample at a rate of Accelerator Wt = 1.0% of Envirostone Wt to adjust the waste setup time to the maximum time. Increase the amount of accelerator to the sample until the desired setup time is achieved.

2.10 Continue to mix samples until a satisfactory waste product is produced. If a satisfactory sample cannot be obtained, the operator shall refer to Section 6.2.4 and contact the Customer Service Manager before proceeding.

2.11 Remove the solidified sample from the sample container and visually examine it for evidence of soft, porous or unsolidified areas. The solidified sample should be hard, homogeneous and of uniform coloration.

2.12 Set sample(s) aside for future disposal.

3.0 FULL SCALE SOLIDIFICATION

3.1 After a satisfactory sample solidification has been performed, determine the appropriate amount of additives and cement to be added to the full scale liner solidification using the Solidification Worksheet.

3.2 After determining the appropriate volumes of additive and cement to be added to the Liner, the full scale solidification should be performed using the system operating procedure (Reference 2.4), and the Solidification Operations Logsheet should be filled out.

SAMPLE VERIFICATION WORKSHEET FOR SOLIDIFICATION OF POWDERED RESINS

Operator:_____ Date:_____ No.:_____

Utility/Location:_____

Waste Type:_____

Waste Sample From/By:_____

Waste Temperature:_____F Waste pH:_____Sample Rad Level:_____

Physical Characteristics (viscosity, color, sedimentation, clarity, etc.):

_____

_____

_____

Sample Proportions:

Powdered Resin (Dewatered)	_____mL
Volume with water added	_____mL
Chemical Additives	_____
	_____
	_____
Final pH	_____
Cement	_____gm
Accelerator (if required)	_____gm

Blend the water added and any Chemical Additives thoroughly into the waste before adding the cement.

Blend the required volume of cement into the waste and record the time the addition starts:_____

Record the time when the mixture viscosity increases to the point when the mixer is secured:_____(1)

Record the time when the mixture is firm to the touch:_____(2)

SAMPLE VERIFICATION WORKSHEET FOR SOLIDIFICATION OF POWDERED RESINS

Sample Results:

Mix time (1):_____minutes

Setup time (2):_____minutes

Free Water, if any:_____

Relative set (soft, firm, very hard):_____

Observations:_____

_____

_____

Sample proportions and solidification results acceptable for calculation of large scale solidification ratios:_____yes _____no

Isotopic results of sample:_____

_____

_____

Solidification Efficiency (Waste Volume/Solidified Volume):_____

_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF POWDERED RESINS

Operator:_____ Date:_____No.:_____

Utility/Location:_____

Waste Type:_____

Satisfactory Sample Verification No.:_____Date:_____

Solidification Efficiency:_____

Container Model:_____

SEE THE LINER DATA SHEET FOR THE LINER BEING USED

Usable Liner Volume (with 2" safety margin):_____cf

Waste Volume:_____cf

Waste Height in Liner:_____in
(Waste Full/Level Bubbler Tube to be set at this height)

Maximum Waste and Water Added Height in Liner:_____in
(Waste & Water Added Level Bubbler Tube to be set at this Height)

Weight of cement to be added to liner (Use the values determined from the Sample Verification Worksheet):

_____gms of cement in sample/_____ml of waste in sample

x 62.38 = _____lbs of cement/cf of Waste

x _____ cf of waste (resin only) to be added to the liner

= _____ lbs of cement to be added to the liner.

NOTE: Cement weight may be rounded up to the next 100 pound increment thus allowing full 100 pound bags of cement to be added to container.

DRY CHEMICAL ADDITIVES

Chemical Additive:_____
Weight of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____lbs Chemical Additive

SOLIDIFICATION WORKSHEET
FOR SOLIDIFICATION OF POWDERED RESINS

Chemical Additive:_____
Weight of Chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____gms chemical in sample/_____gms cement in sample

x_____lbs cement to be added to the liner

=_____ lbs Chemical Additive

WET CHEMICAL ADDITIVES

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____gallons Chemical Additive

Chemical Additive:_____
Volume of chemical to be added to the liner (use the values from the Sample Verification Worksheet):

_____ml chemical in sample/_____ml waste in sample

x_____cf waste to be added to the liner

x 7.48 = _____ gallons Chemical Additive

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____

SOLIDIFICATION OPERATIONS LOGSHEET

Operator:_____Date:_____ No.:_____

Utility/Location:_____

Liner Serial No.:_____

Waste Type:_____

Waste From:_____

Solidification Worksheet No:_____

Waste Volume Added:_____ cf:_____ Time Completed:_____

Height of Waste: _____In. From Inside Bottom of Liner

Height of Waste & Water Added:_____ Inches From Inside Bottom of Liner

Time Mixer Started:_____ Hydraulic Press:_____

Wet Chemicals Added (List):
_____gal_____time completed_____
_____gal_____time completed_____

Dry Chemicals Added (List):
_____lbs_____time completed_____
_____lbs_____time completed_____

Cement Added:_____ lbs:_____Time Started:_____Complete:_____

Mixer Hydraulic Pressure	PSI	Time
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Time Mixer Secured:_____ Waste Setup Time:_____

Time Fillhead Removed:_____Time Liner Capped:_____

Only Cap Liner With Utility Representative's Approval:_____

Comments and Observations:_____

Date Liner Shipped/Shipment Number:_____/_____

Operator Signature:_____ Date:_____

Utility Representative Signature:_____

Title:_____ Date:_____