ALABAMA POWER COMPANY

FARLEY NUCLEAR PLANT UNIT NO. ONE

LICENSE NO. NPF-2

AND

FARLEY NUCLEAR PLANT UNIT NO. TWO

LICENSE NO. NPF-8

SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JAN. 1, 1984 THROUGH JUNE 30, 1984

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A. INTRODUCTION

This Semi-annual radioactive release report, for the period Jan. 1 through June 30, 1984, is submitted in accordance with Appendix A of License Nos. NPF-2 and NPF-8. Appendix A will hereinafter be referred to as the Standard Technical Specifications or STS.

A single submittal is made for both units which combines those sections that are common. Separate tables of releases and release totals are included where separate processing systems exist.

B. SUPPLEMENTAL INFORMATION FOR EFFLUENT AND WASTE DISPOSAL

1. Regulatory Limits

a. Fission and Activation Gases

The release rate limit at any time of noble gases to areas at or beyond the site boundary shall be such that

$$10^{6}\,\frac{\text{pCi}}{\text{uCi}}\sum_{i}^{14} K_i \left[\sum_{v}^{2}\left[\overline{(X/Q)}_v\, Q_{iv}\right]\right] < 500 \text{ mrem/yr}$$

and

$$10^{6}\,\frac{\text{pCi}}{\text{uCi}}\sum_{i}^{14}\left[(L_i + 1.1\, M_i)\sum_{v}^{2}\left[\overline{(X/Q)}_v\, Q_{iv}\right]\right] < 3000 \text{ mrem/yr}$$

where the terms are defined in the ODCM.

b. Iodines and Particulates

The release rate limits in the grass-cow-milk pathway for the sampling period of all radioiodines and radioactive materials in particulate form and radionuclides other than noble gases released to the environs as part of the gaseous wastes from the site shall be such that

$$10^{6}\,\frac{\text{pCi}}{\text{uCi}}\sum_{i}^{18}\left[P_i\sum_{v}^{2}\left[\overline{(X/Q)}_{mv}\, Q_{iv}\right]\right] < 6.3 \text{ mrem/yr}$$

where the terms are defined in the ODCM.

c. Liquid Effluents

The concentration of radioactive materials released in liquid effluents to unrestricted areas from all reactors at the site shall not exceed at any time the values specified in 10 CFR Part 20, Appendix B, Table II, Column 2. The concentration of dissolved or entrained noble gases, released in liquid effluents to unrestricted areas from all reactors at the site, shall not exceed at any time 2 E-4 uCi/ml in water.

2. Maximum Permissible Concentrations

   a. Airborne - The maximum permissible concentration of radioactive materials in gaseous effluents is limited by the dose rate restrictions of 10CFR20. In this case, the maximum permissible concentrations are actually determined by the dose factors in the ODCM.

   b. Liquid - 10 CFR Part 20, Appendix B Table II, Column 2.*

      *NOTE: The MPC chosen is the most conservative value of either the soluble or insoluble MPC for each isotope.

3. Average Energy
   Not Applicable for Farley's STS.

4. Measurements and Approximations of Total Activity

   The following discussion details the methods used to measure and approximate total activity for the following:

   a. Fission and Activation Gases
   b. Iodines and Particulates
   d. Liquid Effluents

   Tables 5 and 6 give sampling frequencies and minimum detectable concentration requirements for the analysis of liquid and gaseous effluent streams.

   Values in the attached tables given as zero do not mean that the nuclides were not present. A zero indicates that the nuclide was not present at levels greater than the sensitivity requirements shown in Tables 5 and 6. For some nuclides, lower detection limits than required may be readily achievable; when a nuclide is measured below its stated limits, it is reported.

   Fission and Activation Gases

   The following noble gases are considered in evaluating gaseous airborne discharge:

Kr-87	Xe-133
Kr-88	Xe-135
Xe-133m	Xe-138

Periodic grab samples from plant effluent streams are analyzed by a computerized pulse height analyzer system utilizing high resolution germanium detectors. (See Table 6 for sampling and analytical requirements). Isotopic values thus obtained are used for release rate calculations as given in section 1a of this report. Only those nuclides that are detected are used in this computation. During the period between grab samples, the amount of radioactivity released is based on the effluent monitor readings. Monitors are assigned a calibration factor based upon the last isotopic analysis using the following relationship:

$CF_i = A_i / m$, where

CF_i = isotopic calibration factor for isotope i.

A_i = concentration of isotope in the grab sample, in uCi/ml.

m = net monitor reading associated with the effluent stream.

m = net monitor reading associated with the effluent stream.

These calibration factors along with the hourly effluent monitor readings are inputs to the laboratory computer where the release rates for individual nuclides are calculated and stored.

To ensure isotopic distributions do not change significantly during major operational occurrences, the frequency of grab sampling is increased to satisfy the requirements of footnotes b & d of Table 4.11-2, "Radioactive Gaseous Waste Sampling and Analysis Program", (STS Table 4.11-2).

Iodines and Particulates

The radioiodines and radioactive materials in particulate forms to be considered are:

Mn-54	I-131
Fe-59	I-133
Co-58	Cs-134
Co-60	Cs-137
Zn-65	Ce-141
Sr-89	Ce-144
Sr-90	* H-3
Mo-99	

Other nuclides with half-lives greater than 8 days which are identified and measured are also considered. The MDC's will vary and are not required to meet the MDC limits of those isotopes listed specifically.

* Tritium is considered in the gaseous or water vapor form.

Continuous Releases

Continuous Realeases: Continuous sampling is performed on the continuous release points (i.e. the Plant Vent Stack, Containment Purge and the Turbine Building Vent). Particulate material is collected by filtration. Periodically these filters are removed and analyzed on the pulse height analyzer to identify and quantify radioactive materials collected on the filters. Particulate filters are then analyzed for gross alpha and strontium as required. Gross alpha determinations are made using a 2 pi gas flow proportional counter. Sr-89 and 90 values are obtained by chemical separation and subsequent analysis using 2 pi gas flow proportional counters.

Batch Releases: The processing of batch type releases (from Containment Waste Gas Decay Tanks) is analogous to continuous releases, except that the release is not commenced until grab samples have been obtained and analyzed.

Liquid Effluents

The radionuclides listed below are considered when evaluating liquid effluents:

Mn-54	I-131
Fe-59	Cs-134
Co-58	Cs-137
Co-60	Ce-141
Zn-65	Ce-144
Sr-89	Mo-99
Sr-90	Fe-55
	H-3

Batch Releases: Representative pre-release grab samples are obtained and analyzed per Table 5. Isotopic analyses are performed using the computerized pulse height analysis system previously described. Aliquots of each pre-release sample proportional to the waste volume released are composited in accordance with requirements in Table 5. Strontium and Iron determinations are made by performing a chemical separation and counting the isotope thus separated using a 2 pi gas flow proportional counter. Gross beta and gross alpha determinations are made using 2 pi gas flow proportional counters. Tritium concentrations are determined by using liquid scintillation techniques. Dissolved gases are determined employing grab sampling techniques and then counting on the pulse height analyzer.

Continuous releases: Continuous releases (from the Steam Generator Blowdown) are analogous to that of the batch releases except that they are analyzed on a weekly composite basis per Table 5.

UNIT # 1

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5. Batch Release

a. Liquid	Quarter 1	Quarter 2
1. Number of batch releases:	136	111
2. Total time period for releases:	11143 min.	9831 min.
3. Maximum time period for a release:	181 min.	186 min.
4. Average time period for a release:	82 min.	89 min.
5. Minimum time period for a release:	53 min.	50 min.
6. Average stream flow during periods of release of effluent into a flowing stream:	*1.15E4 cfs	*1.15E4 cfs

b. Gaseous	Quarter 1	Quarter 2
1. Number of releases:	4	4
2. Total time period for releases:	3720 min.	2640 min.
3. Maximum time period for a release:	1440 min.	900 min.
4. Average time period for a release:	930 min.	660 min.
5. Minimum time period for a release:	660 min.	420 min.

6. Abnormal Releases

a. Liquid	
1. Number of releases:	None
2. Total activity released:	N/A

b. Gaseous	
1. Number of releases:	None
2. Total activity released:	N/A

* Annual Average River Flow Rate.

UNIT # 2

1984

5. Batch Release

a. Liquid	Quarter 1	Quarter 2
1. Number of batch releases:	74	36
2. Total time period for releases:	6527 min.	3046 min.
3. Maximum time period for a release:	[illegible] min.	157 min.
4. Average time period for a release:	88 min.	85 min.
5. Minimum time period for a release:	20 min.	48 min.
6. Average stream flow during periods of release of effluent into a flowing stream:	*1.15E4 cfs	*1.15E4 cfs

b. Gaseous	Quarter 1	Quarter 2
1. Number of releases:	3	0
2. Total time period for releases:	1860 min.	0 min.
3. Maximum time period for a release:	900 min.	0 min.
4. Average time period for a release:	620 min.	0 min.
5. Minimum time period for a release:	300 min.	0 min.

6. Abnormal Releases

a. Liquid	
1. Number of releases:	None
2. Total activity released:	N/A

b. Gaseous	
1. Number of releases:	None
2. Total activity released:	N/A

* Annual Average River Flow Rate.

7. Estimate of Total Error

a. Liquid

1. The maximum error associated with volume and flow measurements, based upon plant calibration practice is estimated to be + or - 10%.

2. The average error associated with counting is estimated to be less than + or - 15%.

b. Gaseous

1. The maximum errors associated with monitor readings, sample flow, vent flow, sample collection, monitor calibration and laboratory procedure are collectively estimated to be:

Fission and Activation Gases	Iodines	Particulates	Tritium
75%	60%	50%	45%

2. The average error associated with counting is estimated to be:

Fission and Activation Gases	Iodines	Particulates	Tritium
6%	18%	19%	12%

c. Solid Radwaste

The error involved in determining the contents of solid radwaste shipments is estimated to be less than + or - 15%.

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8. Solid Waste

See Table 3

9. Radiological Impact On Man

a. Water Related Exposure Pathways

	1st Quarter	2nd Quarter
Total Body	= 1.3E-02 mrem	2.4E-03 mrem
Bone	= 1.7E-02 mrem	2.0E-03 mrem
Liver	= 1.8E-02 mrem	3.4E-03 mrem
Thyroid	= 3.9E-03 mrem	3.8E-04 mrem
Kidney	= 9.9E-03 mrem	1.5E-03 mrem
Lungs	= 2.8E-03 mrem	9.4E-04 mrem
GI Tract	= 2.5E-02 mrem	5.4E-02 mrem

b. Gaseous Related Exposure Pathways

	1st Quarter	2nd Quarter
Total Body	= 6.9E-02 mrem	3.2E-02 mrem
Skin	= 1.4E-01 mrem	4.5E-02 mrem

c. Particulate and Iodine

	1st Quarter	2nd Quarter
Organ Dose	= 2.5E-02 mrem	5.3E-03 mrem

8. Solid Waste

See Table 3

9. Radiological Impact On Man

a. Water Related Exposure Pathways

	1st Quarter	2nd Quarter
Total Body	= 1.2E-02 mrem	5.2E-03 mrem
Bone	= 1.2E-02 mrem	4.1E-03 mrem
Liver	= 1.7E-02 mrem	7.2E-03 mrem
Thyroid	= 1.5E-03 mrem	4.2E-04 mrem
Kidney	= 6.8E-03 mrem	2.5E-03 mrem
Lungs	= 2.4E-03 mrem	1.5E-03 mrem
GI Tract	= 6.1E-02 mrem	1.3E-02 mrem

b. Gaseous Related Exposure Pathways

	1st Quarter	2nd Quarter
Total Body	= 1.8E-02 mrem	8.2E-03 mrem
Skin	= 2.4E-02 mrem	1.3E-02 mrem

c. Particulate and Iodine

	1st Quarter	2nd Quarter
Organ Dose	= 1.1E-02 mrem	2.3E-02 mrem

10. Meteorological Data

See Tables, "Cumulative Joint Frequency Distribution".

Continuous Release Mode:
1st Quarter, 1984 : 4A-CQ1
2nd Quarter, 1984 : 4A-CQ2

Batch Release Mode (Units 1 & 2)
1st Quarter, 1984 : 4A-1BQ1 & 4A-2BQ1
2nd Quarter, 1984 : 4A-1BQ2 & 4A-2BQ2

11. Minimum Detectable Concentration (MDC)

Detectable limits for activity analyses are based upon the technical feasibility and on the potential significance in the environment of the quantities released. However, in practice, when an isotope's a posteriori MDC could not be met due to other nuclides being present in much greater concentrations, the a priori MDC as defined in the STS Table 4.11-1 a. is relied upon.

TABLE 1A-1Q1

GASEOUS EFFLUENTS--SUMMATION OF ALL RELEASES

Farley Unit 1 - 1st Quarter, 1984

	UNITS	QTR 1	Est Error
A. Fission & activation gases:			
1. Total release	Ci	1.35E 03	3.87E 01
2. Average Release rate	uCi/sec	1.72E 02	
3. % of Technical specification	%	3.63E-03*	
	%	8.22E-03**	
B. Iodines			
1. Total iodine-131	Ci	1.95E-03	9.22E-05
2. Average Release rate	uCi/sec	2.48E-04	
3. % of Technical specification	%	7.56E-07***	
C. Particulates			
1. Particulates with T1/2>8 days	Ci	8.53E-06	1.07E-06
2. Average Release rate	uCi/sec	1.08E-06	
3. % of Technical specification	%	4.42E-08***	
4. Gross alpha radioactivity	Ci	0.00E 00	
D. Tritium			
1. Total release	Ci	5.18E 00	1.03E-01
2. Average Release rate	uCi/sec	6.58E-01	
3. % of Technical specification	%	6.10E-08***	

*: Whole body limit (<500 mrem/yr)
**: Skin limit (<3000 mrem/yr)
***: % of 6.3 mrem/yr for all 18 isotopes

TABLE 1A-1Q2

GASEOUS EFFLUENTS--SUMMATION OF ALL RELEASES

Farley Unit 1 - 2nd Quarter, 1984

	UNITS	QTR 2	Est Error
A. Fission & activation gases:			
1. Total release	Ci	2.74E 02	1.86E 01
2. Average Release rate	uCi/sec	3.48E 01	
3. % of Technical specification	%	1.55E-03*	
	%	3.29E-03**	
B. Iodines			
1. Total iodine-131	Ci	3.55E-04	2.00E-05
2. Average Release rate	uCi/sec	4.52E-05	
3. % of Technical specification	%	1.38E-07***	
C. Particulates			
1. Particulates with T1/2>8 days	Ci	5.75E-10	5.43E-10
2. Average Release rate	uCi/sec	7.32E-11	
3. % of Technical specification	%	1.12E-09***	
4. Gross alpha radioactivity	Ci	0.00E 00	
D. Tritium			
1. Total release	Ci	8.53E 00	1.14E-01
2. Average Release rate	uCi/sec	1.08E 00	
3. % of Technical specification	%	1.00E-07***	

*: Whole body limit (<500 mrem/yr)
**: Skin limit (<3000 mrem/yr)
***: % of 6.3 mrem/yr for all 18 isotopes

TABLE 1A-2Q1

GASEOUS EFFLUENTS--SUMMATION OF ALL RELEASES

Farley Unit 2 - 1st Quarter, 1984

	UNITS	QTR 1	Est Error
A. Fission & activation gases:			
1. Total release	Ci	3.59E 02	1.92E 01
2. Average Release rate	uCi/sec	4.56E 01	
3. % of Technical specification	%	1.24E-03*	
	%	2.36E-03**	
B. Iodines			
1. Total iodine-131	Ci	7.45E-04	6.13E-05
2. Average Release rate	uCi/sec	9.47E-05	
3. % of Technical specification	%	2.89E-07***	
C. Particulates			
1. Particulates with T1/2>8 days	Ci	1.02E-05	3.09E-06
2. Average Release rate	uCi/sec	1.30E-06	
3. % of Technical specification	%	7.40E-08***	
4. Gross alpha radioactivity	Ci	0.00E 00	
D. Tritium			
1. Total release	Ci	4.10E 01	1.50E-01
2. Average Release rate	uCi/sec	5.21E 00	
3. % of Technical specification	%	4.95E-07***	

*: Whole body limit (<500 mrem/yr)
**: Skin limit (<3000 mrem/yr)
***: % of 6.3 mrem/yr for all 18 isotopes

TABLE 1A-2Q2

GASEOUS EFFLUENTS--SUMMATION OF ALL RELEASES

Farley Unit 2 - 2nd Quarter, 1984

	UNITS	QTR 2	Est Error
A. Fission & activation gases:			
1. Total release	Ci	1.92E 02	1.83E 01
2. Average Release rate	uCi/sec	2.44E 01	
3. % of Technical specification	%	1.59E-03*	
	%	2.75E-03**	
B. Iodines			
1. Total iodine-131	Ci	2.77E-04	3.19E-05
2. Average Release rate	uCi/sec	3.53E-05	
3. % of Technical specification	%	1.07E-07***	
C. Particulates			
1. Particulates with T1/2>8 days	Ci	4.87E-05	3.51E-05
2. Average Release rate	uCi/sec	6.19E-06	
3. % of Technical specification	%	1.01E-07***	
4. Gross alpha radioactivity	Ci	0.00E 00	
D. Tritium			
1. Total release	Ci	5.45E 01	3.10E-01
2. Average Release rate	uCi/sec	6.93E 00	
3. % of Technical specification	%	6.42E-07***	

*: Whole body limit (<500 mrem/yr)
**: Skin limit (<3000 mrem/yr)
***: % of 6.3 mrem/yr for all 18 isotopes

TABLE 1B-1Q1

GASEOUS EFFLUENTS--ELEVATED RELEASE

Farley Unit 1 - 1st Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 1	BATCH Mode QTR# 1
1. Fission gases			
Ar-41	Ci	3.03E-01	0.00E 00
Xe-135M	Ci	2.67E-01	0.00E 00
Kr-85	Ci	0.00E 00	2.86E 00
Xe-138	Ci	0.00E 00	0.00E 00
Kr-87	Ci	2.23E-01	0.00E 00
Kr-85M	Ci	9.66E-01	4.18E-02
Xe-135	Ci	2.27E 02	0.00E 00
Xe-133M	Ci	7.02E 00	3.85E-01
Kr-88	Ci	6.54E-01	0.00E 00
Xe-131M	Ci	0.00E 00	1.18E 00
Xe-133	Ci	9.88E 02	1.04E 02
Total for period	Ci	1.23E 03	1.08E 02
2. Iodines			
I-133	Ci	7.20E-05	5.66E-09
I-131	Ci	1.93E-03	5.29E-06
Total for period	Ci	2.00E-03	5.29E-06
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	3.60E-09
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	3.22E-06	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
* I-133	Ci	9.33E-05	5.66E-09
I-131	Ci	0.00E 00	5.29E-06
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	9.66E-05	5.30E-06

* Isotope with half-life less than 8 days

TABLE 1B-1Q2

GASEOUS EFFLUENTS--ELEVATED RELEASE

Farley Unit 1 - 2nd Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 2	BATCH Mode QTR# 2
1. Fission gases			
Kr-85	Ci	0.00E 00	2.15E-01
Xe-138	Ci	9.41E 00	0.00E 00
Kr-87	Ci	4.42E 00	0.00E 00
Xe-135	Ci	8.90E 01	1.36E-02
Xe-133M	Ci	0.00E 00	8.13E-03
Kr-88	Ci	0.00E 00	0.00E 00
Xe-133	Ci	1.65E 02	3.22E-01
Total for period	Ci	2.68E 02	5.59E-01
2. Iodines			
I-133	Ci	2.46E-05	0.00E 00
I-131	Ci	3.49E-04	0.00E 00
Total for period	Ci	3.74E-04	0.00E 00
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
* I-133	Ci	0.00E 00	0.00E 00
I-131	Ci	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	0.00E 00	0.00E 00

* Isotope with half-life less than 8 days

TABLE 1B-2Q1

GASEOUS EFFLUENTS--ELEVATED RELEASE

Farley Unit 2 - 1st Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 1	BATCH Mode QTR# 1
1. Fission gases			
Ar-41	Ci	1.41E 01	0.00E 00
Kr-85	Ci	0.00E 00	8.88E-01
Xe-138	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Kr-85M	Ci	0.00E 00	9.91E-04
Xe-135	Ci	1.95E 01	5.10E-02
Xe-133M	Ci	0.00E 00	4.92E-01
Kr-88	Ci	0.00E 00	0.00E 00
Xe-131M	Ci	0.00E 00	1.03E 00
Xe-133	Ci	2.87E 02	3.39E 01
Total for period	Ci	3.21E 02	3.64E 01
2. Iodines			
I-133	Ci	6.44E-05	0.00E 00
I-131	Ci	7.45E-04	0.00E 00
Total for period	Ci	8.09E-04	0.00E 00
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	5.37E-06	0.00E 00
Cs-134	Ci	9.99E-07	0.00E 00
* I-133	Ci	0.00E 00	0.00E 00
I-131	Ci	3.83E-06	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	1.02E-05	0.00E 00

* Isotope with half-life less than 8 days

TABLE 1B-2Q2

GASEOUS EFFLUENTS--ELEVATED RELEASE

Farley Unit 2 - 2nd Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 2	BATCH Mode QTR# 2
1. Fission gases			
Ar-41	Ci	2.46E 01	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Xe-135	Ci	3.95E 01	0.00E 00
Xe-133M	Ci	0.00E 00	0.00E 00
Kr-89	Ci	5.45E-02	0.00E 00
Kr-88	Ci	4.64E-02	0.00E 00
Xe-133	Ci	1.23E 02	0.00E 00
Total for period	Ci	1.88E 02	0.00E 00
2. Iodines			
I-133	Ci	1.69E-05	0.00E 00
I-131	Ci	2.76E-04	0.00E 00
Total for period	Ci	2.92E-04	0.00E 00
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	6.19E-06	0.00E 00
Cs-134	Ci	1.47E-06	0.00E 00
Ba-140	Ci	2.97E-05	0.00E 00
* I-133	Ci	0.00E 00	0.00E 00
I-131	Ci	5.83E-06	0.00E 00
Cr-51	Ci	5.28E-06	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	4.85E-05	0.00E 00

* Isotope with half-life less than 8 days

TABLE 1C-1Q1

GASEOUS EFFLUENTS--GROUND RELEASE

Farley Unit 1 - 1st Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 1	BATCH Mode QTR# 1
1. Fission gases			
Xe-135M	Ci	4.81E-03	0.00E 00
Kr-85	Ci	0.00E 00	1.07E-01
Xe-138	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Kr-85M	Ci	1.74E-02	9.40E-04
Xe-135	Ci	3.18E 00	0.00E 00
Xe-133M	Ci	1.15E-01	3.97E-03
Kr-88	Ci	0.00E 00	0.00E 00
Xe-131M	Ci	0.00E 00	3.66E-02
Xe-133	Ci	1.13E 01	1.85E 00
Total for period	Ci	1.46E 01	2.00E 00
2. Iodines			
I-133	Ci	0.00E 00	0.00E 00
I-131	Ci	1.61E-05	1.55E-08
Total for period	Ci	1.61E-05	1.55E-08
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	5.95E-13
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	2.98E-09	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	1.49E-09	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
* I-133	Ci	2.03E-06	0.00E 00
I-131	Ci	2.69E-09	1.46E-08
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	2.04E-06	1.46E-08

* Isotope with half-life less than 8 days

TABLE 1C-1Q2

GASEOUS EFFLUENTS--GROUND RELEASE

Farley Unit 1 - 2nd Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 2	BATCH Mode QTR# 2
1. Fission gases			
Kr-85	Ci	0.00E 00	4.24E-04
Xe-138	Ci	1.99E-01	0.00E 00
Kr-87	Ci	9.35E-02	0.00E 00
Xe-135	Ci	1.70E 00	5.03E-06
Xe-133M	Ci	0.00E 00	1.45E-05
Kr-88	Ci	0.00E 00	0.00E 00
Xe-133	Ci	3.09E 00	8.04E-04
Total for period	Ci	5.08E 00	1.25E-03
2. Iodines			
I-133	Ci	1.95E-07	0.00E 00
I-131	Ci	5.84E-06	0.00E 00
Total for period	Ci	6.03E-06	0.00E 00
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	5.75E-10	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
* I-133	Ci	0.00E 00	0.00E 00
I-131	Ci	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	5.75E-10	0.00E 00

* Isotope with half-life less than 8 days

TABLE 1C-2Q1

GASEOUS EFFLUENTS--GROUND RELEASE

Farley Unit 2 - 1st Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 1	BATCH Mode QTR# 1
1. Fission gases			
Ar-41	Ci	1.01E-01	0.00E 00
Kr-85	Ci	0.00E 00	3.12E-03
Xe-138	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Xe-135	Ci	6.83E-02	1.22E-03
Xe-133M	Ci	0.00E 00	1.17E-02
Kr-88	Ci	0.00E 00	0.00E 00
Xe-131M	Ci	0.00E 00	1.84E-02
Xe-133	Ci	7.80E-01	7.27E-01
Total for period	Ci	9.48E-01	7.61E-01
2. Iodines			
I-133	Ci	6.44E-10	0.00E 00
I-131	Ci	3.32E-07	0.00E 00
Total for period	Ci	3.33E-07	0.00E 00
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	5.84E-10	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	4.50E-08	0.00E 00
Cs-134	Ci	5.25E-10	0.00E 00
* I-133	Ci	0.00E 00	0.00E 00
I-131	Ci	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	4.61E-08	0.00E 00

* Isotope with half-life less than 8 days

TABLE 1C-2Q2

GASEOUS EFFLUENTS--GROUND RELEASE

Farley Unit 2 - 2nd Quarter, 1984

Nuclides Released	Unit	CONTINUOUS Mode QTR# 2	BATCH Mode QTR# 2
1. Fission gases			
Ar-41	Ci	5.05E-01	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Xe-135	Ci	8.31E-01	0.00E 00
Xe-133M	Ci	0.00E 00	0.00E 00
Kr-89	Ci	1.11E-03	0.00E 00
Kr-88	Ci	9.47E-04	0.00E 00
Xe-133	Ci	2.67E 00	0.00E 00
Total for period	Ci	4.01E 00	0.00E 00
2. Iodines			
I-133	Ci	3.10E-09	0.00E 00
I-131	Ci	1.61E-06	0.00E 00
Total for period	Ci	1.61E-06	0.00E 00
3. Particulates			
* Mo-99	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Cs-137	Ci	1.22E-07	0.00E 00
Cs-134	Ci	4.02E-08	0.00E 00
* I-133	Ci	0.00E 00	0.00E 00
I-131	Ci	2.48E-09	0.00E 00
Cr-51	Ci	6.96E-08	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Total for period	Ci	2.35E-07	0.00E 00

* Isotope with half-life less than 8 days

TABLE 2A-1

LIQUID EFFLUENT--SUMMATION OF ALL RELEASES
Farley Unit 1 - 1st Half, 1984

	UNIT	Qrtr 1, 84	Qrtr 2, 84
A. Fission and Activation Products			
1. Total release Note (4)	Ci	2.31E-02	1.63E-02
2. Average diluted concentration During Period Note (1)	uCi/ml	1.84E-08	1.01E-08
3. Percent of applicable limit During Period Note (1)	%	3.36E-01	5.14E-02
B. Tritium			
1. Total release Note (4)	Ci	1.02E 02	4.40E 01
2. Average diluted concentration During Period Note (1)	uCi/ml	8.14E-05	3.44E-05
3. Percent of applicable limit During Period Note (1)	%	2.71E 00	1.15E 00
C. Dissolved and Entrained Gases			
1. Total release Note (4)	Ci	5.35E 00	4.11E-01
2. Average diluted concentration During Period Note (1)	uCi/ml	4.25E-06	3.22E-07
3. Percent of applicable limit During Period Note (1)	%	1.06E 01	8.05E-01
D. Gross Alpha Radioactivity			
1. Total release Note (4)	Ci	4.43E-04	1.65E-04
E. Volume of Waste Water Note (2)			
1. WMT	liters	1.81E 06	1.49E 06
2. SGBD and Turbine Bldg Sumps	liters	4.41E 07	1.03E 07
3. Liquid Radioactive Effluent TOTAL Note(3)	liters	1.81E 06	1.49E 06
F. Volume of Dilution Water During Quarter	liters	8.96E 09	1.74E 10

NOTE:

(1) During period of discharge
(2) Prior to dilution
(3) Steam Generator Blowdown and Turbine Building Sump releases are excluded from Total Liquid Radioactive Effluent in accordance with 10 CFR 20, Appendix B, Note 5.
(4) Steam Generator Blowdown and Turbine Building Sump release curie amounts and doses were measured and are included in these totals and in table 2B-1C in accordance with TABLE 4.11-1, Footnote E of Joseph M. Farley Nuclear Plant Unit Number 1 Technical Specifications (Appendix A of License No. NPF-2).

TABLE 2A-2

LIQUID EFFLUENT--SUMMATION OF ALL RELEASES
Farley Unit 2 - 1st Half, 1984

	UNIT	Qrtr 1, 84	Qrtr 2, 84
A. Fission and Activation Products			
1. Total release Note (4)	Ci	1.99E-02	1.06E-02
2. Average diluted concentration During Period Note (1)	uCi/ml	2.20E-08	9.17E-09
3. Percent of applicable limit During Period Note (1)	%	2.01E-01	3.16E-02
B. Tritium			
1. Total release Note (4)	Ci	7.81E 01	2.18E 01
2. Average diluted concentration During Period Note (1)	uCi/ml	9.33E-05	5.69E-05
3. Percent of applicable limit During Period Note (1)	%	3.11E 00	1.90E 00
C. Dissolved and Entrained Gases			
1. Total release Note (4)	Ci	2.91E 00	9.15E-04
2. Average diluted concentration During Period Note (1)	uCi/ml	3.48E-06	2.43E-09
3. Percent of applicable limit During Period Note (1)	%	8.70E 00	6.07E-03
D. Gross Alpha Radioactivity			
1. Total release Note (4)	Ci	3.27E-04	8.63E-05
E. Volume of Waste Water Note (2)			
1. WMT	liters	1.04E 06	5.07E 05
2. SGBD and Turbine Bldg Sumps	liters	7.57E 08	1.13E 08
3. Liquid Radioactive Effluent TOTAL Note(3)	liters	1.04E 06	5.07E 05
F. Volume of Dilution Water During Quarter	liters	1.53E 10	1.81E 10

NOTE:

(1) During period of discharge
(2) Prior to dilution
(3) Steam Generator Blowdown and Turbine Building Sump releases are excluded from Total Liquid Radioactive Effluent in accordance with 10 CFR 20, Appendix B, Note 5.
(4) Steam Generator Blowdown and Turbine Building Sump release curie amounts and doses were measured and are included in these totals and in table 2B-2C in accordance with TABLE 4.11-1, Footnote E of Joseph M. Farley Nuclear Plant Unit Number 2 Technical Specifications (Appendix A of License No. NPF-8).

TABLE 2B-1B

LIQUID EFFLUENTS--BATCH
Farley Unit 1 - 1st Half, 1984

Nuclides Released	Unit	Qrtr 1, 1984	Qrtr 2, 1984
Sr-89	Ci	4.64E-05	5.19E-04
Sr-90	Ci	1.30E-05	1.48E-05
Fe-55	Ci	2.53E-05	4.57E-03
Co-57	Ci	6.88E-07	0.00E 00
Ce-144	Ci	1.99E-03	1.05E-03
Ce-141	Ci	6.00E-06	7.76E-05
Tc-99M	Ci	1.84E-06	0.00E 00
Cr-51	Ci	4.75E-05	0.00E 00
I-131	Ci	6.78E-04	2.87E-06
Ru-103	Ci	7.02E-05	8.35E-05
I-133	Ci	1.38E-04	0.00E 00
As-76	Ci	0.00E 00	0.00E 00
Cs-134	Ci	2.73E-04	1.69E-05
Ru-106	Ci	6.52E-04	5.66E-04
Cs-137	Ci	7.14E-04	1.45E-04
Mo-99	Ci	0.00E 00	6.52E-06
Zr-95	Ci	5.14E-05	9.60E-05
Nb-95	Ci	1.52E-04	1.29E-03
I-132	Ci	1.07E-02	0.00E 00
Co-58	Ci	6.62E-04	9.21E-04
Cs-136	Ci	5.19E-06	2.09E-04
Mn-54	Ci	4.94E-05	3.15E-05
Ag-110M	Ci	1.61E-04	4.72E-03
Sr-91	Ci	3.16E-06	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
I-135	Ci	8.21E-06	0.00E 00
Fe-59	Ci	7.38E-06	2.65E-06
Co-60	Ci	1.67E-03	1.80E-03
Na-24	Ci	1.41E-06	0.00E 00
La-140	Ci	5.90E-04	1.02E-04
Zr-97	Ci	6.14E-07	5.73E-06
Te-132	Ci	4.22E-03	0.00E 00
Te-131M	Ci	8.86E-05	0.00E 00
Sb-124	Ci	0.00E 00	2.32E-06
TOTALS	Ci	2.30E-02	1.62E-02
Xe-133	Ci	5.35E 00	4.11E-01
Xe-135	Ci	0.00E 00	1.45E-05
Xe-138	Ci	0.00E 00	0.00E 00
Xe-133M	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00
TOTALS	Ci	5.35E 00	4.11E-01
H-3	Ci	1.02E 02	4.40E 01

TABLE 2B-2B

LIQUID EFFLUENTS--BATCH
Farley Unit 2 - 1st Half, 1984

Nuclides Released	Unit	Qrtr 1, 1984	Qrtr 2, 1984
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Fe-55	Ci	1.48E-03	7.40E-04
Co-57	Ci	3.47E-07	0.00E 00
Ce-144	Ci	7.02E-04	3.52E-04
Tc-99M	Ci	2.40E-07	0.00E 00
Ce-141	Ci	1.79E-04	4.17E-05
Cr-51	Ci	1.62E-03	0.00E 00
I-131	Ci	2.34E-04	3.38E-06
Ru-103	Ci	1.01E-03	5.29E-06
I-133	Ci	3.30E-06	0.00E 00
Ba-140	Ci	5.76E-05	0.00E 00
As-76	Ci	3.27E-07	0.00E 00
Cs-134	Ci	2.33E-04	3.19E-07
Ru-106	Ci	7.16E-04	5.40E-05
Cs-137	Ci	7.96E-04	1.11E-07
Mo-99	Ci	0.00E 00	0.00E 00
Zr-95	Ci	8.81E-04	1.36E-05
Nb-95	Ci	1.31E-03	3.03E-04
I-132	Ci	4.24E-03	0.00E 00
Co-58	Ci	2.58E-03	3.18E-04
Cs-136	Ci	1.12E-05	3.39E-05
Mn-54	Ci	1.34E-04	2.96E-06
Ag-110M	Ci	4.05E-04	1.05E-03
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	5.71E-05	1.02E-06
Co-60	Ci	1.19E-03	2.73E-04
Na-24	Ci	0.00E 00	2.66E-07
La-140	Ci	3.02E-04	7.15E-06
Sb-124	Ci	7.55E-05	1.65E-04
Te-132	Ci	1.45E-03	0.00E 00
Te-131M	Ci	9.73E-06	0.00E 00
TOTALS	Ci	1.97E-02	3.36E-03
Xe-133	Ci	2.90E 00	9.15E-04
Xe-135	Ci	2.87E-05	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00
Xe-133M	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00
TOTALS	Ci	2.90E 00	9.15E-04
H-3	Ci	7.81E 01	2.17E 01

TABLE 2B-1C

LIQUID EFFLUENTS--CONTINUOUS
Farley Unit 1 - 1st Half, 1984

Nuclides Released	Unit	Qrtr 1, 1984	Qrtr 2, 1984
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
Cs-137	Ci	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	1.17E-04
Zr-95	Ci	6.43E-05	0.00E 00
TOTALS	Ci	6.43E-05	1.17E-04
Xe-133	Ci	0.00E 00	0.00E 00
Xe-135	Ci	0.00E 00	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00
Xe-133M	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00
TOTALS	Ci	0.00E 00	0.00E 00
H-3	Ci	0.00E 00	0.00E 00

NOTE:

(1) Although Steam Generator Blowdown and Turbine Building Sump releases were excluded from total liquid radioactive effluent volume in accordance with 10 CFR 20, Appendix B, Note 5, curie amounts and doses from these releases were measured and are reported here in accordance with Table 4.11-1, Footnote E of Joseph M. Farley Nuclear Plant Unit Number 1 Technical Specification (Appendix A of License No. NPF-2).

TABLE 2B-2C

LIQUID EFFLUENTS--CONTINUOUS
Farley Unit 2 - 1st Half, 1984

Nuclides Released	Unit	Qrtr 1, 1984	Qrtr 2, 1984
Sr-89	Ci	0.00E 00	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00
Ce-144	Ci	1.55E-04	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	2.12E-04
Cs-137	Ci	0.00E 00	3.75E-04
Mo-99	Ci	0.00E 00	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00
Mn-54	Ci	0.00E 00	0.00E 00
Zn-65	Ci	0.00E 00	0.00E 00
Fe-59	Ci	0.00E 00	0.00E 00
Co-60	Ci	0.00E 00	0.00E 00
I-131	Ci	0.00E 00	1.09E-04
I-133	Ci	0.00E 00	2.61E-04
Na-24	Ci	0.00E 00	2.02E-04
Fe-55	Ci	0.00E 00	6.09E-03
TOTALS	Ci	1.55E-04	7.25E-03
Xe-133	Ci	1.26E-02	0.00E 00
Xe-135	Ci	0.00E 00	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00
Xe-133M	Ci	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00
TOTALS	Ci	1.26E-02	0.00E 00
H-3	Ci	0.00E 00	1.35E-01

NOTE:

(1) Although Steam Generator Blowdown and Turbine Building Sump releases were excluded from total liquid radioactive effluent volume in accordance with 10 CFR 20, Appendix B, Note 5, curie amounts and doses from these releases were measured and are reported here in accordance with Table 4.11-1, Footnote E of Joseph M. Farley Nuclear Plant Unit Number 2 Technical Specification (Appendix A of License No. NPF-8).

TABLE 3

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1984)

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL
(Not irradiated fuel)

1. Type of Waste	UNITS	PERIOD 6-MONTHS
a. Spent resins, filter sludges, evaporator bottoms, etc.	m^3	2.002E 01
	Ci	1.138E 02
b. Dry compressible waste, contaminated equipment, etc.	m^3	2.884E 02
	Ci	1.209E 01
c. Irradiated components, control rods, etc.	m^3	None
	Ci	None
d. Other (described)	m^3	None
	Ci	None

2. Estimate of major nuclide composition

	ISOTOPES	%	ISOTOPES	%
a.	H-3	0.95		
	Co-58	11.04		
	Co-60	57.80		
	Ni-63	11.07		
	Nb-95	0.50		
	Cs-134	1.80		
	I-131	12.18		
	Cs-137	3.75		
b.	H-3	8.33	Zr-95	1.87
	Cr-51	1.00	Cs-134	4.45
	Mn-54	3.46	Cs-137	11.50
	Co-58	4.57	Ba-140	4.93
	Co-60	32.18	La-140	6.41
	Ni-63	9.13	Ce-141	5.40
	Nb-95	3.78	Ce-144	2.38

TABLE 3 (con't)

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1984)

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

3.	Solid Waste Disposition	
	a. Number of Shipments	17
	b. Mode of Transportation	Chem-Nuclear Transport (11) Hittman Transport (6)
	c. Destination	Chem-Nuclear Systems, Inc. Barnwell, South Carolina
4.	Type of Containers	
	a. (1a)	170 cf. steel liners (dewatered resin & charcoal media) 55 cf. High Integrity Containers (Spent filters)
	b. (1b)	55 gallon steel drum 112 cf. wooden boxes
5.	Solidification Agents	
	a. (1a)	No solidifications during this period. All items (spent resin and charcoal) that are categorized for item 1a were shipped dewatered.
	b. (1b)	N/A

B. IRRADIATED FUEL SHIPMENTS (Disposition)

1.	Number of Shipments	None
2.	Mode of Transportation	N/A
3.	Destination	N/A

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: A
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	3	0	0	0	0	3
NNE	0	2	1	0	0	0	3
NE	0	34	0	0	0	0	34
ENE	0	6	0	0	0	0	6
E	0	2	1	1	0	0	4
ESE	0	3	2	0	0	0	5
SE	0	8	7	0	0	0	15
SSE	0	0	2	0	0	0	2
S	0	4	1	0	0	0	5
SSW	0	3	11	1	0	0	15
SW	0	1	0	1	0	0	2
WSW	0	1	2	1	1	0	5
W	0	11	1	0	1	0	13
WNW	0	4	0	1	0	0	5
NW	0	0	0	0	0	0	0
NNW	0	30	2	0	0	0	32
VARIABLE	0	177	13	6	0	0	196
Total	0	112	30	5	2	0	149

Periods of calm(hours):
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: A
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	4	0	0	0	0	4
NNE	0	2	0	0	0	0	2
NE	0	3	0	0	0	0	3
ENE	0	4	0	0	0	0	4
E	0	3	0	0	0	0	3
ESE	0	2	1	0	0	0	3
SE	0	9	7	0	0	0	16
SSE	0	1	4	0	0	0	5
S	0	1	1	0	0	0	2
SSW	0	8	10	0	0	0	18
SW	0	3	0	1	0	0	4
WSW	0	2	0	1	0	0	3
W	0	55	0	0	0	0	55
WNW	0	4	1	0	0	0	5
NW	0	0	0	0	0	0	0
NNW	0	16	0	0	0	0	16
VARIABLE	0	177	24	1	0	0	202
Total	0	117	24	2	0	0	143

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: B
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	18	0	0	0	0	18
ENE	0	2	1	0	0	0	3
E	0	4	1	0	0	0	5
ESE	0	1	2	0	0	0	3
SE	0	20	7	3	0	0	30
SSE	0	0	1	0	0	0	1
S	0	1	1	0	0	0	2
SSW	0	8	11	9	2	1	31
SW	0	3	1	0	0	0	4
WSW	0	2	0	0	0	0	2
W	0	12	8	9	4	0	33
WNW	0	3	3	0	0	0	6
NW	0	0	1	0	0	0	1
NNW	0	49	8	0	0	0	57
VARIABLE	0	164	36	11	2	0	213
Total	0	125	45	21	6	1	198

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: B
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	7	0	0	0	0	7
E	0	0	2	0	0	0	2
ESE	0	5	2	0	0	0	7
SE	0	11	8	1	0	0	20
SSE	0	0	1	0	0	0	1
S	0	2	0	0	0	0	2
SSW	0	22	9	4	1	0	36
SW	0	1	1	0	0	0	2
WSW	0	1	0	0	0	0	1
W	0	40	13	11	0	0	64
WNW	0	2	2	0	0	0	4
NW	0	3	2	0	0	0	5
NNW	0	20	0	0	0	0	20
VARIABLE	0	205	28	5	0	0	238
Total	0	116	40	16	1	0	173

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: C
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	14	0	0	0	0	14
ENE	0	1	0	0	0	0	1
E	0	0	0	1	0	0	1
ESE	0	2	0	0	0	0	2
SE	0	0	5	2	0	0	7
SSE	0	0	0	0	0	0	0
S	0	1	0	0	0	0	1
SSW	0	6	1	3	3	0	13
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	6	6	13	6	0	31
WNW	0	0	1	0	0	0	1
NW	0	3	0	0	0	0	3
NNW	0	26	1	0	0	0	27
VARIABLE	0	62	11	2	0	0	75
Total	0	61	14	19	9	0	103

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: C
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	3	6	0	0	0	9
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	10	2	3	1	0	16
SW	0	2	0	0	0	0	2
WSW	0	2	0	0	0	0	2
W	0	28	15	4	0	0	47
WNW	0	3	0	0	0	0	3
NW	0	0	0	0	0	0	0
NNW	0	12	0	0	0	0	12
VARIABLE	0	73	9	4	0	0	86
Total	0	61	23	7	1	0	92

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: D
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	1	0	0	1
NNE	0	1	0	0	0	0	1
NE	0	24	1	0	0	0	25
ENE	0	4	1	0	0	0	5
E	0	1	2	1	0	0	4
ESE	0	0	1	0	0	0	1
SE	0	4	6	1	1	1	13
SSE	0	2	0	1	0	0	3
S	0	0	2	1	0	0	3
SSW	0	9	4	3	2	4	22
SW	0	1	0	0	0	0	1
WSW	0	1	0	0	0	0	1
W	0	10	7	15	6	1	39
WNW	0	1	0	0	0	0	1
NW	0	5	0	0	0	0	5
NNW	0	26	1	0	0	0	27
VARIABLE	0	111	12	4	3	0	130
Total	0	89	25	23	9	6	152

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: D
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	1	0	0	0	1
NNE	0	2	0	0	0	0	2
NE	0	1	1	0	0	0	2
ENE	0	2	0	0	0	0	2
E	0	0	1	0	0	0	1
ESE	0	1	1	0	0	0	2
SE	0	7	6	0	1	0	14
SSE	0	0	0	0	0	0	0
S	0	3	1	1	0	0	5
SSW	0	13	4	5	5	0	27
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	0	27	9	9	0	0	45
WNW	0	4	0	0	0	0	4
NW	0	7	0	0	0	0	7
NNW	0	17	0	0	0	0	17
VARIABLE	0	129	11	12	0	0	152
Total	0	85	24	15	6	0	130

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: E
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	3	1	0	0	0	4
NNE	0	1	0	0	0	0	1
NE	0	22	0	0	0	0	22
ENE	0	8	2	0	0	0	10
E	0	1	0	0	0	0	1
ESE	0	8	0	2	0	0	10
SE	0	18	10	1	1	0	30
SSE	0	3	2	0	0	0	5
S	0	3	2	0	0	0	5
SSW	0	17	26	6	2	0	51
SW	0	1	2	0	0	0	3
WSW	0	0	0	0	0	0	0
W	0	41	7	0	2	0	50
WNW	0	2	1	0	0	0	3
NW	0	3	1	0	0	0	4
NNW	0	41	1	0	0	0	42
VARIABLE	0	159	20	3	2	0	184
Total	0	172	55	9	5	0	241

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EAC' WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: E
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	2	0	0	0	0	2
ENE	0	10	0	1	0	0	11
E	0	0	1	0	0	0	1
ESE	0	6	1	0	0	0	7
SE	0	24	4	0	1	0	29
SSE	0	2	1	0	0	0	3
S	0	2	2	0	0	0	4
SSW	0	36	10	1	1	0	48
SW	0	3	0	0	0	0	3
WSW	0	1	0	0	0	0	1
W	0	72	1	1	0	0	74
WNW	0	9	0	0	0	0	9
NW	0	3	0	0	0	0	3
NNW	0	15	0	0	0	0	15
VARIABLE	0	200	11	3	0	0	214
Total	0	186	20	3	2	0	211

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: F
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	0	0	0	0	1
NNE	0	2	0	0	0	0	2
NE	0	16	0	0	0	0	16
ENE	0	8	0	0	0	0	8
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	13	3	0	0	0	16
SSE	0	1	0	0	0	0	1
S	0	0	1	0	0	0	1
SSW	0	34	11	0	0	0	45
SW	0	1	1	0	0	0	2
WSW	0	0	0	0	0	0	0
W	0	32	7	0	0	0	39
WNW	0	0	0	0	0	0	0
NW	0	1	0	0	0	0	1
NNW	0	38	2	0	0	0	40
VARIABLE	0	71	5	0	0	0	76
Total		147	25	0	0	0	172

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: F
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	0	0	0	0	1
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	4	0	0	0	0	4
E	0	1	0	0	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	11	0	0	0	0	11
SSE	0	0	1	0	0	0	1
S	0	1	2	0	0	0	3
SSW	0	31	0	0	0	0	31
SW	0	1	0	0	0	0	1
WSW	0	1	0	0	0	0	1
W	0	36	0	0	0	0	36
WNW	0	4	0	0	0	0	4
NW	0	2	0	0	0	0	2
NNW	0	20	0	0	0	0	20
VARIABLE	0	130	1	0	0	0	131
Total	0	114	3	0	0	0	117

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: G
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	29	0	0	0	0	29
ENE	0	10	0	0	0	0	10
E	0	0	0	0	0	0	0
ESE	0	1	0	0	0	0	1
SE	0	18	0	0	0	0	18
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	21	2	0	0	0	23
SW	0	1	1	1	0	0	3
WSW	0	0	1	0	0	0	1
W	0	29	1	0	0	0	30
WNW	0	1	0	0	0	0	1
NW	0	2	0	0	0	0	2
NNW	0	53	1	0	0	0	54
VARIABLE	0	114	7	0	0	0	121
Total	0	167	6	1	0	0	174

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: G
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2	0	0	0	0	2
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	3	0	0	0	0	3
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	22	1	0	0	0	23
SW	0	3	2	0	0	0	5
WSW	0	3	1	0	0	0	4
W	0	42	0	0	0	0	42
WNW	0	4	0	0	0	0	4
NW	0	3	0	0	0	0	3
NNW	0	35	0	0	0	0	35
VARIABLE	0	172	0	0	0	0	172
Total	0	119	4	0	0	0	123

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: A
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	0	2	0	0	0	2
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	1	1	0	2
SE	0	2	0	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	1	0	0	0	0	1
SW	0	1	0	1	0	0	2
WSW	0	0	0	2	0	1	3
W	1	1	0	0	2	2	6
WNW	0	0	2	0	0	0	2
NW	0	1	0	0	0	0	1
NNW	0	0	1	0	0	0	1
VARIABLE	12	1	0	0	0	0	13
Total	2	6	5	4	3	3	23

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: A
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	2	0	0	0	2
ENE	0	0	0	0	0	0	0
E	0	0	1	0	0	0	1
ESE	1	0	0	0	1	0	2
SE	2	1	0	0	0	0	3
SSE	0	0	0	0	0	0	0
S	0	1	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	1	0	0	1	0	0	2
WSW	1	0	0	2	0	1	4
W	0	0	1	0	2	2	5
WNW	0	1	0	0	0	0	1
NW	2	0	1	0	0	0	3
NNW	0	0	0	0	0	0	0
VARIABLE	11	1	0	0	0	0	12
Total	7	3	5	3	3	3	24

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: B
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	1	1	0	0	2
NE	0	1	1	1	0	0	3
ENE	0	1	0	0	0	0	1
E	0	0	0	1	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	1	0	0	0	1
SSE	1	1	0	0	0	0	2
S	0	0	1	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	1	0	0	0	0	1
WSW	0	1	0	0	0	0	1
W	0	1	0	0	0	0	1
WNW	1	1	0	0	0	0	2
NW	0	0	1	1	0	0	2
NNW	0	0	0	0	0	0	0
VARIABLE	1	0	0	0	0	0	1
Total	2	7	5	4	0	0	18

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: B
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	1	0	0	0	2
NNE	0	1	0	0	0	0	1
NE	0	0	2	0	0	0	2
ENE	0	1	1	0	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	1	0	0	0	1
SE	1	1	0	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	1	0	0	0	1
SSW	0	1	0	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	0	1	0	0	0	1
W	1	2	0	0	0	0	3
WNW	0	0	1	0	0	0	1
NW	0	0	1	0	0	0	1
NNW	0	0	0	0	0	0	0
VARIABLE	1	0	0	0	0	0	1
Total	2	7	9	0	0	0	18

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: C
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	5	1	0	0	7
NNE	0	2	2	0	0	0	4
NE	0	1	4	1	0	0	6
ENE	0	3	0	0	0	0	3
E	0	1	0	1	0	0	2
ESE	1	1	0	0	0	0	2
SE	1	4	2	0	0	0	7
SSE	4	3	4	0	0	0	11
S	1	4	4	1	0	0	10
SSW	0	2	1	0	0	0	3
SW	0	0	2	1	0	0	3
WSW	0	0	1	0	0	0	1
W	0	1	1	0	0	0	2
WNW	1	7	4	2	0	0	14
NW	0	0	1	0	0	0	1
NNW	0	0	1	0	0	0	1
VARIABLE	1	0	0	0	0	0	1
Total	8	30	32	7	0	0	77

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: C
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1	1	0	0	0	0	2
NNE	0	3	3	0	0	0	6
NE	0	1	3	0	0	0	4
ENE	0	3	0	0	0	0	3
E	0	1	1	0	0	0	2
ESE	2	1	0	0	0	0	3
SE	3	4	4	0	0	0	11
SSE	4	6	3	0	0	0	13
S	1	0	2	1	0	0	4
SSW	1	1	0	0	0	0	2
SW	0	0	3	0	0	0	3
WSW	0	0	1	0	0	0	1
W	2	4	4	0	0	0	10
WNW	0	5	2	0	0	0	7
NW	0	0	2	0	0	0	2
NNW	0	2	2	0	0	0	4
VARIABLE	1	0	0	0	0	0	1
Total	14	32	30	1	0	0	77

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: D
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	9	15	13	8	0	0	45
NNE	18	15	14	4	0	6	57
NE	12	18	10	0	0	0	40
ENE	15	16	6	1	0	1	39
E	11	24	10	0	0	0	45
ESE	7	35	14	0	0	0	56
SE	16	28	13	0	0	0	57
SSE	15	32	26	5	1	5	84
S	15	17	17	2	1	1	53
SSW	8	10	8	6	1	1	34
SW	8	15	17	21	11	6	78
WSW	19	22	13	2	0	2	58
W	19	35	17	4	2	2	79
WNW	22	37	8	3	0	1	71
NW	9	29	11	1	0	2	52
NNW	8	9	7	5	0	0	29
VARIABLE	0	0	0	0	0	0	0
Total	211	357	204	62	16	27	877

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: D
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	18	22	10	0	0	0	50
NNE	21	13	3	0	0	6	43
NE	29	14	4	1	0	0	48
ENE	13	17	4	1	0	1	36
E	19	28	5	0	0	0	52
ESE	10	32	4	0	0	0	46
SE	24	37	10	0	0	1	72
SSE	25	30	19	1	1	5	31
S	16	10	8	1	0	0	35
SSW	4	13	6	10	0	5	38
SW	24	25	24	12	3	1	89
WSW	28	21	5	0	0	2	56
W	34	37	6	3	2	2	84
WNW	24	36	6	1	1	2	70
NW	8	20	6	1	0	0	35
NNW	14	21	5	2	0	0	42
VARIABLE	0	0	0	0	0	0	0
Total	311	376	125	33	7	25	877

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: E
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	4	12	7	7	0	0	30
NNE	2	9	9	1	1	0	22
NE	1	10	4	0	0	0	15
ENE	7	7	1	1	0	1	17
E	2	6	5	0	0	0	13
ESE	4	19	5	0	0	0	28
SE	8	18	7	2	0	0	35
SSE	9	27	23	8	3	3	73
S	12	35	24	9	0	0	80
SSW	9	13	8	3	0	0	33
SW	8	29	41	21	5	1	105
WSW	10	39	30	2	0	0	81
W	21	32	13	1	1	0	68
WNW	6	28	7	0	0	0	41
NW	8	19	3	1	0	0	31
NNW	5	6	3	0	1	0	15
VARIABLE	0	0	0	0	0	0	0
Total	116	309	190	56	11	5	687

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: E
ELEVATION: 10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	15	6	2	0	0	0	23
NNE	12	4	0	0	1	0	17
NE	10	6	1	0	0	0	17
ENE	16	6	0	2	0	0	24
E	18	5	1	0	0	0	24
ESE	18	11	2	0	0	0	31
SE	25	20	21	1	0	0	67
SSE	24	37	12	0	3	3	79
S	13	12	5	0	0	0	30
SSW	14	10	8	2	0	2	36
SW	36	61	29	3	0	0	129
WSW	34	26	2	0	0	0	62
W	51	12	5	0	1	0	69
WNW	21	8	4	0	0	0	33
NW	15	5	0	0	0	0	20
NNW	6	13	4	1	1	0	25
VARIABLE	1	0	0	0	0	0	1
Total	328	242	96	9	6	5	686

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: F
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	2	11	11	1	0	0	25
NNE	5	3	4	0	0	0	12
NE	2	4	4	0	0	0	10
ENE	9	4	0	0	0	0	13
E	2	4	2	0	0	0	8
ESE	5	8	2	0	0	0	15
SE	5	8	1	0	0	0	14
SSE	8	6	6	3	0	1	24
S	2	3	2	1	0	0	8
SSW	1	1	2	0	0	0	4
SW	5	4	9	4	0	0	22
WSW	3	6	5	0	0	0	14
W	16	14	5	1	0	0	36
WNW	9	14	0	0	0	1	24
NW	5	17	6	1	0	0	29
NNW	9	2	3	0	0	0	14
VARIABLE	2	0	0	0	0	0	2
Total	88	109	62	11	0	2	272

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-34
STABILITY CLASS: F
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	12	2	0	0	0	0	14
NNE	14	1	0	1	0	0	16
NE	10	0	0	0	0	0	10
ENE	15	0	0	0	0	0	15
E	11	2	0	0	0	0	13
ESE	7	6	1	0	0	0	14
SE	6	1	1	0	0	0	8
SSE	4	5	2	3	0	1	15
S	4	2	1	0	0	0	7
SSW	3	3	1	0	0	0	7
SW	7	9	3	0	0	0	19
WSW	12	3	0	0	0	0	15
W	27	6	1	2	0	0	36
WNW	28	5	0	0	0	0	33
NW	12	5	0	0	0	0	17
NNW	23	7	0	0	0	0	30
VARIABLE	5	0	0	0	0	0	5
Total	195	57	10	6	0	1	269

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: G
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	6	6	5	0	0	0	17
NNE	7	5	3	0	1	0	16
NE	3	5	2	0	0	0	10
ENE	4	6	7	1	0	0	18
E	4	6	6	0	1	0	17
ESE	5	7	2	0	1	0	15
SE	1	4	2	0	0	0	7
SSE	2	9	1	0	0	0	12
S	5	2	1	0	0	0	8
SSW	3	0	0	0	0	0	3
SW	3	0	3	0	0	0	6
WSW	1	3	2	0	0	0	6
W	3	5	5	0	0	0	13
WNW	5	4	3	0	0	0	12
NW	7	9	10	0	0	0	26
NNW	10	9	3	0	0	0	22
VARIABLE	5	0	0	0	0	0	5
Total	69	80	55	1	3	0	208

Periods of calm(hours): 0
Hours of missing data: 0

Table 4A-CQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Nuclear Plant - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: CONTINUOUS
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: G
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	51	2	0	0	0	0	53
NNE	21	1	0	0	1	0	23
NE	7	1	0	0	0	0	8
ENE	5	4	0	0	0	0	9
E	2	0	0	0	1	0	3
ESE	5	0	0	0	1	0	6
SE	3	1	0	0	0	0	4
SSE	3	1	0	0	0	0	4
S	1	1	0	0	0	0	2
SSW	1	0	0	0	0	0	1
SW	3	0	0	0	0	0	3
WSW	5	6	0	0	0	0	11
W	8	2	0	0	0	1	11
WNW	8	4	0	0	0	0	12
NW	14	3	0	0	0	0	17
NNW	33	1	0	0	0	0	34
VARIABLE	12	0	0	0	0	0	12
Total	170	27	0	0	3	1	201

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: A
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: A
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: B
ELEVATION:45.7m

	Wind Speed (mph) at 45.7m level						
Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	2	1	0	0	3
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	1	0	0	0	1
Total	0	0	2	1	0	0	3

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: B
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	3	0	0	0	3
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	1	0	0	0	1
Total	0	0	3	0	0	0	3

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 ! 3-31-84
STABILITY CLASS: C
ELEVATION:45.7m

	Wind Speed (mph) at 45.7m level						
Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	1	0	0	1
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	1	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	2	0	0	0	0	2
VARIABLE	0	3	1	1	0	0	5
Total	0	3	1	1	0	0	5

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: C
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	2	1	0	0	0	3
WNW	0	1	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	2	0	0	0	0	2
VARIABLE	0	2	1	1	0	0	4
Total	0	5	1	0	0	0	6

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: D
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	1	1	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	1	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	4	1	0	1	0	6
Total	0	1	1	0	1	1	4

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: D
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	1	0	1
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	1	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	4	0	0	0	0	4
VARIABLE	0	2	0	2	0	0	4
Total	0	4	1	0	1	0	6

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: E
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	1	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	1	0	1	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	1	0	0	0	2
WNW	0	1	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	4	0	0	0	0	4
VARIABLE	0	13	4	0	1	0	18
Total	0	8	3	0	1	0	12

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: E
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	1	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	15	0	0	0	0	15
WNW	0	1	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	1	0	0	0	0	1
VARIABLE	0	7	3	1	0	0	11
Total	0	18	0	0	1	0	19

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: F
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	4	0	0	0	0	4
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	1	0	0	0	0	1
Total	0	5	0	0	0	0	5

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: F
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	3	0	0	0	0	3
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	2	0	0	0	0	2
Total	0	4	0	0	0	0	4

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: G
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	3	0	0	0	0	3
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	3	0	0	0	0	3
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	6	0	0	0	0	6

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: G
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	4	0	0	0	0	4
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	2	0	0	0	0	2
Total	0	4	0	0	0	0	4

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: A
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: A
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: B
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: B
ELEVATION:10.0m

	Wind Speed (mph) at 10.0m level						
Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: C
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	0	1	0	0	0	0	1
ENE	0	1	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	3	0	0	0	0	3

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: C
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	3	0	0	0	0	3

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: D
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	2	0	0	0	2
ENE	0	0	1	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	1	0	1	0	0	0	2
SSE	2	1	0	0	0	0	3
S	0	0	0	0	0	0	0
SSW	0	0	1	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	1	1	0	0	0	0	2
WNW	0	0	1	0	0	0	1
NW	0	0	1	0	0	0	1
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	4	2	7	0	0	0	13

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: D
ELEVATION:10.0m

	Wind Speed (mph) at 10.0m level						
Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	2	0	0	0	0	2
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	3	1	0	0	0	0	4
SSE	1	0	0	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	2	0	0	0	0	2
WNW	0	2	0	0	0	0	2
NW	0	1	0	0	0	0	1
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	5	8	0	0	0	0	13

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: E
ELEVATION:45.7m

	Wind Speed (mph) at 45.7m level						
Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	1	1	0	0	0	0	2
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	0	2	0	0	0	2
WSW	1	2	3	0	0	0	6
W	0	0	2	1	0	0	3
WNW	0	0	1	0	0	0	1
NW	0	1	0	0	0	0	1
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	3	5	8	1	0	0	17

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: E
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	1	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	1	0	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	0	0	0	0	0	0	0
SW	0	3	0	0	0	0	3
WSW	2	6	0	0	0	0	8
W	1	1	0	0	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	5	12	0	0	0	0	17

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: F
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	0	1	1	0	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	1	0	0	0	0	1
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	1	3	1	0	0	0	5

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: F
ELEVATION:10.0m

	Wind Speed (mph) at 10.0m level						
Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	1	0	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	1	0	0	0	0	0	1
WSW	0	0	0	0	0	0	0
W	1	0	0	0	0	0	1
WNW	1	0	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	1	0	0	0	0	0	1
VARIABLE	0	0	0	0	0	0	0
Total	5	0	0	0	0	0	5

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: G
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	1	0	0	0	0	1
ENE	0	2	0	0	0	0	2
E	0	1	1	0	0	0	2
ESE	0	0	2	0	0	0	2
SE	0	0	0	0	0	0	0
SSE	0	0	1	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	1	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	1	0	0	0	0	1
NNW	1	0	0	0	0	0	1
VARIABLE	0	0	0	0	0	0	0
Total	1	5	5	0	0	0	11

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-1BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 1 - 2nd Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 4 -1-84 } 6-30-84
STABILITY CLASS: G
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	6	0	0	0	0	0	6
NNE	3	0	0	0	0	0	3
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	1	0	0	0	0	1
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	1	0	0	0	0	0	1
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	10	1	0	0	0	0	11

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: A
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	2	0	0	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	2	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	1	0	0	1
Total	0	2	2	0	0	0	4

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: A
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	1	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	2	1	0	0	0	3
Total	0	1	1	0	0	0	2

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: B
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	3	1	1	0	0	5
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	1	0	0	0	1
Total	0	3	1	1	0	0	5

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: B
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	2	0	1	0	0	3
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	3	0	0	0	0	3
Total	0	2	0	1	0	0	3

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: C
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	1	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	1	1	0	0	0	2
Total	0	0	1	0	0	0	1

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: C
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	2	0	0	0	0	2
Total	0	1	0	0	0	0	1

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: D
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	2	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	0	2	0	0	0	2

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: D
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	2	0	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	0	0	0	0	0	0
Total	0	2	0	0	0	0	2

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: E
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	1	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	2	0	0	0	0	2
Total	0	1	1	0	0	0	2

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: E
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	1	0	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	3	0	0	0	0	3
Total	0	1	0	0	0	0	1

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: F
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	1	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	2	0	0	0	0	2
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	4	0	0	0	0	4
Total	0	4	0	0	0	0	4

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: F
ELEVATION:10.0m

	Wind Speed (mph) at 10.0m level						
Wind Direction	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	1	0	0	0	0	1
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	1	0	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	2	0	0	0	0	2
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	4	0	0	0	0	4
Total	0	4	0	0	0	0	4

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: G
ELEVATION:45.7m

Wind Direction	Wind Speed (mph) at 45.7m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	1	0	0	0	0	1
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	0	0	0	0	0	0
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	6	0	0	0	0	6
Total	0	1	0	0	0	0	1

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ1

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 1st Quarter, 1984

HOURS AT EACH WIND SPEED AND DIRECTION

RELEASE MODE: BATCH
PERIOD OF RECORD: 1 -1-84 } 3-31-84
STABILITY CLASS: G
ELEVATION:10.0m

Wind Direction	Wind Speed (mph) at 10.0m level						
	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	0	0
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	0	0
W	0	1	0	0	0	0	1
WNW	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
VARIABLE	0	6	0	0	0	0	6
Total	0	1	0	0	0	0	1

Periods of calm(hours): 0
Hours of missing data: 0

TABLE 4A-2BQ2

CUMULATIVE JOINT FREQUENCY DISTRIBUTION

Farley Unit 2 - 2nd Quarter, 1984

No batch releases were made during 2nd Quarter 1984 therefore Cumulative Joint Frequency Distribution tables are not applicable.

TABLE 4B

CLASSIFICATION OF ATMOSPHERIC STABILITY

Stability Classification	Pasquill Categories	$\theta\sigma_a$ (degrees)	Temperature change with height (°F/51m)
Extremely unstable	A	25.0	<-1.74
Moderately unstable	B	20.0	-1.74 to -1.56
Slightly unstable	C	15.0	-1.56 to -1.38
Neutral	D	10.0	-1.38 to -0.46
Slightly stable	E	5.0	-0.46 to 1.38
Moderately stable	F	2.5	1.38 to 3.6
Extremely stable	G	1.7	>3.6

a Standard deviation of horizontal wind direction fluctuation over a period of 15 minutes to 1 hour. The values shown are averages for each stability classification.

TABLE 5

RADIAOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM
FARLEY NUCLEAR PLANT - UNIT 1 & 2

Liquid Release Type	Sampling Frequency	Mimimum Analysis Frequency	Type of Activity Analysis	Minimum Detectable Concentration (MDC)(uCi/ml) [a,g]
A. Batch Waste Release Tanks [c]	P Each Batch	P Each Batch	Principal Gamma Emmiters [e]	5E-07
			I-131	1E-06
	One Batch/M	M	Dissolved & Entrained Gases (Gamma Emitters)	1E-05
	P Each Batch	M [b] Composite	H-3	1E-05
			Gross Alpha	1E-07
	P Each Batch	Q [b] Composite	Sr-89, Sr-90	5E-08
			Fe-55	1E-06
B. Continuous Releases [d,f]	D Grab Sample	Q [b] Composite	Principal Gamma Emitters [e]	5E-07
			I-131	1E-06
1. Steam Generator Blowdown	M Grab Sample	M	Dissolved & Entrained Gases (Gamma Emitters)	1E-05
	D Grab Sample	M [b] Composite	H-3	1E-05
			Gross Alpha	1E-07
	D Grab Sample	Q [b] Composite	Sr-89, Sr-90	5E-08
			Fe-55	1E-06
2. Turbine Building Sump	P Grab Sample	W [b] Composite	Principle Gamma Emmitters [e]	5E-07
			H-3	1E-05

TABLE 5 (Continued)

TABLE NOTATION

a. The MDC is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$MDC = \frac{4.66\, s_b}{E * V * 2.22 \times 10^6 * Y * \exp(-\lambda \Delta t)}$$

where:

MDC is the "a priori" lower limit of detection as defined above (as microcurie per unit mass or volume),

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

E is the counting efficiency (as counts per transformation),

V is the sample size (in units mass or volume),

2.22×10^6 is the number of transformations per minute per microcurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide, and

Δt is the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples).

The value of s_b used in the calculation of the MDC for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. Typical values of E, V, Y, and Δt shall be used in the calculation.

TABLE 5 (Continued)

TABLE NOTATION

b. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

c. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed, by a method described in the ODCM, to assure representative sampling.

d. A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume of system that has an input flow during the effluent release.

e. The principal gamma emitters for which the MDC specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifable, together with the above nuclides, shall also be identified and reported.

f. Sampling will be performed only if the effluent will be discharged to the environment.

g. Deviation from the MDC requirements of Table 4.11-1 shall be reported per Specification 6.9.1.8 in lieu of any other report.

TABLE 6

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM
FARLEY NUCLEAR PLANT - UNITS 1 & 2

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis [a,h]	Minimum Detectable Concentration (MDC)(uCi/ml)
A. Waste Gas Storage Tank	Each Tank Grab Sample [b] P	Each Tank P	Principle Gamma Emitters [g,h]	1E-04
B. Containment Purge	Each Purge Grab Sample [b] P	Each Purge Grab Sample [b] P	Principle Gamma Emitters [g,j]	1E-04
			H-3	1E-06
C. Condenser Steam Jet Air Ejector Plant Vent Stack	M-[b,c,e] Grab Sample	[b] M	Principle Gamma Emitters [g,j]	1E-04
			H-3	1E-06
D. Plant Vent Stack Containment Purge	[f] Continuous Charcoal	Charcoal Sample [d] W	I-131	1E-12
			I-133	1E-10
	[f] Continuous	Particulate Sample [d] W	Principle Gamma Emitters (I-131, Others) [g]	1E-11
	[f] Continuous	W [i] Composite Particulate Sample	Gross Alpha	1E-11
	[f] Continuous	Q [i] Composite Particulate Sample	Sr-89, Sr-90	1E-11
	[f] Continuous	Noble Gas Monitor	Noble Gases Gross Beta & Gamma	1E-06

TABLE 6 (Continued)

TABLE NOTATION

a. The MDC is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$MDC = \frac{4.66\, s_b}{E * V * 2.22 \times 10^6 * Y * \exp(-\lambda \Delta t)}$$

where:

MDC is the "a priori" lower limit of detection as defined above (as microcurie per unit mass or volume),

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

E is the counting efficiency (as counts per transformation),

V is the sample size (in units mass or volume),

2.22×10^6 is the number of transformations per minute per microcurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide, and

Δt is the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples).

The value of s_b used in the calculation of the MDC for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. Typical values of E, V, Y, and Δt shall be used in the calculation.

TABLE 6 (Continued)

TABLE NOTATION

b. Analyses shall also be performed following shutdown from > or = 15% RATED THERMAL POWER, startup to > or = 15% RATED THERMAL POWER or a THERMAL POWER change exceeding 15% of the RATED THERMAL POWER within a one hour period.

c. Tritium grab samples shall be taken from the plant vent stack at least once per 24 hours when the refueling canal is flooded.

d. Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing (or after removal from sampler). Sampling shall also be performed at least once per 24 hours for at least 2 days following each shutdown from > or = 15% RATED THERMAL POWER, startup to > or = 15% RATED THERMAL POWER or THERMAL POWER change exceeding 15% of RATED THERMAL POWER in one hour and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding MDC may be increased by a factor of 10.

e. Tritium grab samples shall be taken at least once per 7 days from the ventilation exhaust from the spent fuel pool area, whenever spent fuel is in the spent fuel pool.

f. The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Specifications 3.11.2.1, 3.11.2.2 and 3.11.2.3.

g. The principle gamma emitters for which the MDC specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emmissions. This list does not mean that only these nuclides are to be detected and reported. Other which are measureable and identifiable, together with the above nuclides, shall also be identified and reported.

h. Deviations from MDC requirements of Table 4.11-2 shall be reported per Specification 6.9.1.8 in lieu of any other report.

i. A composite particulate sample is one in which the quantity of air sampled is proportional to the quantity of air discharged. Either a specimen which is representative of the air discharged may be accumulated and analyzed or the individual samples may be analyzed and weighted in proportion to their respective volume discharged.

j. The principal gamma emitters for which the MDC specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions. This does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable together with the above nuclides, shall also be identified and reported.

TABLE 7

LIQUID DISCHARGES NOT MEETING SPECIFIED DETECTION LIMITS
Farley Units 1 & 2 - 1st half, 1984

Batch #	N/A*
Date	N/A
Count Time in Seconds	N/A
Volume Discharged in Gallons	N/A
Dilution Water in Gallons	N/A
Total Isotopic Acitvity (uCi/ml)	N/A
Isotope of Interest	N/A
MDC Measured	N/A
% of Total Isotopic Activity	N/A
% of Total Dose	N/A

* No liquid discharges made that did not meet specified detection limits.

12. Process Control Program

The Process Control Program (PCP) has been revised to allow implementation of the cement solidification process required to meet the stablity requirements of 10 CFR 61. The change to the PCP is described in Section B of the plant Manual, FNP-0-M-030, " Process Control Program. " In accordance with STS section 6.13.2, the change is provided as Attachment A. Information which supports the rationale for the change and which provides the determination that the change did not reduce the overall conformance of the solidified waste program to existing criteria for solid wastes is provided as Attachment B, " Topical Report - Cement Solidified Waste to Meet the Stability Requirements of 10 CFR 61. " Documentation that the change was reviewed and found acceptable by the Plant Operations Review Committee is provided as Attachment C.

ATTACHMENT A

PROCESS CONTROL PROGRAM CHANGE

EXERPT FROM FNP-0-M-030,

" PROCESS CONTROL PROGRAM "

FNP-0-M-030
April 2, 1984
Revision 0

ALABAMA POWER COMPANY

JOSEPH M. FARLEY NUCLEAR PLANT

UNITS 1 AND 2

PROCESS CONTROL PROGRAM

SUPERSEDED

Approved:

C. D. Nesbitt
Technical Superintendent

Date Issued: 4-2-84

List of Effective Pages

		WHNI Revision	Number of Pages
Section A Dewatering			
STD-P-03-003	RADLOCK^{RM} Manway Lid Closure and Sealing Procedure	6	4
STD-P-03-005	Dewatering Bead Ion Exchange Resin in HITTMAN RADLOK^{TM} Containers with Flexable Underdrains to Less Than 1% Drainable Liquid	4	5
STD-D-03-008	A Users Manual for the HITTMAN RADLOCK^{TM}-55	3	6
STD-P-03-008	Dewatering Powdered Resin in a HITTMAN RADLOCK^{TM}-100 or 200 Container with Flexable Underdrain Assembly to Less Than 1% Drainable Liquid	1	5
STD-D-03-009	A Users Manual for the HITTMAN RADLOK^{TM}-100 and RADLOK^{TM}-200 High Integrity Containers	4	7
STD-P-03-010	Preoperation & Operation Procedures for HITTMAN Bead Resin Transfer & Dewatering in a High Integrity Container	2	7
STD-P-03-013	Verification Program for HITTMAN Layered Dewatering System	0	7
STD-P-04-002	P.C.P. for Dewatering Ion Exchange Resin & Activated Charcoal Filter Media to ½% Drainable Liquid	2	4
Section B Solidification			
STD-P-05-001	P.C.P. for Incontainer Solidification for Powdered Resin	3	19
STD-P-05-002	P.C.P. for Incontainer Solidification of Oily Waste	2	12
STD-P-05-003	P.C.P. for Incontainer Solidification of 10 to 14 Weight Percent Boric Acid	2	12
STD-P-05-004	P.C.P. for Incontainer Solidification of Bead Resin	3	15

		WHNI Revision	Number of Pages
STD-P-05-007	P.C.P. for Incontainer Solidification of 15 to 20 Weight Percent Boric Acid	1	12
STD-P-05-008	P.C.P. for Incontainer Solidification of Sodium Sulfate Slurries (0-30 Weight % Solids)	5	27
STD-P-05-009	P.C.P. for Incontainer Solidification of Sodium Sulfate Slurries Containing Powdered or Bead Resins	1	20
STD-P-05-010	P.C.P. for Incontainer Solidification of 25 to 30 Weight Percent Boric Acid	1	12
STD-P-05-014	Sodium Sulfate Solidification Procedures	0	5
STD-P-05-015	P.C.P. for Incontainer Solidification of 20 to 25 Weight Percent Boric Acid	1	12
STD-P-05-021	P.C.P. for Incontainer Solidification of Decanted Diatomaceous Earth Filter Sludge	0	12
STD-P-05-022	Calcium Hydroxide Addition Procedure	0	5
F434-P-005	P.C.P. for Incontainer Solidification of Dilute Filter Sludge	1	10
STD-P-05-025	P.C.P. for Incontainer Solidification of Sodium Sulfate Slurries Containing Mixed Solids	0	24
Section C Equipment Information			
F524-S-001	Radwaste Demineralization & Solidification Skid Fabrication	0	4
STD-D-01-001	Operation & Maintenance Manual Standard Dewatering Pump Skid	1	18
STD-S-03-007	Fabrication Specification for Steel Liners	2	8
STD-P-04-001	Final Dewatering Pump Skid Operating Instructions	1	8
STD-D-05-001	Standard Dewatering Pump Skid System Description	0	2
STD-P-02-002	Leak Test Procedure for Hittman Casks with Vent and/or Drain	0	9

		WHNI Revision	Number of Pages
Section D Reports			
STD-R-03-002	Report on Dewatering of Bead Ion Exchange Resin and Activated Carbon in HITTMAN RADLOK™ High Integrity Containers	0	16
STD-R-01-001	Dewatering of Bead ION Exchange Resin and Activated Carbon	0	17
STD-R-05-005	HITTMAN Waste Qualification Program Report for Cement Solidified Wastes	1	29
Section E General Specifications			
HNDC-S-L001	Radioactive Waste Container General Specification	8	5
HNDC-TS-13000	Field Assembly & Operating Procedure for Flexcon Cement Feed System	1	6
HNDC-TS-14000	Liner Loading Procedure	2	3
NDC-TS-17000	Mixer Head Drive Mounting Procedure (Hydraulic / Electric)	1	2
HNDC-TS-19000	Field Assembly & Operating Procedure for Electric Mixer Drive Assembly	2	6
HNDC-TS-20000	Boric Acid Solidification Procedure	2	5
HNDC-TS-25000	Dewatering Pump Skid (Standard) Operating Procedure	0	2

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-001	Rev: 3	Rev Date: 12-27-83
	Title: Process Control Program for Incontainer Solidification for Powdered Resins		

Rev.	Rev Date	Prepared by	Supervisor Laboratory Services	Director Engineering	Manager Field Services	QA	ECN
0	12-15-81						----
1	12-22-81						81-305
2	2-10-82						82-024
3	12-27-83					D. Sillyman	ECN-83-285

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No. 03

PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF POWDERED RESIN

1.0 Scope

This procedure is applicable to the solidification of powdered resin classified as either Class A, Class B or Class C wastes under the requirements of 10 CFR 61.55, Waste Classification.

2.0 Purpose

2.1 The purpose of the Process Control Program (PCP) for incontainer solidification of powdered resin is to provide a program which will assure a solidified product which meets the requirements of 10 CFR 61.56, Waste Characteristics.

The program consists of three major steps, which are:

(a) Procedures for collecting and analyzing samples;

(b) Procedures for solidifying samples;

(c) Criteria for process parameters for acceptance or rejection as solidified waste.

2.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the acceptable ratio of waste, additional water (if required), cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into the recommended quantity of cement and additive that must be mixed with the waste. Assurance that the proper quantity of cement and additive is actually mixed with the waste is covered in the Field Solidification Operating Procedures.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BWR's the PCP shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as quantity of waste required to fill a disposable

liner with the appropriate quantity of waste prior to solidification.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification, then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidifications. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, where handling of samples could result in personnel radiation exposures which are inconsistent with the ALARA principle, representative non-radioactive samples will be tested. These samples should be as close to the actual wastes' chemical properties as possible. Typical unexpended powdered resin shall be used, with the appropriate anion to cation mix to simulate used material.

3.2 Collection of Samples

3.2.1 Radiological Protection

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by placing in the solidified liner.

3.2.1.3 A Test Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Test Solidification Data Sheet

The Test Solidification Data Sheet will contain pertinent information on the characteristics of

the test sample solidified so as to verify solidification of subsequent batches of similar wastes without retesting.

3.2.2.1 The test sample data for powdered resin will include, but not necessarily be limited to, the type of waste solidified, volume of sample and the quantity of any additives used to precondition the waste.

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

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.2 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification. For Class A wastes, approximately 6 hours are required to perform and verify the test solidification, and to allow for retesting, if necessary. For Class B or Class C wastes, approximately 28 hours are required.

3.2.3.3 The waste to be solidified should be mixed for 10 minutes, or recirculated in the tank for at least three volume changes, prior to sampling to assure a representative sample.

3.2.3.4 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. These samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.1. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

4.7 Solidification of Off Design Weight Percent Slurries of Class A Powdered Resin.

4.7.1 If the mass balance data sheets from the Field Assembly and Operating Procedures for Powdered Resin Transfer and Dewatering System show the dry weight percent slurry to be less than 28 percent, refer to Footnote 4 on page 11.

Solidification No: _____
Liner No: _____
Sample No: _____
Date: _____

CLASS A TEST SOLIDIFICATION DATA SHEET
for Powdered Resin

Sample Volume, ml: _____ (1)

pH[1]: _____ Volume NaOH solution used to adjust pH, ml: _____ (2)

Quantity of oil %: _____ (3)

Quantity of emulsifier (20% by volume of oil) ml[1]: _____ (4)

Quantity of anti-foaming agent, ml: _____ (5)

Quantity of Cement Added: Cement Ratio[2] (#/ft[3] Waste)

Sample _____gms Sample _____ (6)

Quantity of Additive Added: Additive Ratio[3] (#/ft[3] Waste)

Sample _____gms Sample _____ (7)

Product Acceptable: Sample _____Yes_____No (If no, refer to Section 4.6 and proceed as directed).

Additional batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by: _____ Date _____

Acceptance Verified by: _____ Date _____

FOOTNOTES:

[1]If pH adjustment is required to bring the pH > 5.0, note chemical used, quantity used and pH after adjustment.

[2]For the ratios given in Section 4.2.4, the cement-to-waste ratio is 48.7 pounds of cement per cubic foot of settled powdered resin. If a quantity of cement is used for the test solidification that is different from the quantity listed in Section 4.2.4, multiply the gms cement by 0.218 to obtain the correct pounds of cement per cubic foot of settled powdered resin.

[3]For the ratios given in Section 4.2.4, the additive-to-waste ratio is 4.9 pounds additive per cubic foot of settled powdered resin. If alternate additive ratios are used see the multiplier in Note 2 to obtain the correct pounds of additive per cubic foot of powdered resin.

[4]The following table shows the minimum mix ratio for a 390 gms sample size of 5 to 27 dry weight percent powdered resin:

	Minimum			
Slurry Concentration, Dry Weight Percent	Cement (gms)	Additive (gms)	Cement (lb/ft^3)	Additive (lb/ft^3)
5 - 12	429	42.4	93.5	9.4
13 - 21	351	35.1	76.6	7.7
22 - 27	234	23.4	51.0	5.1

CLASS 'A' WASTE SOLIDIFICATION CALCULATION SHEET

Waste Volume to be Solidified[1]: _____ (1)

Cement Ratio, #/ft^3: Sample _____ (2)
Item 2 - Form STD-P-05-001-01

Additive Ratio, #/ft^3: Sample _____ (3)
Item 3 - Form STD-P-05-001-01

Cement Quantity[2]

_____(1) x _____ (2) = _____ lbs. (6)
Waste Volume lb/ft^3

Additive Quantity[2]

_____(1) x _____ (3) = _____ lbs. (7)
Waste Volume lb/ft^3

Quantity of Water to be added:

_____(1) x _____^{3} = _____ gallons (8)
Waste Volume gal/ft^3

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

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

Quantities of additional additives that must be added to the liner are found by multiplying the volume of the additive used in the test solidification, in ml, by 0.0249 and then by the volume of waste to be solidified. Volumes of additional additives are taken from items 2, 4, and 5 on Form STD-P-05-001-01:

_____ ml x 0.0249 x _____ (1) = _____ gallons (11)
Item 2, 4, or 5
Form STD-P-05-001-01

[1]The quantity of waste to be solidified in a single liner can not exceed the maximum waste volume listed on Form STD-P-05-001-03 Class A Waste Solidification Data Table.

[2]6 and 7 define the recommended quantity of cement and additive respectively that must be mixed with the waste to assure solidification.

[3]For decanted powdered resin, add 2.02 gallons of water per cubic foot of settled waste and 2.36 gallons of water per cubic foot of dewatered powdered resin.

[4]Reduce the quantity of waste in the liner by 1 ft^3 for every 10 gallons of additional additive.

CLASS 'A' WASTE SOLIDIFICATION DATA TABLE
for Powdered Resins

	HN-600[1]	HN-200
Usable Liner Volume, ft^3	65	60
Max. Solidified Waste Vol. ft^3	65	60
Max. Dewatered or Decanted Waste Vol., ft^3	42.4[2]	39.2[3]
Cement Added at Max. Waste Vol.: Pounds	2063	1910
: 1 ft^3 bags	22	20½
Water Added at Max Waste Volume: gallons		
Dewatered	100	93
Decanted	86	79
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.: Pounds	206	191
: 100 lb. bags	2	2
Max. Radiation Level R/hr Contact of Liner	100	800

[1] Values shown for regular and grappable. Multiply all values by 0.922 for stackable or 0.893 for the grappable/stackable liners.

[2] Based on 18" maximum depth of filter sludge in the liner, 16-3/4 inches in the stackable or grappable/stackable.

[3] Based on 31½" maximum depth of filter sludge in the liner.

Solidification No: _____
Batch No: _____
Sample No: _____
Date: _____

CLASS B AND C TEST SOLIDIFICATION DATA SHEET
for Powdered Resin

I. Sample Preparation

Sample Volume, ml: _____ (1)

Initial pH: _____ Quantity of Oil[1], % _____

Grams $Ca(OH)_2$ to raise pH to ≥ 11.0[2], gm: _____ (2)

Grams Portland Type I Cement added, gm: _____ (3)

II. Sample Inspection

Sample cured for 24 hours[3] @ 120°F ± 5° F:

_____ Verified by _____ Date

Sample contains 'No Free Liquid':

_____ Verified by _____ Date

Sample is 'Free Standing Monolith':

_____ Verified by _____ Date

III. Parameters for Full Scale Solidification:

Quantity of $Ca(OH)_2$: _____ (2) gm $Ca(OH)_2$ from above
x 0.172 = _____ lb $Ca(OH)_2$ per ft^3 decanted/dewatered powdered resin (4)

Quantity of Cement: _____ (3) gm Cement from above
x 0.172 = _____ lb Portland Type I Cement per ft^3 decanted/dewatered powdered resin (5)

[1]Must be ≤1% of waste volume.

[2]Added in accordance with Section 4.3.5.

[3]If the sample is qualified in less than 24 hours cure time note the total hours cured.

CLASS B AND C WASTE SOLIDIFICATION CALCULATION SHEET

Waste Volume to be Solidified[1]: _____ (1)

$Ca(OH)_2$ Ratio; #/ft^3: _____ (Item 4, Form STD-P-05-001-04) (2)

Cement Ratio; #/ft^3: _____ (Item 5, Form STD-P-05-001-04) (3)

Quantity of Water to be Added:

_____ (1) x _____[2] gal/ft^3 = _____ gallons (4)

Quantity of Calcium Hydroxide ($Ca(OH)_2$) to be added:

$\frac{\text{\_\_\_\_\_}}{\text{Waste Volume}}$ (1) x $\frac{\text{\_\_\_\_\_}}{\text{lb/ft}^3}$ (2) = _____ lbs. (5)

Quantity of Cement (Portland Type I) to be added:

$\frac{\text{\_\_\_\_\_}}{\text{Waste Volume}}$ (1) x $\frac{\text{\_\_\_\_\_}}{\text{lb/ft}^3}$ (3) = _____ lbs. (6)

[1]The volume of waste, either dewatered or decanted settled solids, to be solidified in a liner cannot exceed the maximum settled waste volume listed on Form STD-P-05-001-06, Class B Waste Solidification Data Table.

[2]For decanted powdered resin, add 2.75 gallons of water per cubic foot of settled waste, and 3.12 gallons of water per cubic foot of dewatered waste.

CLASS B AND C WASTE SOLIDIFICATION DATA TABLE
for Powdered Resin

	HN-600[1]	HN-200
Usable Liner Volume, ft^3	65	60
Max. Solidified Waste Vol., ft^3	65	60
Max. Settled Waste Vol., ft^3	36.5[2]	33.7[3]
Water Added at Max. Waste Volume:		
Dewatered	114	105
Decanted	100	93
$Ca(OH)_2$ Added	--[4]	--[4]
Cement Added at Max. Waste Vol : Pounds	2787	2574
: 1 ft^3 bags	29.7	27.4
Max Radiation Level R/hr. Contact of Liner	100	800

[1] Values shown for plain and grappable liner. Multiply all values by 0.922 for stackable or 0.893 for the stackable/grappable liners.

[2] Based on 15 inches of settled powdered resin in the liner, 14 inches for stackable and stackable/grappable.

[3] Based on 28½ inches of settled powdered resin in the liner.

[4] To be calculated for each solidification in accordance with Section 4.3.5, Item 4, Form STD-P-05-001-04 and Item 5, Form STD-P-05-001-05.

APPENDIX A

CONCENTRATION OF POWDERED RESIN SLURRIES FOR PCP SOLIDIFICATION

In order for powdered resin slurry samples to be solidified in accordance with this PCP, these samples must be concentrated to a higher weight percent solids. The simplest, easiest, and most accurate procedure to use is decanting, i.e., pouring off excess liquid until only a thin layer of liquid remains on the settled solids layers. Decanting is to be performed after the sample has been allowed to sit undisturbed for two hours. The excess water is then poured off, being careful not to lose any solids. If there is not enough sample to perform the PCP, the procedure is to be repeated until the required quantity is obtained.

If the radiation level of the sample is too high for such handling, a decanting apparatus may be assembled much like that shown in Figure 1. The materials used depend upon availability and H.P. requirements. This set up would allow for less physical handling of the sample by the person performing the test. The decant beaker should have the tube located at the 400 ml mark. A two hour settling time is required. At that time, the stopcock (or clamp) is opened to allow the liquid to drain off of the solids layer. If more than a thin layer of water remains on the settled layer, the sample will have to be decanted as described above. Also, if less than the required slurry quantity results, additional waste must be decanted in the same manner to the prescribed amount.

Following this procedure will result in the proper weight percent slurry as required by the PCP. H.P. requirements will govern which of the two procedures should be used.

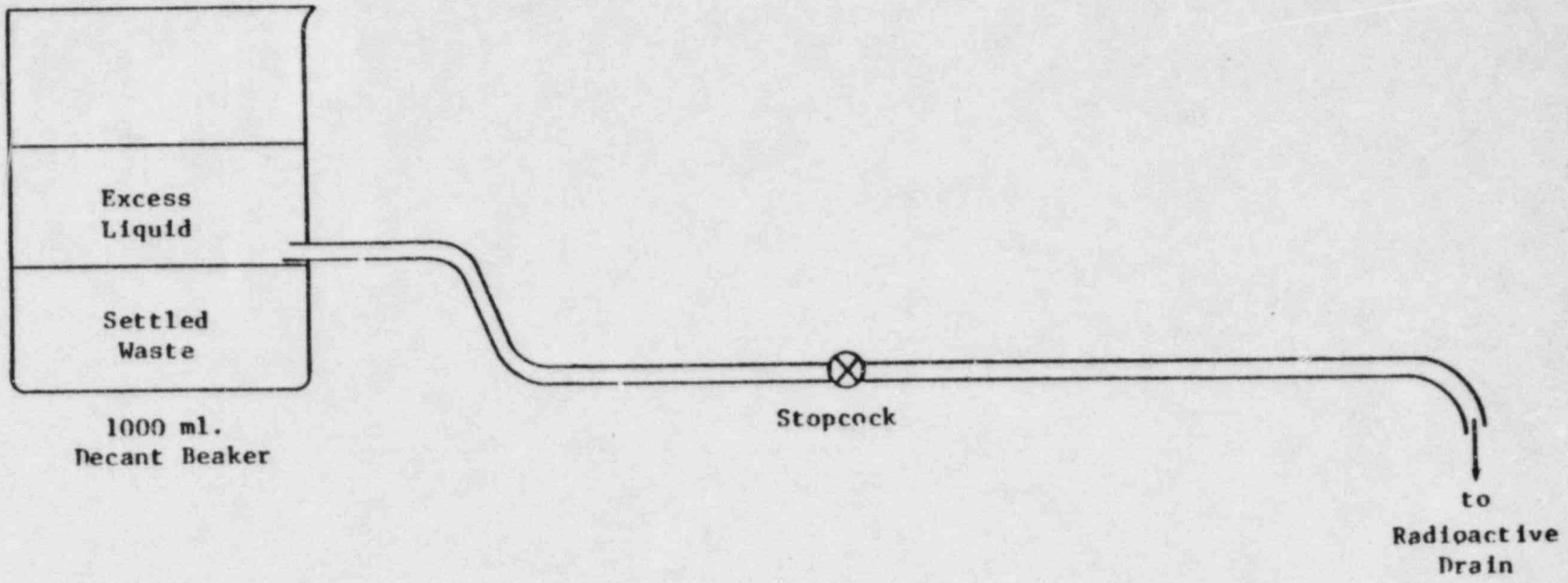

Figure 1. Decanting Apparatus Schematic

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-002	Rev: 2	Rev Date: 7-2-82
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Rev.	Rev Date	Prepared by	Supervisor Laboratory Services	Director Engineering	Manager Field Services	QA	
0	11-17-81		E. Cloran				
1	6-9-82	E Cloran	E Cloran			J. Pawlik for B. Howe	ECN-82-124
2	7-2-82	E Cloran	E Cloran				ECN-82-137

PROCESS CONTROL PROGRAM
for
SOLIDIFICATION OF OILY WASTE WATER

1.0 Purpose

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

The program consists of the following four major steps:

a. Procedures for collecting and analyzing samples.

b. Procedures for conditioning the waste water samples.

c. Procedures for solidifying the samples.

d. Criteria and process parameters for acceptance as solidified waste.

2.0 System Description

The system described herein is designed to solidify oily liquid waste at concentrations up to 40 percent oil by volume. The various operations are described below.

2.1 Waste Feed System

Due to the low activity levels associated with oily wastes the liners in which the oil is to be solidified can be filled by hand. Oily waste which has been collected in small quantities, up to 55 gallon drums, are skimmed of the oil floating on top and deposited in a larger liner. When the liner is filled to a preset level with oil, water is added to dilute the oil. In lieu of water, a volume of liquid waste, such as 4 percent boric acid, can be added to the oil.

2.2 Emulsifier Feed

Liquid emulsifier is added using a small positive displacement pump. The quantity of emulsifier required is determined prior to being added and only that amount required is used.

2.3 Cement and Additive Feed

Cement and additive are added from bags to the liner.

2.4 Mixing

Each liner is supplied with an internal mixing device designed to provide thorough mixing of the entire liner contents. A mixing motor mounted on top of the liner prior to the filling operation is started before the emulsifier is added. Mixing continues for approximately twenty minutes after the cement is added or until the motor trips automatically due to high resistance to mixing. The mixture will be completely firm within four to six hours and be suitable for transport within 24 hours.

2.5 Vent Air Filter Subsystem

The fill head also includes an elbowed vent connection to which a vent hose is connected to allow the air being vented from the liner to be conveyed to the vent air filter.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWRs and BWRs, the PCP shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste (e.g., evaporator bottoms, boric acid solution, sodium sulfate solutions, etc.).

3.1.2 For the purpose of the PCP a batch is defined as that quantity of waste solidified in a single liner.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternative solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification then representative test specimens shall be collected from each consecutive batch of the same type until three (3) consecutive initial test specimens demonstrate solidification. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

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

3.2 Collection of Samples

3.2.1 Radiological Protection

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

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

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

3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of wastes solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

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

3.2.2.1 The test sample data will include, but not be limited to, the type of waste solidified, major constituents, percent solids, pH, volume of sample, amount of oil in sample and the ratio of the sample volume to the final volume of the solidified product.

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

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for analysis. Sample sizes shall be compatible with the standard size sample used in the plant multichannel analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the Plant Health Physics Staff.

3.2.3.2 Samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification, and to allow for retesting if necessary.

3.2.3.3 The liner containing the waste to be solidified should be mixed for at least ten minutes prior to sampling to assure a representative sample. The sample is to be taken immediately after the

mixer is stopped. The sample shall be taken after the waste is diluted but prior to the addition of the emulsifier.

3.3 Analysis of Samples

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

3.3.1 Oily wastes should be analyzed for the following applicable parameters.

a. pH
b. Boron or Boric Acid
c. Oil (percent by volume)
d. Weight percent solids
e. Any other suspected major constituent

4.0 Test Solidification and Acceptance Criteria

4.1 Waste Conditioning

4.1.1 Allow two samples to stand undisturbed until the water/oil interface is clearly discernable and determine the percent; by volume, of the sample that is oil. If this volume is greater than 40 percent, add a sufficient quantity of water (or other liquid to be solidified) to reduce the percent oil to less than 40 percent. Use the Waste Calculation Data Sheet to determine the quantity of liquid to add. When the correct oil to water ratio is reached, measure and record the pH.

4.1.2 Prior to the test sample solidification, the oily waste is treated with a predetermined quantity of emulsifier. For this application, Maysol 776 is used at a ratio of 1 part emulsifier to 5.1 parts oil by volume. The emulsifier has a density of one (1).

4.2 Test Solidification

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

4.2.2 Test solidifications should be conducted using a 1000 ml. disposal beaker or similar size container.

4.2.3 For the test solidifications of oily waste, measure into two mixing vessels 320 ml. of the waste to be solidified, at an oil concentration of 40 percent or less by volume.

4.2.4 Measure out two 25 ml portions of Maysol 776 and add one portion to each beaker. Mix with a stirrer which will provide sufficient stirring action that a homogeneous mixture is obtained (i.e., use magnetic stirrer or mixing motor). Mixing time should in no case be shorter than five (5) minutes.

4.2.5 Measure out the required quantities of cement and anhydrous sodium metasilicate as shown below.

	Grams Cement		Grams Anhydrous Sodium Metasilicate	
Waste	Sample A	Sample B	Sample A	Sample B
Oil	400.0	434.0	46.3	50.0

4.2.6 Slowly add the cement to the waste mixture while stirring continuously.

4.2.7 After the cement is added, slowly add the anhydrous sodium metasilicate and slowly mix into the waste until completely dissolved.

4.2.8 After five (5) minutes of mixing and a homogeneous mixture is obtained, allow the waste to stand for a minimum of two (2) hours.

4.2.9 The sample is then tested using the solidification acceptability criteria in 4.3.

4.3 Solidification Acceptability

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

4.3.1 The sample solidification is considered acceptable if there is no visual or drainable free water.

4.3.2 The sample solidifications is considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration by a rigid stick.

4.4 Alternate Solidification Procedure

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

(1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.

(2) If the waste is only partially solidified, try using lower waste to cement ratios. Reduce the quantity of waste by 20 ml. and the emulsifier by 1 ml., (this will result in a slightly higher concentration of emulsifier in the waste) and

proceed with the test solidification. Continue with similar reductions until a satisfactory product is achieved.

Batch No: _____

Sample No: _____

Date: _____

WASTE SOLIDIFICATION DATA SHEET FOR OILY WASTE

Volume % Oils: _____ %
(Maximum of 40% by volume)

Sample Volume, ml: _____

Major Composition of Non-oil Component: _____

Quantity of Emulsifier Added, ml: _____

pH _____

Quantity of Cement Added, gm: _____

Quantity of Anhydrous Sodium Metasilicate Added, gm: _____

Final Product to Waste Ratio (Volumetric) _____ %

Product Acceptability: _____ Acceptable _____ Unacceptable
If unacceptable, note why:

Radionuclides Present.
Isotopes and Concentrations

(1) If the percent of oil in the sample exceeds the maximum allowable quantity, the sample shall be diluted as required (see the Waste Calculation Data Sheet). This new mixture will be thoroughly mixed, tested for % oil and a new sample taken from this mixture as per Section 4.2.3. The volume of dilutant required will be recorded.

WASTE CALCULATION DATA SHEET FOR OILY WASTE

Complete Section A only if the initial samples shows oil in excess of 40% by volume, otherwise go to Section B.

SECTION A

Step 1 Original samples volume _____ ml. (1)

Volume % oil in sample ___0.___ as decimal fraction) (2)

Step 2 Sample volume (ml) multiplied by (2): =

_____ (ml) X ___0.___ = _____ (ml) (3)

Step 3 Divide (3) by 0.4: _____ ÷0.4 = _____ (4)

Step 4 Subtract original sample volume (1) from (4) to get quantity of liquid needed to dilute sample to 40% oil by volume:

_____ (4) - _____ (1) ml (5)

SECTION B

Step 1 Volume of waste in liner, gallons: _____ (6)

(HN-100 liner contains 17.62 gallons/inch). The maximum allowable waste depth is 42 inches.

Step 2 If the volume percent oil is greater than 40% it is necessary to determine the amount of liquid (i.e., water) that must be added to the liner to reduce the percent oil to less than 40% (If the fluid level in the liner is close to 42 inches such that the addition of any liquid would raise the fluid level above the 42 inches level proceed to Step 3). Take the quantity of liquid (5), added to the test sample in Section A and divide it by the original sample volume (1). Multiply this decimal fraction increase by the volume of fluid in the liner to obtain the quantity of liquid needed to dilute the contents of the liner to less than 40% oil by volume.

$$\frac{\text{(5) ml}}{\text{(1) ml}} = \frac{0.}{} \times \text{(6)} \_\_\_\_\_ \text{gal} = \_\_\_\_ \text{gal} \quad (7)$$

Calculate new fluid level in liner. Add (7) to (6) and divide by 17.62 gallons/inch and add this increased depth to the original fluid depth.

$$\frac{(6) + (7) \text{ gallons}}{17.62 \text{ gallons/inch}} = \text{\_\_\_\_\_ inches} \quad (8)$$

(8) must not exceed 42 inches. If it does, do not add any liquid to the liner but proceed to Step 3. If the fluid level (8) is less than or equal to 42", add the quantity of liquid calculated in (7) to the liner and proceed to Step 4.

Step 3 This step is to be completed only when the quantity of oil in the liner exceeds 40% by volume and diluting with water would raise the fluid level above 42 inches.

Multiply the original samples volume (1) by 0.4:

$$\frac{(1)(\text{ml})}{} \times 0.4 = \text{\_\_\_\_\_} \quad (9)$$

Subtract (9) from (3) above:

$$\text{\_\_\_\_\_}(3) - \text{\_\_\_\_\_}(9) = \text{\_\_\_\_\_ ml} \quad (10)$$

Divide (10) by the original sample volume (1) to obtain the decimal fractional decrease in sample oil volume to bring the percent oil down to 40 by volume.

$$\frac{\text{\_\_\_\_\_}(10)}{(1)} = \frac{0.\text{\_\_\_\_\_}}{} \quad (11)$$

Multiply the volume of waste in the liner (6) by this decimal fraction (11).

$$\text{\_\_\_\_\_}(6) \times \text{\_\_\_\_\_}(11) = \text{\_\_\_\_\_ gallons} \quad (12)$$

This represents the quantity of oil that must be removed from the liner, and replaced by an equal volume of liquid waste, to bring the percent oil down below 40 percent by volume. To do this, first allow the fluid in the liner to stand undisturbed for a period of 15 minutes and then pump oil out using a rubber hose extended into the liner to a level just below the top of the oil layer.

Step 4 If the lab sample showed less than 40% oil by volume proceed without an additional sample and enter below the volume % oil in the liner.

Vol. % oil 0. (13)

If liquid was added to dilute the oil (Step 2) or oil was removed (Step 3) mix the contents of the liner for 15 minutes and resample to confirm the volume percent oil in the liner and enter below. (If not applicable enter N/A).

Resample Vol. % oil 0. (14)

Measure the fluid level in the liner. Again this level must not exceed 42 inches.

Fluid level _____ inches (15)

Calculate the quantity of oil in the liner by multiplying the fluid level (in inches) by the gallons per inch (17.62 gallons per inch) by the percent oil by volume from either (13) or (14).

_____ inches (15) x 17.62 $\frac{\text{gallons}}{\text{inch}}$ x 0. (13 or 14) =

_____ gallons (16)

Step 5 With the mixing motor "ON" add the emulsifier Maysol 776 at 1 part emulsifier to 5.1 parts oil by volume. To obtain the quantity of Maysol 776 required, divide the gallons of oil (16) by 5.1.

$$\frac{\text{(16) gallons}}{\frac{\text{5.1 gallons oil}}{\text{gallon emulsifier}}} = \text{\_\_\_\_\_ gallons of emulsifier} \quad (17)$$

Continue mixing until the oil is completely mixed and the contents of the liner is a uniform milky white in appearance. Record the mixing time.

_____ minutes mixing

Note that mixing times of up to 120 minutes may be required to completely emulsify some oils.

Step 6 For every gallon of fluid in the liner add 10.4 to 11.3 pounds of uncompacted cement. This is equivalent to 78 to 84.2 pounds of cement for every cubic foot of waste.

To calculate the quantity of cement required, multiply the fluid level (15) by 17.62 gallons per inch by 11.2 pounds cement per gallon of fluid.

$$\underline{\quad}^{(15)} \times 17.62 \times 11.3 = \underline{\quad}\text{ pounds of cement} \qquad (19)$$

Convert this to cubic feet of loose cement by dividing (19) by 94 pounds per cubic foot.

$$\frac{(19)\text{ pounds}}{94\text{ pounds per ft}^3} = \underline{\quad}\ \text{ft}^3$$

This is equivalent to the number of one ft^3 bags required.

Add the cement slowly while mixing continually until all the cement is added.

Step 7 For every gallon of fluid in the liner, add 1.2 to 1.3 pounds of anhydrous sodium metasilicate. This is equivalent to 9.0 to 9.7 pounds of additive for every cubic foot of waste. To calculate the quantity of anhydrous sodium metasilicate required, multiply the fluid level (15) by 17.62 gallons per inch by 1.3 pounds additive per gallon of fluid.

$$\underline{\quad}^{(15)} \times 17.62 \times 1.3 = \underline{\quad}\text{ pounds anhydrous sodium metasilicate} \qquad (20)$$

Convert this to cubic feet of additive by dividing(20) by 100 pounds per cubic foot.

$$\frac{(20)\text{ pounds}}{100\text{ pounds per cubic foot}} = \underline{\quad}\ \text{ft}^3$$

This is equivalent to the number of one ft^3 bags required. Add the anhydrous sodium metasilicate slowly and continue mixing the contents of the liner until all the additive has been added and the motor trips due to high resistance to mixing or for 20 minutes after the last bag is added.

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-003	Rev: 2	Rev Date: 12-8-83
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Rev.	Rev Date	Prepared by	Reviewed by	Supervisor Laboratory Services	Director Engineering	Manager QA	
0	1-5-82	[signature]	[signature]	[signature]	[signature]	[signature]	
1	12-14-82	K. McDaniel	[signature]	[signature]	[signature]	[signature]	ECN-82-263
—	———	Director Engr.	Project Manager	QA Manager	———	———	———
2	12-8-83	[signature] for BL	[signature]	[signature]			ECN-83-276

PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF 10 TO 14 WEIGHT PERCENT BORIC ACID

1.0 Purpose

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

The program consists of four major steps, which are:

(a) Procedures for collecting and analyzing samples;

(b) Procedures for solidifying samples;

(c) Criteria for process parameters for acceptance or rejection as solidified waste.

(d) Calculation of minimum and recommended quantities of cement and anhydrous sodium metasilicate to be used in full scale liner solidifications.

1.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the range of acceptable ratios of waste, cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into minimum and recommended quantities of cement and additive that must be mixed with the waste. Assurance that quantities of cement and additive between these ranges are actually mixed with the waste is covered in the Field Services Weekly Report.

2.0 System Description

To be added for each specific plant.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BRW's the PCP shall be used to verify the solidification of at least one representative test specimen from every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a disposable liner to the waste level indicator.

3.1.3 If the initial test specimen from a batch of waste fails to verify solidification, representative test specimens shall be collected from consecutive batches of the same type of waste. When three consecutive test specimens demonstrate solidification using the initial solidification parameters, the testing may be suspended until every tenth batch.

3.1.4 If any test specimen from paragraph 3.1.3 fails to solidify using the initial solidification parameters, alternate parameters must be established. These new parameters will be tested until three consecutive batches demonstrate solidification.

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

3.2 Collection of Samples

3.2.1 Radiological protection.

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

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by placing in the disposal liner after solidification.

3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of wastes solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

The Waste Solidification Data Sheet will contain pertinent information on the characteristics of the

test sample solidified so as to verify solidification of subsequent batches of similar wastes without retesting.

3.2.2.1 The test sample data for boric acid waste will include, but not necessarily be limited to, the type of waste solidified, percent solids, pH of waste, volume of sample, amount of oil in sample and the ratio of the sample volume to the final volume of the solidified product.

3.2.2.2 The Waste Solidification Data sheet will include the Liner Number, Waste Volume, and Date Solidified, for each batch solidified.

3.2.3 Collection of Samples

3.2.3.1 Evaporator bottoms shall be kept heated or reheated to 100°F prior to testing.

3.2.3.2 Two samples shall be taken for solidification. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.3 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification, and to allow for retesting if necessary.

3.2.3.4 The waste to be solidified should be mixed or recirculated in the tank for at least three volume changes prior to sampling to assure a representative sample.

3.2.3.5 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. The samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.2. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Analysis of Samples

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

Parameter	Acceptable Range
pH	7.4 - 9.2 or > 11.5
Boric Acid or Boron	10 - 14 wgt % or 17,400 to 24,500 ppm
Detergents	No appreciable foaming
Oil	<1%

4.0 Test Solidification and Acceptance Criteria

4.1 Waste Conditioning

4.1.1 Prior to the test sample solidification the pH of the sample shall be adjusted to a range of 7.4 to 9.2 or greater than 11.5.

4.1.2 It is recommended that 50 weight percent sodium hydroxide solution be used to adjust the pH. The amount of sodium hydroxide necessary for the pH adjustment shall be recorded.

4.1.3 If large quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded.

4.1.4 If oil is present in quantities greater than 1% by volume, the oil shall be reduced to less than 1% by skimming. Emulsification agents should be used to break up the remaining oil. The quantity of any substance added to the sample for this purpose shall be recorded.

4.2 Test Solidification

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

4.2.2 Test Solidifications should be conducted using a 1000 ml. disposal beaker or similar size container. Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case for less than two minutes.

4.2.3 For the test solidification of the borated wastes, measure into two mixing vessels 400ml of waste each.

4.2.4 Measure out the required quantities of cement and anhydrous sodium metasilicate as shown below.

	Grams Cement		Grams Anhydrous Sodium Metasilicate	
Waste	Sample A	Sample B	Sample A	Sample B
10-14 wgt. % Boric Acid	440	505	63	84.2

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

4.2.6 After mixing for approximately two minutes once all cement and additive are added and a homogeneous mixture is obtained, allow the waste to stand for a minimum of 4 hours.

4.3 Solidification Acceptablility

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

4.3.1 The sample solidifications are considered acceptable if there is no free standing water.

4.3.2 The sample solidifications are considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration.

4.3.3 The sample solidifications establish a range for the ratios of cement and additive to waste that will result in an acceptable product.

4.4 Solidification Unacceptability

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

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

4.5 Alternate Solidification Parameters

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

(1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.

(2) Add additional caustic solution to raise the pH according to section 4.1.1.

(3) If the waste is only partially solidified, use lower waste to cement and additive ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate, reduce the waste sample volume to 375ml and continue reducing the sample volume by 25ml until the acceptability criteria of Section 4.3 are met.

Liner No.:_____
Sample No.:_____
Date:_____

WASTE SOLIDIFICATION DATA SHEET
for
10-14 Weight Percent Boric Acid

Sample Volume, ml: Sample A_____ Sample B_____

Sample pH:_____ Volume NaOH solution used to adjust pH, ml:_____

Quantity of Oil %:_____

Quantity of Emulsifier (20% of vol. of oil), ml[1]:_____

Quantity of Anti-foaming Agent, ml:_____

Temperature at Solidification, °F:_____

Quantity of Cement Added:

Sample A_____gms

Sample B_____gms

Cement Ratio[2] (#/ft^3 Waste)

Sample A_____

Sample B_____

Quantity of Additive Added:

Sample A_____gms

Sample B_____gms

Additive Ratio[3] (#/ft^3 Waste)

Sample A_____

Sample B_____

Packaging Efficiency: $\frac{\text{Waste Volume}}{\text{Solidified Waste Volume}}$

Sample A_____

Sample B_____

Product Acceptable: Sample A____Yes____No (If no, refer to Section 4.5 and proceed as directed)

Sample B____Yes____No

Additional batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by_____ Date_____

[1]If emulsification is not accomplished, call HITTMAN.

[2]The cement ratio is defined as the pounds of cement required to solidify one cubic foot of waste. Ratios is this PCP yield cement ratios of 68.6 lbs/ft^3 and 78.8 lbs/ft^3 for samples A and B respectively.

[3]The additive ratio is defined as the pounds of additive required to solidify one cubic foot of waste. Ratios in this PCP yield additive ratios of 9.8 lbs/ft^3 and 13.1 lbs/ft^3 for samples A and B respectively.

SOLIDIFICATION CALCULATION SHEET

Waste Volume[1], ft^3: _____ (1)

Cement Ratio, $\#/ft^3$: Sample A _____ (2A)

Sample B _____ (2B)

Additive: _____

Additive Ratio, $\#/ft^3$: Sample A _____ (3A)

Sample B _____ (3B)

Cement Quantity[2]

_____ (1)[1] x _____ (2A) = _____ lbs. (4A)

_____ (1)[1] x _____ (2B) = _____ lbs. (4B)

Additive Quantity[2]

_____ (1)[1] x _____ (3A) = _____ lbs. (5A)

_____ (1)[1] x _____ (3B) = _____ lbs. (5B)

[1]The quantity of waste to be solidified in a single liner can not exceed the maximum waste volume listed on the attached Solidification Data Tables.

[2]4A and 5A define the minimum quantity of cement and additive respectively that must be mixed with the waste to assure solidification. The recommended quantities to use are represented by 4B and 5B.

SOLIDIFICATION DATA TABLES

I. For the Minimum Amount of Cement and Additive.

	HN-100 Series 1	HN-100 Series 2	Series 3	HN-100S	HN-100 LVM Series 3*
Usable Liner Volume, (cu. ft.)	143	143	143	143	160.0
Max. Waste Vol. (cu. ft.)	84.8	82.7	104.5	101.9	117
Max. Solidified Waste Vol. (cu. ft.)	116	113.1	143	139.4	160
Cement Added at Max. Waste Vol.					
Weight (lbs.)	5,814.8	5,673.5	7,171.0	6,991.8	8023.5
Volume (bags)	61.9	60.4	76.3	74.4	85.4
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Weight (lbs.)	830.7	810.5	1,024.4	998.8	1146.2
Volume (bags)	8.3	8.1	10.2	10.0	11.5
Max. Radiation Level R/hr Contact	12	12	12	3	12

* For less than A_2 quantities of LSA waste.

SOLIDIFICATION DATA TABLES

II. For the Recommended Amount of Cement and Additive.

	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S	HN-100 LVM Series 3*
Usable Liner Volume, (cu. ft.)	143	143	143	143	160.0
Max. Waste Vol. (cu. ft.)	77.6	75.7	97.1	93.3	108.6
Max. Solidified Waste Vol. (cu. ft.)	114.3	111.5	143	137.4	160.0
Cement Added at Max. Waste Vol.					
Weight (lbs.)	6,112.9	5,964.5	7,651.2	7,350.4	8560.8
Volume (bags)	65	63.5	81.4	78.2	91.1
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Weight (lbs.)	1,016.2	991.6	1,272	1,222	1423.2
Volume (bags)	10.2	9.9	12.7	12.2	14.2
Max. Radiation Level R/hr Contact	12	12	12	3	12

* For less than A_2 quantities of LSA waste.

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-004	Rev: 3.	Rev Date: 12-27-83
	Title: Process Control Program for Incontainer Solidification of Bead Resin		

Rev.	Rev Date	Prepared by	Supervisor Laboratory Services	Director Engineering	Manager Field Services	QA	ECN
0	2-2-82						----
1	11-2-82	K. McDaniel					82-243
2	7-6-83	K McDaniel	E. Closen				83-154
3	12-27-83					D Sillyman	ECN-83-286

DOCUMENT CONTROL
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NO. 004

PROCESS CONTROL PROGRAM

FOR INCONTAINER SOLIDIFICATION OF BEAD RESIN

1.0 SCOPE

This procedure is applicable to the solidification of bead ion exchange resin of the mixed bed type classified as either Class A, Class B or Class C wastes under the requirements of 10 CFR 61.55, Waste Classification.

2.0 PURPOSE

2.1 The purpose of the Process Control Program (PCP) for incontainer solidification of bead resin is to provide a program which will assure a solidified product which meets the requirements of 10 CFR 61.56, Waste Characteristics.

The program consists of three major steps, which are:

(a) Procedures for collecting and analyzing samples;

(b) Procedures for solidifying samples;

(c) Criteria for process parameters for acceptance or rejection as solidified waste;

2.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the acceptable ratio of waste, additional water, cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into the recommended quantity of cement and additive that must be mixed with the waste. Assurance that the proper quantity of cement and additive is actually mixed with the waste is covered in the Field Solidification Operating Procedure.

3.0 COLLECTION AND ANALYSIS OF SAMPLES

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BWR's the PCP shall be used to verify the solidification of at least one representative test specimen from every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as quantity of waste required to fill a disposable

liner with the appropriate quantity of waste prior to solidification.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification, then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidifications. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, where handling of samples could result in personnel radiation exposures which are inconsistent with the ALARA principle, representative non-radioactive samples will be tested. These samples should be as close to the actual wastes' chemical properties as possible. Typical unexpended mixed bed resin shall be used to simulate the spent bead resin.

3.2 Collection of Samples

3.2.1 Radiological protection.

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

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by placing in the solidified liner.

3.2.1.3 A Test Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Test Solidification Data Sheet

The Test Solidification Data Sheet will contain pertiment information on the characteristics of the test sample solidified so as to verify solidification of subsequent batches of similar waste without retesting.

3.2.2.1 The test sample data for spent resin will include, but not necessarily be limited to, the type of waste solidified, volume of sample, sample number and the quantity of any additive used to precondition the waste.

3.2.2.2 The appropriate Test Solidification Data Sheet will include the Solidification Number, Liner Number, Waste Volume, and Date Solidified, for each batch solidified.

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.2 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification, and to allow for retesting if necessary. For Class A Waste approximately 6 hours are required to perform and verify the test solidification. For Class B wastes, approximately 28 hours are required.

3.2.3.3 The waste to be solidified should be mixed for 10 minutes, or recirculated in the tank for at least three volume changes, prior to sampling to assure a representative sample.

3.2.3.4 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. The samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.1.

If the contents of a particular tank represent x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Analysis of Samples

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

Parameter	Acceptable
pH	>6
Detergents	No Appreciable Foaming
Oil	<1%

4.0 Test Solidification and Acceptance Criteria

4.1 Waste Conditioning

4.1.1 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded on the Test Solidification Data Sheet.

4.1.2 If oil is present in quantities greater than 1% by volume, the oil shall be reduced to less than 1% by skimming. Emulsification agents should be used to break up the remaining oil. The quantity of any substance added to the sample for this purpose shall be recorded on the Test Solidification Data Sheet.

NOTE: Wastes with oil greater than 1% by volume may not be shipped to Barnwell, South Carolina, but must be shipped to Hanford, Washington. Emulsification agents need not be used until the volume of oil exceeds 3% of the waste volume. Oil in concentrations greater than 12% by volume may not be solidified under this procedure.

4.1.3 pH Conditioning

4.1.3.1 For Class A waste, if the pH is <6.0, it shall be adjusted to greater than 6.0 by the addition of a 50 weight percent sodium hydroxide. The quantity of

sodium hydroxide added to the sample shall be recorded on the Test Solidification Data Sheet.

4.1.3.2 pH conditioning of Class B and Class C wastes is accomplished as part of the solidification process.

4.2 Test Solidification of Class A Waste

4.2.1 PRETREAT the sample to be solidified as specified in Section 4.1.

4.2.2 For the test solidifications of resin, MEASURE into the mixing vessel 240 gm of dewatered resin and add 90 gm of water.

NOTE: Test solidifications should be conducted using a 1,000 ml disposal beaker or similar size container.

4.2.3 MEASURE out 189 gm of Portland Type I Cement and 19 gm of anhydrous sodium metasilicate.

4.2.4 Slowly ADD the cement to the test sample while it is being mixed.

NOTE: Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case for less than two minutes.

4.2.5 After all the cement is added, slowly ADD the anhydrous sodium metasilicate to the test sample while it is being mixed.

4.2.6 After mixing for approximately two (2) minutes once all the cement and additive are added, and a homogeneous mixture is obtained, allow the waste to CURE for a minimum of 4 hours.

4.3 Test Solidification of Class B and Class C Wastes

4.3.1 PRETREAT the sample to be solidified as specified in Section 4.1.

4.3.2 For the test solidification of bead resin, MEASURE into the mixing vessel 320 gm of dewatered resin and add 250 gm of water.

NOTE: Test solidifications should be conducted using a 1,000 ml disposable beaker or similar size container.

4.3.3 MEASURE out 714 gm of Portland Type I cement and approximately 18 grams of Calcium Hydroxide, $Ca(OH)_2$, also known as hydrated lime.

4.3.4 Slowly ADD the calcium hydroxide to the bead resin slurry, two (2) grams at a time. Mix for three (3) minutes between additions until the pH of the slurry is at least 11.5. ADD an additional three (3) grams of calcium hydroxide. This final addition may or may not alter the pH of the slurry.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade until a homogeneous mixture is obtained approximately one minute or less if mixture begins to set.

4.3.5 RECORD the quantity of calcium hydroxide added to the slurry on the Class B and C Test Solidification Data Sheet.

4.3.6 Slowly ADD the cement to the test sample while it is being mixed.

4.3.7 MIX for two (2) minutes after all the cement is added to obtain a homogeneous mix.

4.3.8 Allow the sample to CURE for up to 24 hours at 120 ± 5°F.

NOTE: If at any time during the 24-hour cure time, the sample meets the acceptance criteria, the liner solidification may proceed. However, no test solidification shall be disqualified without at least 24 hours of cure.

4.4 Solidification Acceptablility

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

4.4.1 The sample solidifications are considered acceptable if there is no free standing water, and

4.4.2 If upon visual inspection the waste appears that it would hold its shape if removed from the mixing vessel, and

4.4.3 It resists penetration.

4.5 Solidification Unacceptability

4.5.1 If the waste fails any of the criteria set forth in Section 4.4, the solidification will be termed unacceptable and a new set of solidification parameters will need to be established under the procedures in Section 4.6.

4.5.2 If the test solidification is unacceptable then the same test procedures must be followed on each subsequent batch of the same type of waste until three (3) consecutive test samples are solidified.

4.6 Alternate Solidification Parameters

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

4.6.1.1 Class A Wastes

(a) Mix equal weights of dry cement and water to ensure that the problem is not a bad batch of cement.

(b) Add additional caustic solution to raise the pH above 8.

(c) If the waste is only partially solidified, use modified waste to cement and anhydrous sodium metasilicate ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate, change the dewatered waste sample weight by 25 grams. Continue using 90 gm of water. If the mix is too thick, reduce the quantity of dewatered resin, and if the mix is too thin, or watery, increase the quantity dewatered resin. Continue with these 25 gm incremental changes until an acceptable product is achieved.

(d) If an acceptable product is still not achieved, or if additional information is needed, contact HITTMAN

(2) Class B or C Wastes

Contact HITTMAN for specific instructions.

Solidification No.: _____
Liner No.: _____
Sample No.: _____
Date _____

CLASS A TEST SOLIDIFICATION DATA SHEET
for Bead Resin

Sample Volume, ml: _____ (1)

Sample pH: _____ Volume NaOH solution used to adjust pH, ml: ____ (2)

Quantity of oil %: _____ (3)

Quantity of emulsifier (20% by volume of oil), ml[1]: _____ (4)

Quantity of anti-foaming agent, ml: _____ (5)

Temperature at Solidification, °F: _____

Quantity of Cement Added: Cement Ratio[2] (#/ft^3 Waste)

Sample _____ gms Sample _____ (6)

Quantity of Additive Added: Additive Ratio[3] (#/ft^3 Waste)

Sample _____ gms Sample _____ (7)

Product Acceptable: Sample A ____ Yes ____ No (If no, refer to Section 4.6 and proceed as directed)

Additional batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by _____ Date _____

Acceptance Verified by _____ Date _____

NOTES:

[1]See NOTE following Section 4.1.2. If emulsification is not accomplished, call HITTMAN.

[2]The cement ratio is defined as the pounds of cement required to solidify one cubic foot of dewatered waste. The ratio in this PCP is 39.3 lbs/ft^3.

[3]The additive ratio is defined as the pounds of additive required to solidify one cubic foot of dewatered waste. The ratio in this PCP is 3.93 lbs/ft^3.

CLASS A SOLIDIFICATION CALCULATION SHEET

Waste Volume[1], ft^3: _____ (1)

Cement Ratio, #/ft^3: Sample _____ (2)
Item 6 Form STD-P-05-004-01

Additive: _____

Additive Ratio, #/ft^3: Sample _____ (3)
Item 7 Form STD-P-05-004-02

Cement Quantity[2]

_____ (1) x _____ (2) = _____ lbs. (4)
Waste Volume

Additive Quantity[2]

_____ (1) x _____ (3) = _____ lbs. (5)
Waste Volume

Quantity of Water to be added in gallons:

_____ (1) x 2.25 = _____ gallons (6)
Waste Volume

Quantities of additional additives that must be added to the liner are found by multiplying the volume of the additive used in the test solidification, in ml, by 0.0249 and then by the volume of waste to be solidified. Volumes of additional additives are taken from items 2, 4, and 5 on Form STD-P-05-004-01.

_____ ml x 0.0249 x _____ (1) = _____ gallons[3]
Item 2,4 or 5
Form STD-P-05-004-01

[1]The quantity of dewatered waste to be solidified in a single liner cannot exceed the maximum waste volume listed on the attached Solidification Data Tables.

[2](4) and (5) define the recommended quantity of cement and additive respectively that must be mixed with the waste to assure solidification.

[3]Reduce the quantity of waste in the liner by 1 ft^3 for every 10 gallons of additional additives.

Form STD-P-05-004-02

CLASS A WASTE

SOLIDIFICATION DATA TABLES
for Bead Resin

	HN-100					HN-600*			
	Series 1	Series 2	Series 3	100-S	HN-200	S	G	S+G	R
Usable Liner Volume (cu.ft.)	143.0	143.0	143.0	143.0	59.5	59.6	64.6	57.7	64.6
Max. Dewatered Waste Volume (cu.ft.)	105.0	102.3	110.0	110.0	48.3	48.3	52.4	46.8	52.4
Max. Solidified Waste Vol. (cu.ft.)	129.5	126.2	143.0	143.0	59.5	59.6	64.6	57.7	64.6
Cement Added at Max. Waste Volume									
Weight (lbs.)	4126.1	4020.8	4320.7	4320.7	1896.4	1899.6	2059.0	1839.0	2059.0
Volume (bags)	43.9	42.8	46.0	46.0	20.2	20.2	21.9	19.6	21.9
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.									
Weight (lbs.)	412.6	402.1	432.1	432.1	189.6	190.0	205.9	183.9	205.9
Volume (bags)	4.1	4.0	4.3	4.3	1.9	1.9	2.1	1.8	2.1
Water Added to Max. Waste Vol. (Gallons)	236.2	230.2	247.3	247.3	108.6	108.8	117.9	105.3	117.9
Max. Rad. Level R/hr contact	12	12	12	3	800	100	100	100	100

*
S = HN-600 Stackable
G = HN-600 Grappable
S+G = HN-600 Stackable - Grappable
R = HN-600 Regular

Form STD-P-05-004-03

Solidification No.: _____
Batch No.: _____
Sample No.: _____
Date: _____

CLASS B AND C TEST SOLIDIFICATION DATA SHEET
for Bead Resin

I. Sample Preparation

Sample Volume, ml: _____ (1)

Initial pH: _____ Quantity of Oil[1] %: _____

Grams $Ca(OH)_2$ to raise pH to ≥ 11.5[2], gm: _____ (2)

Grams Portland Type I Cement added, gm: _____ (3)

II. SAMPLE INSPECTION

Sample cured for 24 hours[3] @ 120° ± 5° F:

_____ _____
Verified by Date

Sample contains 'No Free Liquid':

_____ _____
Verified by Date

Sample is a 'Free Standing Monolith':

_____ _____
Verified by Date

III. PARAMETERS FOR FULL SCALE SOLIDIFICATION

Quantity of $Ca(OH)_2$: _____ (2) gm $Ca(OH)_2$ from above x 0.156 = _____ lb $Ca(OH)_2$ per ft^3 dewatered resin (4)

Quantity of Cement: _____ (3) gm cement from above x 0.156 = _____ lb Cement per ft^3 dewatered resin (5)

[1]Must be ≤1% of waste volume.

[2]Added in accordance with Section 4.3.5.

[3]If the sample is qualified in less than 24 hours cure time, note the total hours cured.

CLASS B AND C WASTE SOLIDIFICATION CALCULATION SHEET

Volume dewatered resin to be solidified,[1] ft^3: _____ (1)

$Ca(OH)_2$ Ratio, $\#/ft^3$ _____ Item 4, Form STD-P-05-004-04 (2)

Cement Ratio, $\#/ft^3$ _____ Item 5, Form STD-P-05-004-04 (3)

Quantity of Water to be Added:

$$\frac{\text{\_\_\_\_\_}}{\text{Waste Volume } (ft^3)} \text{ (1) x 4.68 gallons/ft}^3 = \text{\_\_\_\_\_ gallons} \quad (4)$$

Quantity of Calcium Hydroxide ($Ca(OH)_2$) to be added:

$$\frac{\text{\_\_\_\_\_}}{\text{Waste Volume } (ft^3)} \text{ (1) x } \frac{\text{\_\_\_\_\_}}{lb/ft^3} \text{ (2) = \_\_\_\_\_ lbs} \quad (5)$$

Quantity of Cement (Portland Type I) to be added:

$$\frac{\text{\_\_\_\_\_}}{\text{Waste Volume } (ft^3)} \text{ (1) x } \frac{\text{\_\_\_\_\_}}{lb/ft^3} \text{ (3) = \_\_\_\_\_ lbs.} \quad (6)$$

[1]The volume of dewatered bead resin to be solidified cannot exceed the maximum waste volume listed on Form STD-P-05-004-04, CLASS B and C TEST SOLIDIFICATION DATA SHEET FOR BEAD RESIN.

CLASS B AND C WASTE

SOLIDIFICATION DATA TABLES
for Bead Resin

	HN-100				HN-200	HN-600[1]			
	Series 1	Series 2	Series 3	100-S		S	G	S+G	R
Usable Liner Volume (cu.ft.)	143	143	143	143	59.5	59.6	64.6	57.7	64.6
Max. Dewatered Waste Volume (cu.ft.)	65.3	63.0	79.6	79.6	33.1	33.2	36.0	32.1	36.0
Max. Solidified Waste Vol. (cu.ft.)	117.2	113.3	143	143	59.5	59.6	64.6	57.7	64.6
$Ca(OH)_2$ Added at Max. Waste Volume[2]									
Weight (lbs.)	102	98	124	124	51.6	51.8	56.2	50.1	56.2
Volume (bags)	2	2	2½	2½	1	1	1	1	1
Portland Type I Cement Added at Max. Waste Vol[2]									
Weight (lbs.)	7276	7020	8870	8870	3688	3700	4011	3577	4011
Volume (bags)	77.4	74.7	94.4	94.4	39.2	39.4	42.7	38.1	42.7
Water Added to Max. Waste Vol. (Gallons)	306	295	373	373	155	155	168	150	168
Max. Rad. Level R/hr contact	12	12	12	3	800	100	100	100	100

(1) S = HN-600 Stackable
G = HN-600 Grappable
S+G = HN-600 Stackable - Grappable
R = HN-600 Regular

(2) Approximate values - actual quantity determined on Form STD-P-05-004-05

3.3 Analysis of Samples

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

Parameter	Acceptable Range
(a) pH	>5
(b) Detergents	No Appreciable Foaming
(c) Oil	<1%

4.0 Test Solidification and Acceptance Criteria

4.1 Waste Conditioning

4.1.1 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded on the Test Solidification Data Sheet.

4.1.2 If oil is present in quantities greater than 1% by volume, the oil should either be removed by skimming or emulsification agents should be used to break up the oil. The quantity of any substance added to the sample for this purpose shall be recorded on the Test Solidification Data Sheet.

NOTE: Waste with oil greater than 1% by volume may not be shipped to Barnwell, South Carolina, but must be shipped to Hanford, Washington. Emulsification agents need not be used until the volume of oil exceeds 3% of the waste volume. Oil in concentrations greater than 12% by volume may not be solidified under this procedure.

4.1.3 pH Conditioning

4.1.3.1 For Class A wastes if the pH is < 5.0, it shall be adjusted to greater than 5.0 by the addition of a 50 weight percent solution of sodium hydroxide. The quantity of sodium hydroxide added to the sample shall be recorded on the Test Solidification Data Sheet.

4.1.3.2 pH conditioning of Class B and Class C wastes is accomplished as part of the solidification process.

4.2 Test Solidification of Class A Waste

4.2.1 PRETREAT the sample to be solidified as specified in Section 4.1.

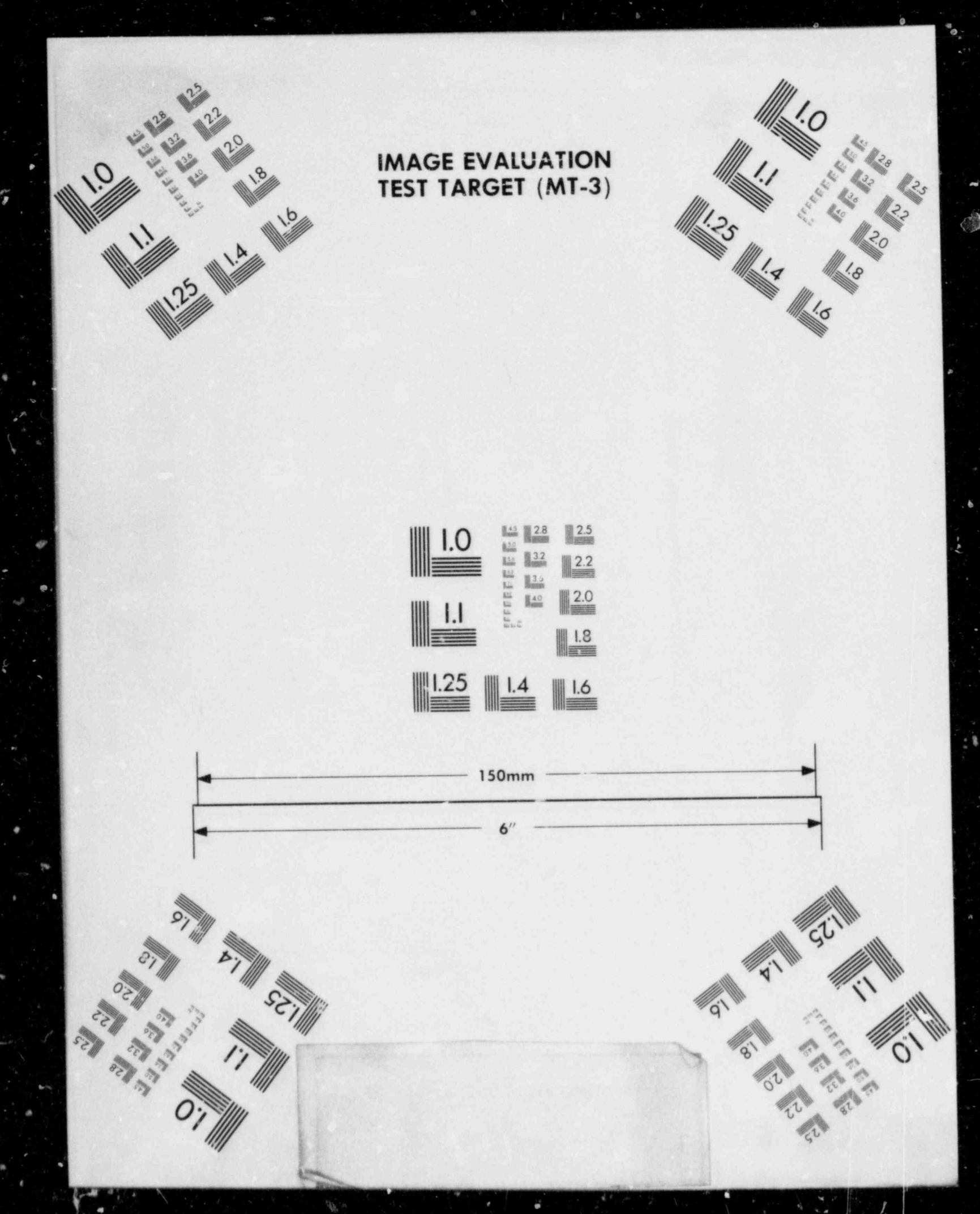
IMAGE EVALUATION
TEST TARGET (MT-3)
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
150mm
6"

4.2.2 Depending on the method of concentrating the powdered resin in the liner, i.e., decanting or dewatering, SELECT the appropriate weights of wet powdered resin and water from below.

	Dewatered	Decanted
Wet Powdered Resin, gm	300	314
Water, gm	90	76

4.2.3 MEASURE out the selected quantities of wet powdered resin and water into the mixing vessel.

NOTE: Test Solidifications should be conducted using a 1,000 ml disposal beaker or similar size container.

4.2.4 MEASURE out 223.2 grams of Portland Type I cement and 22.3 grams of anhydrous sodium metasilicate.

4.2.5 Slowly ADD the cement to the test sample while it is being mixed.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade until a homogeneous mixture is obtained. approximately one minute or less if mixture begins to set.

4.2.6 After all the cement is added, slowly ADD the anhydrous sodium metasilicate to the test sample while it is being mixed.

4.2.7 After sufficient (2 minutes after all cement and anhydrous sodium metasilicate is added) mixing so that a homogeneous mixture is obtained, allow the waste to CURE for a minimum of 4 hours.

4.3 Test Solidification of Class B or Class C Wastes

4.3.1 PRETREAT the sample to be solidified as specified in Section 4.1.

4.3.2 Depending upon the method of concentrating the powdered resin in the liner, i.e., decanting liquid after settling or dewatering through the underdrain, SELECT the appropriate weights of wet powdered resin and water from below.

4.3.3 MEASURE out the selected quantities of wet powdered resin and water into the mixing vessel.

	Dewatered	Decanted
Wet Powdered Resin, gm	381.8	400
Water, gm	151.5	133.3

NOTE: Test solidification should be conducted using a 1,000 ml disposable beaker or similar size container.

4.3.4 MEASURE out 444 grams of Portland Type I cement and approximately 10 grams of Calcium Hydroxide, $Ca(OH)_2$ also known as hydrated lime.

4.3.5 Slowly ADD the calcium hydroxide to the powdered resin slurry, two (2) grams at a time. MIX for three (3) minutes between additions until the pH is at least 11. ADD an additional three (3) grams of calcium hydroxide. This final addition may or may not alter the pH of the slurry.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade until a homogeneous mixture is obtained, approximately one (1) minute or less if mixture begins to set.

4.3.6 RECORD the quantity of calcium hydroxide added to the slurry on the Class B and C Test Solidification Data Sheet.

4.3.7 Slowly ADD the cement to the test sample while it is being mixed.

4.3.8 MIX for one (1) minute after all the cement is added to obtain a homogeneous mixture.

4.3.9 Allow the sample to CURE for 24 hours at 120 ± 5°F.

NOTE: If at any time during the 24-hour cure time, the sample meets the acceptance criteria, the liner solidification may proceed. However, no test solidification shall be disqualified without at least 24 hours of cure.

4.4 Solidification Acceptability

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

4.4.1 The sample solidifications are considered acceptable if there is no visual or drainable free water, and

4.4.2 If upon visual inspection the waste appears that it would hold its shape if removed from the mixing vessel and

4.4.3 It resists penetration.

4.5 Solidification Unacceptability

4.5.1 If the waste fails any of the criteria set forth in Section 4.4, the solidification will be termed unacceptable and a new set of solidification parameters will need to be established under the procedures in Section 4.6.

4.5.2 If the test solidification is unacceptable then the same test procedures must be followed on each subsequent batch of the same type of waste until three (3) consecutive test samples are solidified.

4.6 Alternate Solidification Parameters

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

4.6.1.1 Class A Wastes

(a) Mix equal weights of dry cement and water to ensure that the problem is not a bad batch of cement.

(b) If the waste is only partially solidified, use modified waste to cement and anhydrous sodium metasilicate ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate change the dewatered waste sample weight by 25 gm. Continue using 90 ml of water. If the mix is too thick, reduce the quantity of dewatered waste, and if the mix is too thin, or watery, increase the quantity of decanted material by 25 gm. Continue with these 25 gm incremental changes until an acceptable product is achieved.

(c) If an acceptable product is still not achieved, or if additional information is needed, contact HITTMAN.

(2) Class B or C Wastes

Contact HITTMAN for specific instructions.

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STP-P-05-007	Rev: 1	Rev Date: 12-12-83
	Title: PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION FOR 15 to 20 WEIGHT PERCENT BORIC ACID		

Rev.	Rev Date	Prepared by	Responsible Engineer	Director Engineering	Manager Field Services	Manager QA	
0	8-16-82	L. Cloer	L. Cloer				EWR-82-358
1	12-12-83	X	X				ECN-83-277

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PROCESS CONTROL PROGRAM
IN-CONTAINER SOLIDIFICATION
FOR 15 to 20 WEIGHT PERCENT BORIC ACID

1.0 Purpose

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

The program consists of four major steps, which are:

(a) Procedures for collecting and analyzing samples;

(b) Procedures for solidifying samples;

(c) Criteria for process parameters for acceptance or rejection as solidified waste.

(d) Calculation of minimum and maximum quantities of cement and anhydrous sodium metasilicate to be used in full scale liner solidifications.

1.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the range of acceptable ratios of waste, additional water (if required), cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into minimum and maximum quantity of cement and additive that must be mixed with the waste. Assurance that quantities of cement and additive between these ranges are actually mixed with the waste is covered in the Field Solidification Operating Procedures.

2.0 System Description

To be added for each specific plant.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BRW's the PCP shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste (e.g., evaporator bottoms, boric acid solution, sodium sulfate solutions, resin, and precoat sludge).

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a disposable liner to the waste level indicator.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidifications. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, such as spent resin or used precoat, where handling of samples could result in personnel radiation exposures which are inconsistant with the ALARA principal, representative non-radioactive samples will be tested. These samples should be as close to the actual wastes' chemical properties as possible. Typical unexpended mixed bed resin shall be used to simulate the spent bead resin and the appropriate mix of anion to cation powdered resin shall be used to simulate used precoat.

3.2 Collection of Samples

3.2.1 Radiological protection.

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by solidification in the disposal liner.

3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

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

3.2.2.1 The test sample data for concentrated waste will include, but not necessarily be limited to, the type of waste solidified, major constituents, percent solids pH, volume of sample, amount of oil in sample and the ratio of the sample volume to the final volume of the solidified product.

3.2.2.2 The waste solidification data sheet will include the Batch Number, Batch Volume, and Date Solidified, for each batch solidified based on sample described.

3.2.3 Collection of Samples

3.2.3.1 Evaporator bottoms shall be kept heated or reheated to 130°F prior to the adjustment of pH. The adjustment of pH will cause exothermic heating of the sample and may require cooling of the sample prior to solidificatin testing. Do not cool below 100°F before solidifying.

3.2.3.2 Three samples shall be taken for analysis. One sample shall be compatible with the standard size sample used for the radioactivity analysis. The remaining two samples shall be used for the chemical analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.3 Samples should be drawn at least six hours prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification.

3.2.3.4 The tank containing the waste to be solidified should be mixed by recirculating the tank contents for at least one volume change prior to sampling to assure a representative sample.

3.2.3.5 If the contents of more than one tank are to be solidified in the same liner then representative

samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.2. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Sample Analysis

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

Parameter	Acceptable Range
pH	>12*
Boric Acid or Boron	15 - 20 wgt % or 26,200 to 34,900 ppm
Detergents	No appreciable foaming
Oil	<1%

* After addition of sodium hydroxide.

4.0 Test Solidification and Acceptance Criteria

4.1. Waste Conditioning

4.1.1 Prior to the test sample solidification the pH of the sample shall be adjusted to greater than 12.0.

4.1.2 It is recommended that sodium hydroxide be used to adjust the pH. The amount of sodium hydroxide necessary for the pH adjustment shall be recorded.

4.1.3 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded.

4.1.4 If oil is present in quantities greater than 1% by volume, the oil shall be reduced to less than 1% by skimming. Emulsification agents should be used to break up the remaining oil. The quantity of any substance added to the sample for this purpose shall be recorded.

4.2 Test Solidification

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

4.2.2 Test Solidifications should be conducted using a 1000 ml. disposal beaker or similar size container. Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case for less than three (3) minutes.

4.2.3 For the test solidification of the borated wastes, measure into two mixing vessels 520 ml of waste each.

4.2.4 Measure out the required quantities of cement and anhydrous sodium metasilicate as shown below.

Waste	Grams Cement		Grams Anhydrous Sodium Metasilicate	
	Sample A	Sample B	Sample A	Sample B
15-20 wgt % Boric Acid	657.1	946.2	98.6	141.9

4.2.5 Slowly add the cement to the test sample while it is being mixed.

4.2.6 After all the cement is added, slowly add the anhydrous sodium metasilicate to the test sample while it is being mixed.

4.2.7 After sufficient (3 minutes after all cement and anhydrous sodium metasilicate is added) mixing so that a homogeneous mixture is obtained allow the waste to stand for a minimum of 4 hours.

4.3 Solidification Acceptability

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

4.3.1 The sample solidifications are considered acceptable if there is no visual or drainable free water.

4.3.2 The sample solidifications are considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration by a rigid stick.

4.3.3 The sample solidifications establish a range for the ratios of cement to waste that will result in an acceptable product.

4.4 Solidification Unacceptability

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

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

4.5 Alternate Solidification Parameters

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

(1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.

(2) Add additional caustic solution to raise the pH according to Section 4.1.1.

(3) If the waste is only partially solidified, use lower waste to cement ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate, reduce the waste sample volume to 495 ml and continue reducing the sample volume by 25 ml until the acceptability criteria of Section 4.3 are met.

Batch No.: _____
Sample No.: _____
Date: _____

WASTE SOLIDIFICATION DATA SHEET
for
Boric Acid

Sample Volume, ml: Sample A _____ Sample B _____ (1)

pH[1]:

Quantity of Oil %:

Quantity of Cement Added:

Sample A _____ gms
Sample B _____ gms

Cement Ratio[2] (#/ft^3 Waste)

Sample A _____ (2)
Sample B _____ (3)

Quantity of Additive[3] Added:

Sample A _____ gms
Sample B _____ gms

Additive Ratio[4] (#/ft^3 Waste)

Sample A _____ (4)
Sample B _____ (5)

Final Waste to Product Ratio: Sample A _____ Sample B _____ (6)

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

Sample B ___ Yes ___ No

Radionuclides Present: (Isotopes & Concentrations)

Additional batches solidified based on this sample solidification:

Batch No.	Batch Vol.	Date	Batch No.	Batch Vol.	Date	Batch No.	Batch Vol.	Date
2			5			8		
3			6			9		
4			7			10		

Test Solidifications Performed by: _____ Date: _____
PCP Samples Approved by: _____ Date: _____

NOTES:

[1]If pH adustment required, note chemical used, quantity used and pH after adjustment.

[2]For the ratios given in Section 4.2.4, cement-to-waste ratios are 78.8 to 113.5 pounds cement per cubic foot of boric acid.

[3]The additive used in this process is anhydrous sodium metasilicate as referenced in the text.

[4]For the ratios given in Section 4.2.4, additive-to-waste ratios are 11.8 to 17.0 pounds additive per cubic foot of boric acid.

SOLIDIFICATION CALCULATION SHEET

Waste Volume[1], ft^3: _____ (1)

Cement Ratio, $\#ft^3$: Sample A _____ (2A)
Sample B _____ (2B)

Additive: _____

Additive Ratio, $\#/ft^3$: Sample A _____ (3A)
Sample B _____ (3B)

Cement Quantity[2]

_____ (1)[1] x _____ (2A) = _____ lbs. (4A)

_____ (1)[1] x _____ (2B) = _____ lbs. (4B)

Additive Quantity[2]

_____ (1) x _____ (3A) = _____ lbs. (5A)

_____ (1) x _____ (3B) = _____ lbs. (5B)

[1]The quantity of waste to be solidified in a single liner cannot exceed the maximum waste volume listed on the attached Solidification Data Tables.

[2]4A and 5A define the minimum quantity of cement and additive respectively that must be mixed with the waste to assure solidification. When these quantities of materials are mixed, additional cement and additive are to be mixed until further mixing is not possible or the values in 4B and 5B are reached.

SOLIDIFICATION DATA TABLES

For 15-20 wgt. % boric acid, the cask payload is limiting

I. For the Minimum Amount of Cement and Additive

	HN-100			HN-100S	HN-100 LVM
	Series 1	Series 2	Series 3		Series 3*
Usable Liner Volume, ft^3	143	143	143	143	160.0
Max. Solidified Waste Vol., ft^3	109.6	107.5	138.9	131.6	160.0
Max. Waste Vol. ft^3	75	73	95	90	109.4
Cement Added at Max. Waste Vol.					
Pounds	5,910	5,752	7,486	7,092	8623.9
1 ft^3 bags	62.9	61.2	79.6	75.4	91.7
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Pounds	885	861	1,121	1,062	1291.4
1 ft^3 bags	8.9	8.6	11.2	10.6	12.91
Max. Radiation Level					
R/hr Contact	12	12	12	5	12

* For less than A_2 quantities of LSA waste.

II. For the Recommended Amount of Cement and Additive

	HN-100			HN-100S	HN-100 LVM
	Series 1	Series 2	Series 3		Series 3*
Usable Liner Volume, ft^3	143	143	143	143	160.0
Max. Solidified Waste Vol., ft^3	97.6	95.9	124.4	117.9	160.0
Max. Waste Vol. ft^3	60	59	76.5	72.5	98.4
Cement Added at Max. Waste Vol.					
Pounds	6,810	6,697	8,683	8,229	11168.4
1 ft^3 bags	72.4	71.2	92.4	87.5	118.8
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Pounds	1,020	1,003	1,300.5	1,232.5	1672.8
1 ft^3 bags	10.2	10.0	13.0	12.3	16.7
Max. Radiation Level					
R/hr Contact	12	12	12	5	12

* For less than A_2 quantities of LSA waste.

WESTINGHOUSE HITTMAN NUCLEAR INCORPORATED	Document Number: STD-P-05-008	Rev: 5	Rev Date: 2-21-84
	Title: PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF SODIUM SULFATE SLURRIES (0-30 Weight % Solids)		

Rev.	Rev Date	Prepared by	Director Engineering	Field Services Manager	QA Manager		
0	7-30-82	E. Cloer					TSR-82-433
1	1-19-83	E. Cloer					ECN-83-004
2	5-27-83	E. Cloer for K. McD.					ECN-83-137
3	9-8-83	K. McDaniel	for QA				ECN-83-233
4	12-12-83	X					ECN-83-278
5	2-21-84	X					ECN-84-035 Rewritten

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PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION SODIUM SULFATE SLURRIES (0-30 Weight Percent Solids)

1.0 SCOPE

This procedure is applicable to the solidification of sodium sulfate slurries classified as either Class A, Class B or Class C wastes under the requirements of 10 CFR 61.55, Waste Classification.

2.0 PURPOSE

2.1 The purpose of the Process Control Program (PCP) for incontainer solidification of sodium sulfate slurries is to provide a program which will assure a solidified product which meets the requirements of 10 CFR 61.56, Waste Characteristics.

The program consists of three major steps, which are:

(a) Procedures for collecting and analyzing samples;

(b) Procedures for solidifying samples;

(c) Criteria for process parameters for acceptance or rejection as solidified waste.

2.2 This document shall be considered complete only when used in concert with the Westinghouse Hittman Nuclear Incorporated procedures for field solidification. This document describes the methodology for determining the acceptable ratio of waste, additional water (if required), cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into the recommended quantity of cement and additive that must be mixed with the waste. Assurance that the proper quantity of cement and additive is actually mixed with the waste is covered in the Field Solidification Operating Procedures.

3.0 COLLECTION AND ANALYSIS OF SAMPLES

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BWR's the PCP shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a disposable liner with the appropriate quantity of waste prior to solidification.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification, then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidifications. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, where handling of samples could result in personnel radiation exposures which are inconsistent with the ALARA principle, representative non-radioactive samples will be tested. These samples should be as close to the actual wastes' chemical properties as possible. Typical unexpended powdered resin shall be used, with the appropriate anion to cation mix to simulate used material.

3.2 Collection of Samples

3.2.1 Radiological Protection

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by placing in the solidified liner.

3.2.1.3 A Test Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Test Solidification Data Sheet

The Test Solidification Data Sheet will contain pertinent information on the characteristics of

the test sample solidified so as to verify solidification of subsequent batches of similar wastes without retesting.

3.2.2.1 The test sample data for powdered resin will include, but not necessarily be limited to, the type of waste solidified, volume of sample and the quantity of any additives used to precondition the waste.

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

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.2 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification. Approximately 28 hours are required to perform and verify the test solidification, and to allow for retesting, if necessary.

3.2.3.3 The waste to be solidified should be mixed for 10 minutes, or recirculated in the tank for at least three volume changes, prior to sampling to assure a representative sample.

3.2.3.4 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. These samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.1. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Analysis of Samples

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

Parameter		Acceptable Range
(a)	pH	>6
(b)	Detergents	No Appreciable Foaming
(c)	Oil	<1%
(d)	Percent Solids	0-30

4.0 TEST SOLIDIFICATION AND ACCEPTANCE CRITERIA

4.1 Waste Conditioning

4.1.1 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded on the Test Solidification Data Sheet.

4.1.2 If oil is present in quantities greater than 1% by volume, the oil should either be removed by skimming or emulsification agents should be used to break up the oil. The quantity of any substance added to the sample for this purpose shall be recorded on the Test Solidification Data Sheet.

NOTE: Waste with oil greater than 1% by volume may not be shipped to Barnwell, South Carolina, but must be shipped to Hanford, Washington. Emulsification agents need not be used until the volume of oil exceeds 3% of the waste volume. Oil in concentrations greater than 12% by volume may not be solidified under this procedure.

4.1.3 pH Conditioning

4.1.3.1 For Class A wastes if the pH is < 6.0, it shall be adjusted to greater than 6.0 by the addition of a 50 weight percent solution of sodium hydroxide. The quantity of sodium hydroxide added to the sample shall be recorded on the Test Solidification Data Sheet.

4.1.3.2 pH conditioning of Class B and Class C wastes is accomplished as part of the solidification process.

4.1.3.3 Solidify at 90-100°F. Do not allow the waste to cool below 90°F as crystallization may occur.

4.2 Test Solidification of Class A Waste

4.2.1 MEASURE 200 ml of the waste slurry into a 1,000 ml disposable beaker or similar size container.

4.2.2 PRETREAT the sample to be solidified as specified in Section 4.1.

4.2.3 Based on the concentration of sodium sulfate determined by Chemistry and using Figure 1, DETERMINE the quantity of Portland Type I cement to use for a 200 ml sample.

4.2.4 MEASURE the required quantity of Portland Type I cement and anhydrous sodium metasilicate into separate beakers.

4.2.5 RECORD the quantities on the Class A Test Solidification Data Sheet, STD-P-05-008-01.

NOTE: The quantity of anhydrous sodium metasilicate is 10 percent of the weight of cement.

4.2.6 Slowly ADD the cement to the test sample while it is being mixed.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade until a homogeneous mixture is obtained. Approximately one minute or less if mixture begins to set.

4.2.7 After all the cement is added, slowly ADD the anhydrous sodium metasilicate to the test sample while it is being mixed.

4.2.8 MIX for 2 minutes after all cement and anhydrous sodium metasilicate is added so that a homogeneous mixture is obtained.

4.2.9 DETERMINE the volume of product. RECORD on the Class A Test Solidification Data Sheet, STD-P-05-008-01.

4.2.10 SEAL the sample and cure for 24 hours at 120 ± 5°F.

NOTE: If at any time during the 24 hour cure time, the sample meets the acceptance criteria, the liner solidification may proceed. However, no test solidification shall be disqualified without at least 24 hours of cure.

4.3 Test Solidification of Class B or Class C Wastes
(10 to 20 Weight Percent Sodium Sulfate)

4.3.1 MEASURE 200 ml of the waste slurry into a 1,000 ml disposable beaker or similar size container.

4.3.2 PRETREAT the sample to be solidified as specified in Section 4.1.

4.3.3 Based on the concentration of sodium sulfate determined by chemistry and using Figure 2, DETERMINE the quantity of Portland Type I cement to use for a 200 ml sample.

4.3.4 Slowly ADD 50 grams of calcium hydroxide also known as hydrated lime per 200 ml sample and MIX for 15 minutes.

4.3.5 ADD 2 gms of boric acid powder per 200 ml sample and MIX for 15 minutes.

4.3.6 DETERMINE the pH. The pH may be measured using narrow range pH paper.

NOTE: The pH must be 11.5 to 12.0. If it is not within that range, ADD calcium hydroxide in two (2) gram increments mixing for three (3) minutes between each addition to increase the pH. If the pH is too high, ADD boric acid powder in 0.5 gm increments, mixing three (3) minutes between each addition.

4.3.7 RECORD the quantities of calcium hydroxide and boric acid necessary for pH adjustment as well as the final pH on the Class B and C Test Solidification Data Sheet, STD-P-05-008-03.

4.3.8 MEASURE the quantity of Portland Type I cement determined from Step 4.3.2.

4.3.9 Slowly ADD the cement to the test sample while it is being mixed.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade for approximately two (2) minutes or less if the mixture begins to set.

4.3.10 MEASURE the volume of the product and RECORD on the Class B and C Test Solidification Data Sheet, STD-P-05-008-03.

4.3.11 Seal the samples and CURE for 24 hours at 120 ± 5°F.

NOTE: If at any time during the 24 hour cure time, the sample meets the acceptance criteria, the liner solidification may proceed. However, no test solidification shall be disqualified without at least 24 hours of cure.

4.4 Solidification Acceptability

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

4.4.1 The sample solidifications are considered acceptable if there is no visual or drainable free water, and

4.4.2 If upon visual inspection the waste appears that it would hold its shape if removed from the mixing vessel and

4.4.3 It resists penetration.

4.5 Solidification Unacceptability

4.5.1 If the waste fails any of the criteria set forth in Section 4.4, the solidification will be termed unacceptable and a new set of solidification parameters will need to be established under the procedures in Section 4.6.

4.5.2 If the test solidification is unacceptable then the same test procedures must be followed on each subsequent batch of the same type of waste until three (3) consecutive test samples are solidified.

4.6 Alternate Solidification Parameters

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

4.6.1.1 Class A Wastes

(a) Mix equal weights of dry cement and water to ensure that the problem is not a bad batch of cement.

(b) If the waste is only partially solidified, use modified waste to cement and anhydrous sodium metasilicate ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate change the

waste sample volume by 25 ml. If the mix is too thick, reduce the quantity of waste, and if the mix is too thin, or watery, increase the quantity of waste by 25 ml. Continue with these 25 ml incremental changes until an acceptable product is achieved.

(c) If an acceptable product is still not achieved, or if additional information is needed, contact Hittman.

(2) Class B or C Wastes

Contact Hittman for specific instructions.

31L

Solidification No: _____
Liner No: _____
Sample No: _____
Date: _____

CLASS A TEST SOLIDIFICATION DATA SHEET
for 0 to 30 Weight Percent Sodium Sulfate Slurries

Sample Volume, ml: _____ _____ (1)

pH[1]: _____ (2a) Volume NaOH solution used to adjust pH, ml: _____ (2b)

pH After Adjustment (if required): _____ _____ (2c)

Quantity of oil %: _____ (3)

Quantity of emulsifier (20% by volume of oil) ml: _____ (4)

Quantity of anti-foaming agent, ml: _____ (5)

Weight % Sodium Sulfate from chemistry: _____ (6)

Quantity of Cement Added: _____ gms Cement Ratio[2] (lb/ft^3 Waste) (7)

Quantity of Additive Added: _____ gms Additive Ratio[3] (lb/ft^3 Waste) (8)

Volume of Product, ml: _____ (9)

Product Acceptable: Sample _____ Yes _____ No (If no, refer to Section 4.6 and proceed as directed.)

Additional batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by: _____ Date _____

Acceptance Verified by: _____ Date _____

FOOTNOTES:

[1]If pH adjustment is required to bring the pH >6.0, note chemical used, quantity used and pH after adjustment.

[2]The cement ratio in lb/ft^3 may be calculated by multiplying the grams of cement necessary to solidify 200 ml of waste by 0.312.

[3]The additive ratio in lb/ft^3 may be calculated by multiplying the grams of additive necessary to solidify 200 ml of waste by 0.312.

CLASS 'A' WASTE SOLIDIFICATION CALCULATION SHEET

Waste Volume to be Solidified, ft^3: _____ (1)

Cement Ratio, lb/ft^3: Sample _____ (2)
Item 7 - Form STD-P-05-008-01

Additive Ratio, lb/ft^3: Sample _____ (3)
Item 8 - Form STD-P-05-008-01

Cement Quantity[1]

_____ (1) x _____ (2) = _____ lbs. (6)
Waste Volume lb/ft^3

Additive Quantity[1]

_____ (1) x _____ (3) = _____ lbs. (7)
Waste Volume lb/ft^3

Quantities of additional additives that must be added to the liner are found by multiplying the volume of the additive used in the test solidification, in ml, by 0.0374 and then by the volume of waste to be solidified. Volumes of additional additives are taken from items 2c, 4, and 5 on Form STD-P-05-008-01:

_____ ml x 0.0374 x _____ (1) = _____ gallons[2] (8)
Item 2c, 4 or 5
Form STD-P-05-008-01

[1]6 and 7 define the recommended quantity of cement and additive respectively that must be mixed with the waste to assure solidification.

[2]Reduce the quantity of waste in the liner by 1 ft^3 for every 10 gallons of additional additive.

Solidification No: _____
Batch No: _____
Sample No: _____
Date: _____

CLASS B AND C TEST SOLIDIFICATION DATA SHEET
for 10 to 20 Weight Percent Sodium Sulfate Slurries

I. SAMPLE PREPARATION:

Sample Volume, ml: _____ (1)

Initial pH: _____ (2)

Quantity of oil[1]: % _____ (3)

Quantity of emulsifier (20% by volume of oil), ml: _____ (4)

Quantity of anti-foaming agent, ml: _____ (5)

Quantity of $Ca(OH)_2$ added to sample, gms: _____ (6)

Quantity of H_3BO_3 added to sample, gms: _____ (7)

pH of sample: _____ (8)

Additional Materials for pH adjustment if necessary.

$Ca(OH)_2$, gms _____ (9)

H_3BO_3, gms _____ (10)

Total $Ca(OH)_2$, (6) + (9): _____ (11)

Total H_3BO_3, (7) + (10): _____ (12)

Final pH _____ (13)

Quantity of Portland Type I Cement _____ (14)

Product Volume, ml: _____ (15)

II. SAMPLE INSPECTION

Sample cured for 24 hours[2] at 120 ± 5°F.

_____ _____
Verified By Date

Form STD-P-05-008-03
Sheet 1 of 2

Sample contains "No Free Liquid":

_____ _____
Verified By Date

Sample is "Free Standing Monolith":

_____ _____
Verified By Date

III. PARAMETERS FOR FULL SCALE SOLIDIFICATION

Quantity of $Ca(OH)_2$: _____ (11) gms $Ca(OH)_2$ from above x 0.312 = _____ lbs. $Ca(OH)_2$ per ft^3 of waste (17)

Quantity of H_3BO_3: _____ (12) gms H_3BO_3 from above x 0.312 = _____ lbs. $Ca(OH)_2$ per ft^3 of waste (18)

Quantity of Cement: _____ (14) gms Portland Type I cement from above x 0.312 = _____ lbs. cement per ft^3 waste (19)

FOOTNOTES

[1]Must be ≤1% of waste volume.

[2]If the sample is qualified in less than 24 hours cure time, note the total hours cured.

CLASS B AND C WASTE SOLIDIFICATION CALCULATION SHEET

Waste Volume to be Solidified, ft^3: _____ (1)

$Ca(OH)_2$ Ratio; lb/ft^3: _____ (Item 17, Form STD-P-05-008-03) (2)

H_3BO_3 Ratio; lb/ft^3: _____ (Item 18, Form STD-P-05-008-03) (3)

Portland Type I Cement; lb/ft^3 _____ (Item 19, Form STD-P-05-008-03) (4)

$Ca(OH)_2$ Quantity[1]

_____ (1) x _____ (2) = _____ lbs. (5)
Waste Volume lb/ft^3

H_3BO_3 Quantity[1]

_____ (1) x _____ (3) = _____ lbs. (6)
Waste Volume lb/ft^3

Cement Quantity[1]

_____ (1) x _____ (4) = _____ lbs. (7)
Waste Volume lb/ft^3

Quantities of additional additives that must be added to the liner are found by multiplying the volume of the additive used in the test solidification, in ml, by 0.0374 and then by the volume of waste to be solidified. Volumes of additional additives are taken from items 4 and 5 on Form STD-P-05-008-03:

_____ ml x 0.0374 x _____ (1) = _____ gallons[2] (8)
Item 4 or 5
Form STD-P-05-008-01

[1]5, 6 and 7 define the recommended quantity of cement and additives that must be mixed with the waste to assure solidification.

[2]Reduce the quantity of waste in the liner by 1 ft^3 for every 10 gallons of additional additive.

Figure 1

GRAMS PORTLAND TYPE I CEMENT
per
200ml SODIUM SULFATE CLASS A WASTE

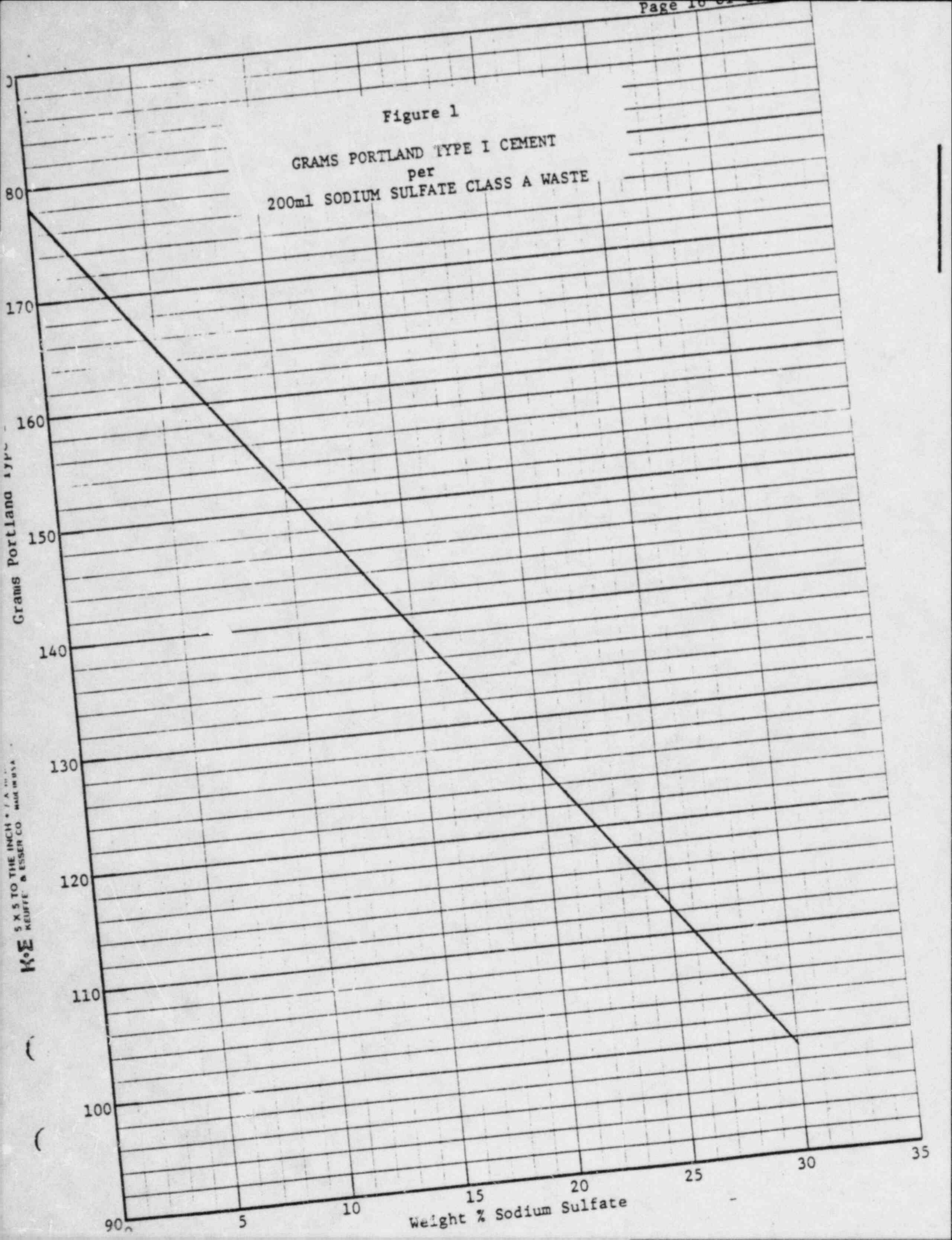
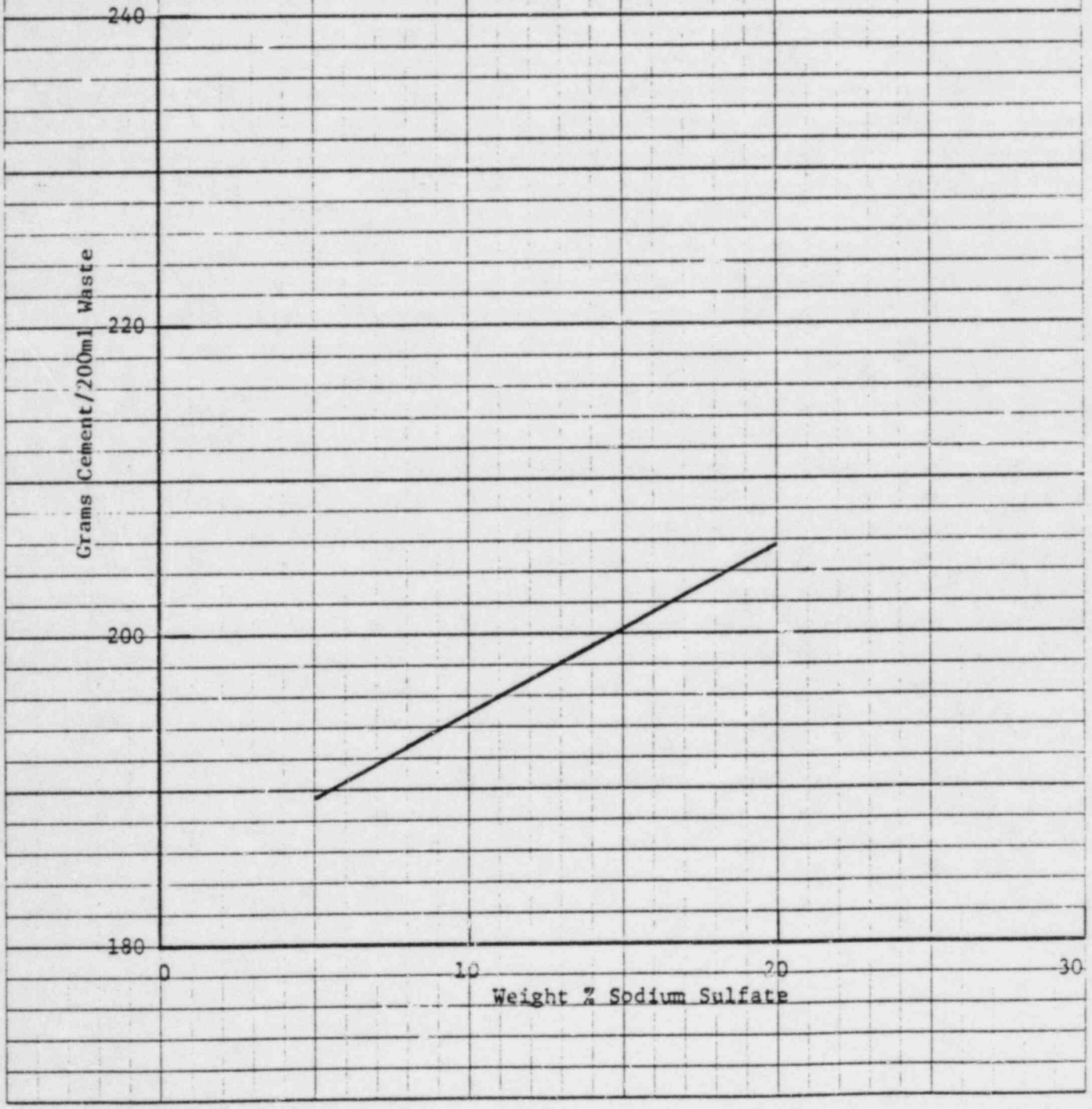


Figure 2

GRAMS PORTLAND TYPE I CEMENT
per
200ml SODIUM SULFATE CLASS B or C WASTE
(5 Wgt. % to 20 Wgt. %)



II. SOLIDIFICATION DATA TABLE FOR CLASS A
SODIUM SULFATE, 2.5 TO < 7.5 W/O

LINER	HN-100				HN-100 LVM	HN-600**			
	Series 1	Series 2	Series 3	100S	Series 3*	S	G	S & G	R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	100.8	98.4	110.5	110.5	123.7	46.1	49.9	44.6	49.9
Solidified Volume (cu.ft.)	130.4	127.3	143.0	143.0	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	5222.3	5095.4	5725.9	5725.9	6406.6	2386.5	2586.7	2310.4	2586.7
1 cu. ft. bags	55.6	54.2	60.9	60.9	68.2	25.4	27.5	24.6	27.5
Ahydrous Sodium Metasilicate Added									
lbs.	522.2	509.5	572.6	572.6	640.7	238.7	258.7	231.0	258.7
100 lb. bags	5.2	5.1	5.7	5.7	6.4	2.4	2.6	2.3	2.6
Max Rad Level									
R/hr. Contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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III. SOLIDIFICATION DATA TABLE FOR CLASS A
SODIUM SULFATE, 7.5 to < 12.5 W/O

LINER	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S	HN-100 LVM Series 3*	HN-600** S	HN-600** G	HN-600** S & G	HN-600** R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	102.9	100.4	115.3	115.3	129	48.0	52.1	46.5	52.1
Solidified Volume (cu.ft.)	127.7	124.6	143	143	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	4888.5	4769.8	5474.8	5474.8	6125.6	2281.8	2473.2	2209	2473.2
1 cu. ft. bags	52.0	50.7	58.2	58.2	65.2	24.3	26.3	23.5	26.3
Anhydrous Sodium Metasilicate Added									
lbs.	488.9	477.0	547.5	547.5	612.6	228.2	247.3	220.1	247.3
100 lb. bags	4.9	4.8	5.5	5.5	6.1	2.3	2.5	2.2	2.5
Max. Rad Level R/hr. contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

3IM

I. SOLIDIFICATION DATA TABLE FOR CLASS A
SODIUM SULFATE, < 2.5 W/O

LINER	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S	HN-100 LVM Series 3*	HN-600** S	HN-600** G	HN-600** S & G	HN-600** R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	99.9	97.5	109.0	109.0	121.9	45.4	49.2	44.0	49.2
Solidified Volume (cu.ft.)	131.1	127.9	143	143	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	5555.5	5420.6	6058.5	6058.5	6778.8	2525.1	2736.9	2444.6	2736.9
1 cu. ft. bags	59.1	57.7	64.5	64.5	72.1	26.9	29.1	26.0	29.1
Anhydrous Sodium Metasilicate Added									
lbs.	555.5	542.1	605.9	605.9	677.9	252.5	273.7	244.5	273.7
100 lb. bags	5.6	5.4	6.1	6.1	6.8	2.5	2.7	2.5	2.7
Max. Rad Level									
R/hr. Contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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IV. SOLIDIFICATION DATA TABLE FOR CLASS A
SODIUM SULFATE, 12.5 TO < 17.5 W/O

LINER	HN-100				HN-100 LVM	HN-600**			
	Series 1	Series 2	Series 3	100S	Series 3*	S	G	S & G	R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	104.2	101.7	116	116	129.8	48.3	52.4	46.8	52.4
Solidified Volume (cu.ft.)	128.5	125.4	143	143	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	4523.1	4413.3	5033.2	5033.2	5631.6	2097.8	2273.8	2030.9	2273.8
1 cu. ft. bags	48.1	47	53.5	53.5	59.9	22.3	24.2	21.6	24.2
Anhydrous Sodium Metasilicate Added									
lbs.	452.3	441.3	503.3	503.3	563.2	210	227.4	203.1	227.4
100 lb. bags	4.5	4.4	5.0	5.0	5.6	2.1	2.3	2.0	2.3
Max. Rad Level R/hr. contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

31M

V. SOLIDIFICATION DATA TABLE FOR CLASS A
SODIUM SULFATE, 17.5 TO < 22.5 W/O

LINER	HN-100				HN-100 LVM	HN-600**			
	Series 1	Series 2	Series 3	100S	Series 3*	S	G	S & G	R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	105.7	103.1	117.7	117.7	131.7	49.1	53.2	47.5	53.2
Solidified Volume (cu.ft.)	128.4	125.3	143	143	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	4151.9	4051	4625.2	4625.2	5175	1927.7	2089.4	1866.2	2089.4
1 cu. ft. bags	44.2	43.1	49.2	49.2	55.1	20.5	22.2	19.9	22.2
Anhydrous Sodium Metasilicate Added									
lbs.	415.2	405.1	462.5	462.5	517.5	192.8	208.9	186.6	208.9
100 lb. bags	4.2	4.1	4.6	4.6	5.2	1.9	2.1	1.9	2.1
Max. Rad Level									
R/hr. contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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I. SOLIDIFICATION DATA TABLE FOR CLASS B OR C
SODIUM SULFATE, 5 TO < 10.0 W/O

LINER	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S	HN-100 LVM Series 3*	HN-600** S	HN-600** G	HN-600** S & G	HN-600** R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	96.1	93.8	100.0	100.0	111.8	41.7	45.2	40.3	45.2
Solidified Volume (cu.ft.)	137.5	134.2	143	143	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	5843.4	5701.5	6077.4	6077.4	6799.9	2533.0	2745.5	2452.2	2745.5
1 cu. ft. bags	62.2	60.7	64.7	64.7	72.3	27.0	29.2	26.1	29.2
Max. Rad Level R/hr. Contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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II. SOLIDIFICATION DATA TABLE FOR CLASS B OR C
SODIUM SULFATE, 10.0 TO < 15.0 W/O

LINER	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S	HN-100 LVM Series 3*	HN-600** S	HN-600** G	HN-600** S & G	HN-600** R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	92.7	90.5	100.8	100.8	112.8	42.0	45.5	40.7	45.5
Solidified Volume (cu.ft.)	131.5	128.3	143.0	143.0	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	5785.6	5645.1	6290.9	6290.9	7038.7	2621.9	2841.9	2538.3	2841.9
1 cu. ft. bags	61.6	60.1	66.9	66.9	74.9	27.9	30.2	27.0	30.2
Max. Rad Level									
R/hr. Contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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	Series 1	Series 2	Series 3	100S	Series 3*	S			
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	89.6	87.5	101.1	101.1	113.1	42.1	45.7	40.8	45.7
Solidified Volume (cu.ft.)	126.8	123.7	143	143	160.0	59.6	64.6	57.7	64.6
Cement Added									
lbs.	5744.8	5605.3	6480.6	6480.6	7251.0	2701.0	2927.6	2614.9	2927.6
1 cu. ft. bags	61.1	59.6	68.9	68.9	77.1	28.7	31.1	27.8	31.1
Max. Rad Level									
R/hr. Contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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WESTINGHOUSE HITTMAN NUCLEAR INCORPORATED	Document Number: STD-P-05-009	Rev: 1	Rev Date: 2-17-84
	Title: PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF SODIUM SULFATE SLURRIES CONTAINING POWDERED OR BEAD RESIN		

Rev.	Rev Date	Prepared by	Director Engineering	Field Services Manager	QA Manager		
0	7-30-82	E. Cloer					EWR-82-420
1	2-17-84	X					ECN-84-036 Rewritten

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PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF SODIUM SULFATE SLURRIES CONTAINING POWDERED OR BEAD RESINS

1.0 SCOPE

This procedure is applicable to the solidification of sodium sulfate slurries containing powdered or bead resins, and classified as Class A waste under the requirements of 10 CFR 61.55, Waste Classification.

2.0 PURPOSE

2.1 The purpose of the Process Control Program (PCP) for incontainer solidification of sodium sulfate slurries containing powdered or bead resins is to provide a program which will assure a solidified product which meets the requirements of 10 CFR 61.56, Waste Characteristics.

The program consists of four major steps, which are:

(a) Procedure for determining proper ratio of solids to sodium sulfate.

(b) Procedure for collecting, analyzing and pretreating samples;

(c) Procedures for solidifying samples;

(d) Criteria for process parameters for acceptance or rejection as solidified waste.

2.2 This document shall be considered complete only when used in concert with the Westinghouse Hittman Nuclear Incorporated procedures for field solidification. This document describes the methodology for determining the acceptable ratio of waste, cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into the recommended quantity of cement and additive that must be mixed with the waste. Assurance that the proper quantity of cement and additive is actually mixed with the waste is covered in the Field Solidification Operating Procedures.

3.0 COLLECTION AND ANALYSIS OF SAMPLES

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BWR's the PCP shall

be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as quantity of waste required to fill a disposable liner with the appropriate quantity of waste prior to solidification.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification, then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidification. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, where handling of samples could result in personnel radiation exposures which are inconsistent with the ALARA principle, representative non-radioactive samples will be tested. These samples should be as close to the actual wastes' chemical properties as possible. Typical unexpended powdered or bead resins shall be used, with the appropriate anion to cation mix to simulate used material.

3.2 Collection of Samples

3.2.1 Radiological Protection

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by placing in the solidified liner.

3.2.1.3 A Test Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Test Solidification Data Sheet

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

3.2.2.1 The test sample data for sodium sulfate slurries containing powdered or bead resins will include, but not necessarily be limited to, the type of waste solidified, volume of sample and the quantity of any additives used to precondition the waste.

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

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.2 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification. Approximately 28 hours are required to perform and verify the test solidification and to allow for retesting if necessary.

3.2.3.3 The waste to be solidified should be mixed for 10 minutes, or recirculated in the tank for at least three volume changes, prior to sampling to assure a representative sample.

3.2.3.4 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. These samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.1. If the contents of a particular tank represents x% of the total waste quantity to be solidified

then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Analysis of Samples

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

Parameter		Acceptable Range
(a)	pH	>5
(b)	Detergents	No Appreciable Foaming
(c)	Oil	<1%

4.0 POWDERED RESIN MIXED WITH SODIUM SULFATE CLASS A WASTE

4.1 Determination of Liner Contents

4.1.1 Based on the depth of the settled powdered resin in the liner and the concentration of sodium sulfate to be transferred, DETERMINE the following from Figure 1, 2 or 3:

4.1.1.1 The total volume of sodium sulfate that can go into the liner. RECORD on the Class A Test Solidification Data Sheet, STD-P-05-009-01.

4.1.1.2 The weight percent solids that will be in the liner after the transfer. RECORD on the Class A Test Solidification Data Sheet, STD-P-05-009-01.

NOTE: Figure 1 must be used for the HN-100 LVM liner. Figure 2 must be used for the HN-100M liner. Figure 3 must be used for the HN-600M liner.

4.1.2 USE the weight percent solids determined from Step 4.1.1.2 and the percent sodium sulfate from Chemistry to determine the grams of Portland Type I cement to use for a 200 ml sample using Figure 4. (See example using Figures 1 and 4.)

4.1.3 TRANSFER the volume of sodium sulfate determined in Step 4.1.1.1, per the appropriate plant procedure, to the liner.

4.1.4 SAMPLE the contents of the liner after mixing for 10 minutes using proper radiological procedure.

4.2 Pre-treatment of Waste

4.2.1 Waste Conditioning

4.2.1.1 MEASURE 200 ml of the waste slurry into a 1,000 ml disposable beaker or similar size container.

4.2.1.2 RECORD the sample volume on the Class A Test Solidification Data Sheet, STD-P-05-009-01.

4.2.1.3 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded on the Class A Test Solidification Data Sheet, STD-P-05-009-01.

4.2.1.4 If oil is present in quantities greater than 1% by volume, the oil should either be removed by skimming or emulsification agents should be used to break up the oil. The quantity of any substance added to the sample for this purpose shall be recorded on the Class A Test Solidification Data Sheet, STD-P-05-009-01.

NOTE: Waste with oil greater than 1% by volume may not be shipped to Barnwell, South Carolina, but must be shipped to Hanford, Washington. Emulsification agents need not be used until the volume of oil exceeds 3% of the waste volume. Oil in concentrations greater than 12% by volume may not be solidified under this procedure.

4.2.2 pH Conditioning

4.2.2.1 For Class A wastes if the pH is < 5.0, it shall be adjusted to greater than 5.0 by the addition of a 50 weight percent solution of sodium hydroxide. The quantity of sodium hydroxide added to the sample shall be recorded on the Class A Test Solidification Data Sheet, STD-P-05-009-01.

4.3 Test Solidification

4.3.1 MEASURE the required quantity of Portland Type I cement and anhydrous sodium metasilicate into separate beakers.

4.3.2 RECORD the quantities on the Class A Test Solidification Data Sheet, STD-P-05-009-01.

NOTE: The quantity of anhydrous sodium metasilicate is 10 percent of the weight of cement.

4.3.3 Slowly ADD the cement to the test sample while it is being mixed.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade until a homogeneous mixture is obtained. approximately one minute or less if mixture begins to set.

4.3.4 After all the cement is added, slowly ADD the anhydrous sodium metasilicate to the test sample while it is being mixed.

4.3.5 MIX the sample for 2 minutes after all the cement and anhydrous sodium metasilicate is added so that a homogeneous mixture is obtained.

4.3.6 SEAL the samples and cure for 24 hours at 120±5°.

NOTE: If at any time during the 24 hour cure time, the sample meets the acceptance criteria, the liner solidification may proceed. However, no test solidification shall be disqualified without at least 24 hours of cure.

5.0 BEAD RESIN MIXED WITH SODIUM SULFATE CLASS A WASTE

5.1 Determination of Liner Contents

5.1.1 Based on the depth (in inches) of the settled bead resin in the liner and the concentration of sodium sulfate (determined by Chemistry) to be transferred, DETERMINE the following from Figures 5, 6 or 7.

5.1.1.1 The total volume of sodium sulfate that can go into the liner. RECORD on the appropriate Test Solidification Data Sheet.

5.1.1.2 The weight percent solids that will be in the liner after the transfer. RECORD on the appropriate Test Solidification Data Sheet.

NOTE: Figure 5 must be used for the HN-100 LVM liner. Figure 6 must be used for the HN-100 liner. Figure 7 must be used for the HN-600 liner.

5.1.2 USE the weight percent solids determined from Step 5.1.1.2 and the percent sodium sulfate from Chemistry to determine the grams of Portland Type I cement to use for a 200 ml sample using Figure 8.

5.1.3 TRANSFER the volume of sodium sulfate determined in Step 5.1.1.1, per the appropriate plant procedure, to the liner.

5.1.4 Sample the contents of the liner after mixing 10 minutes using proper radiological procedures.

5.2 Pre-treatment of Waste

5.2.1 Repeat Steps 4.2.1 through 4.2.2.1.

5.3 Test Solidification

5.3.1 Repeat Steps 4.3.1 through 4.3.6.

6.0 SOLIDIFICATION ACCEPTABILITY

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

6.1 The sample solidifications are considered acceptable if there is no visual or drainable free water, and

6.2 If upon visual inspection the waste appears that it would hold its shape if removed from the mixing vessel and

6.3 It resists penetration.

7.0 SOLIDIFICATION UNACCEPTABILITY

7.1 If the waste fails any of the criteria set forth in Section 6.0, the solidification will be termed unacceptable and a new set of solidification parameters will need to be established under the procedures in Section 8.0.

7.2 If the test solidification is unacceptable then the same test procedures must be followed on each subsequent batch of the same type of waste until three (3) consecutive test samples are solidified.

8.0 ALTERNATE SOLIDIFICATION PARAMETERS

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

8.1.1 Class A Wastes

(a) Mix equal weights of dry cement and water to ensure that the problem is not a bad batch of cement.

(b) If the waste is only partially solidified, use lower waste to cement and additive ratios. Continue using the recommended quantities of

cement and additive. If the mix is thin, reduce the waste sample volume to 175 ml, and if the mix is too thick, increase the waste sample volume to 225 ml. Continue changing the sample volume by 25 ml until the acceptability criteria of Section 6.0 are met.

2D

Solidification No: _____
Liner No: _____
Sample No: _____
Date: _____

CLASS A TEST SOLIDIFICATION DATA SHEET
for Powdered or Bead Resin
Mixed with Sodium Sulfate

I. Determination of Liner Contents

Depth of Settled Solids in Liner, inches: _____ (1)

Weight % Sodium Sulfate from Chemistry: _____ (2)

Total Quantity of Waste in Liner, after liquid transfer, ft^3: _____ (3)

Weight % Solids after Liquid Transfer: _____ (4)

II. Pre-treatment of Sample

Sample Volume, ml: _____ (5)

pH[1]: _____ (6a)

Volume NaOH solution used to adjust pH, ml: _____ (6b)

pH after adjustment (if required): _____ (6c)

Quantity of oil, %: _____ (7)

Quantity of emulsifier (20% by volume of oil), ml: _____ (8)

Quantity of anti-foaming agent, ml: _____ (9)

III. Solidification

Quantity of Cement Added:

Sample _____ gms (10a)

Cement Ratio[2] (lb/ft^3 Waste)

Sample _____ (10b)

Quantity of Additive Added:

Sample _____ gms (11a)

Additive Ratio[3] (lb/ft^3 Waste)

Sample _____ (11b)

Product Acceptable: Sample _____Yes_____No (If no, refer to Section 4.6 and proceed as directed).

Additional batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by: _____ Date _____

Acceptance Verified by: _____ Date _____

FOOTNOTES:

[1]If pH adjustment is required to bring the pH > 5.0, note chemical used, quantity used and pH after adjustment.

[2]Multiply the quantity of cement used for 200 ml of waste by 0.312 to obtain the pounds of cement necessary to solidify one cu. ft. of waste.

[3]Multiply the quantity of anhydrous sodium metasilicate used for 200 ml of waste by 0.312 to obtain the pounds of additive necessary to solidify one cu. ft. of waste.

CLASS 'A' WASTE SOLIDIFICATION CALCULATION SHEET

Waste Volume to be Solidified ft^3: _____ (1)

Cement Ratio, lb/ft^3: Sample _____ (2)
Item 10b - Form STD-P-05-009-01

Additive Ratio, lb/ft^3: Sample _____ (3)
Item 11b - Form STD-P-05-009-01

Cement Quantity[1]

_____(1) x _____ (2) = _____ lbs. (4)
Waste Volume lb/ft^3

Additive Quantity[1]

_____(1) x _____ (3) = _____ lbs. (5)
Waste Volume lb/ft^3

Quantities of additional additives that must be added to the liner are found by multiplying the volume of the additive used in the test solidification, in ml, by 0.0374 and then by the volume of waste to be solidified. Volumes of additional additives are taken from items 6b, 8 and 9 on Form STD-P-05-009-01:

_____ ml x 0.0374 x _____ (1) = _____ gallons[2] (8)
Item 6b, 8, or 9
Form STD-P-05-009-01

[1]4 and 5 define the recommended quantity of cement and additive respectively that must be mixed with the waste to assure solidification.

[2]Reduce the quantity of liquid waste in the liner by 1 ft^3 for every 10 gallons of additional additive.

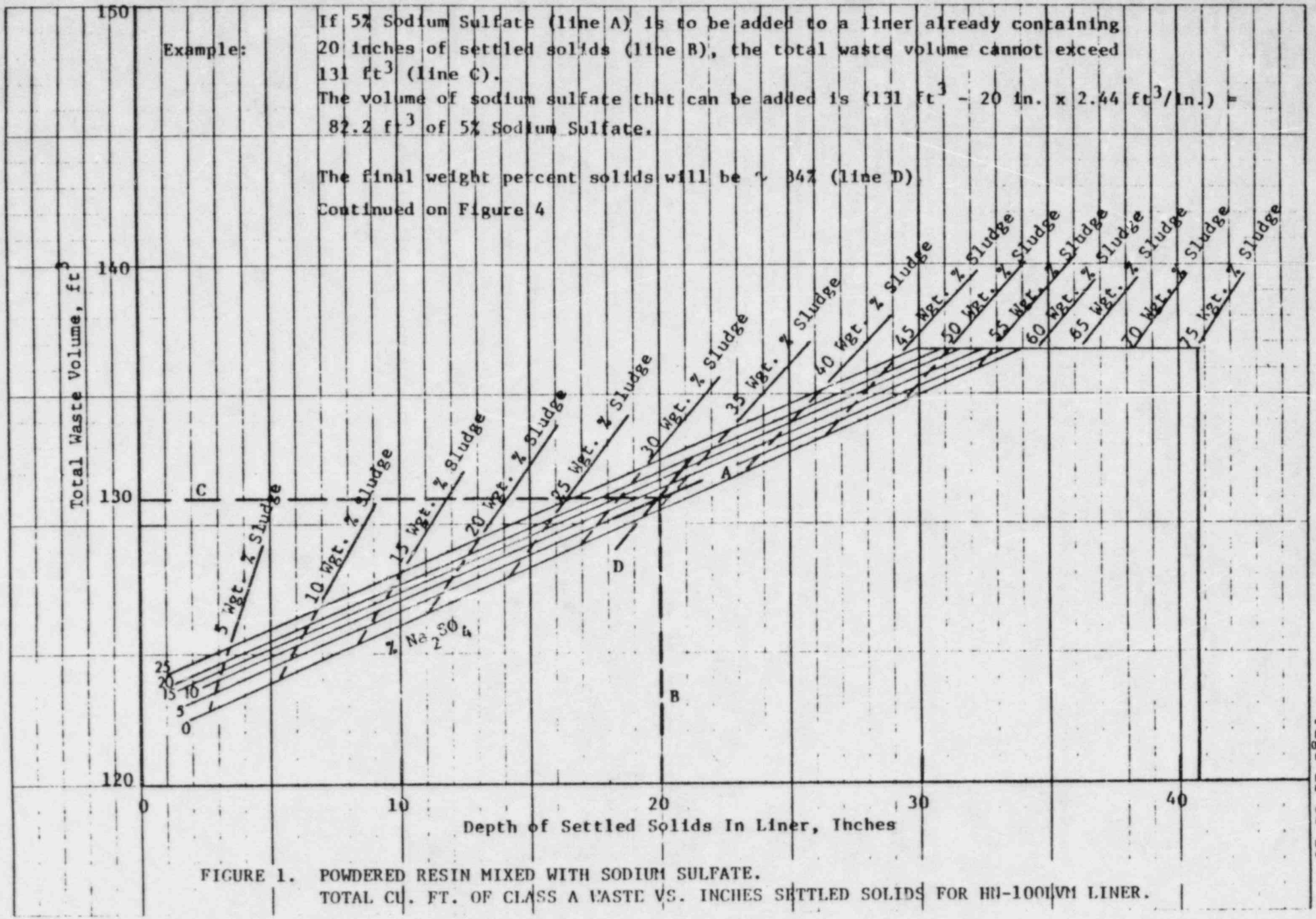

FIGURE 1. POWDERED RESIN MIXED WITH SODIUM SULFATE.
TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-100[VM LINER.

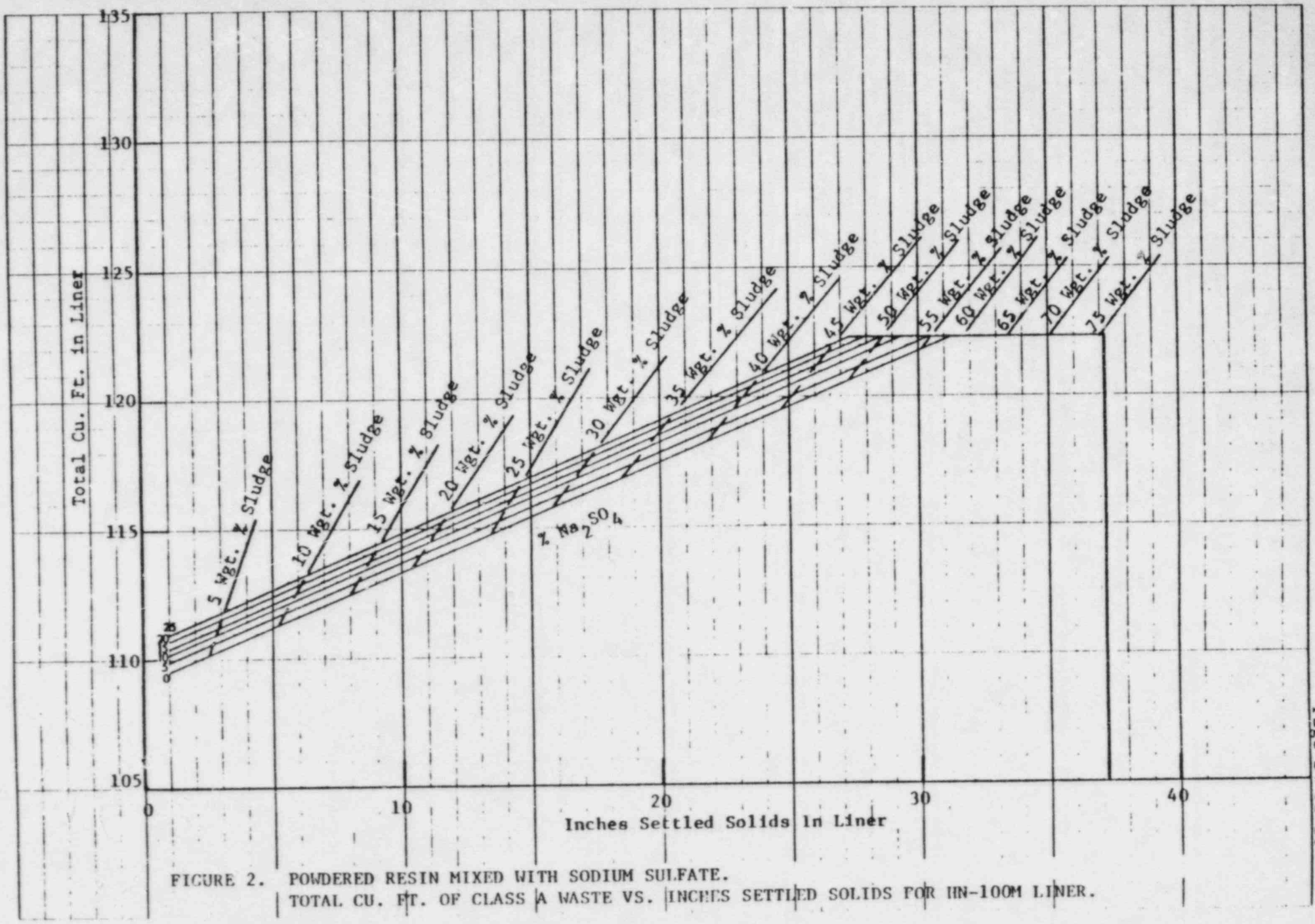

FIGURE 2. POWDERED RESIN MIXED WITH SODIUM SULFATE.
TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-100M LINER.

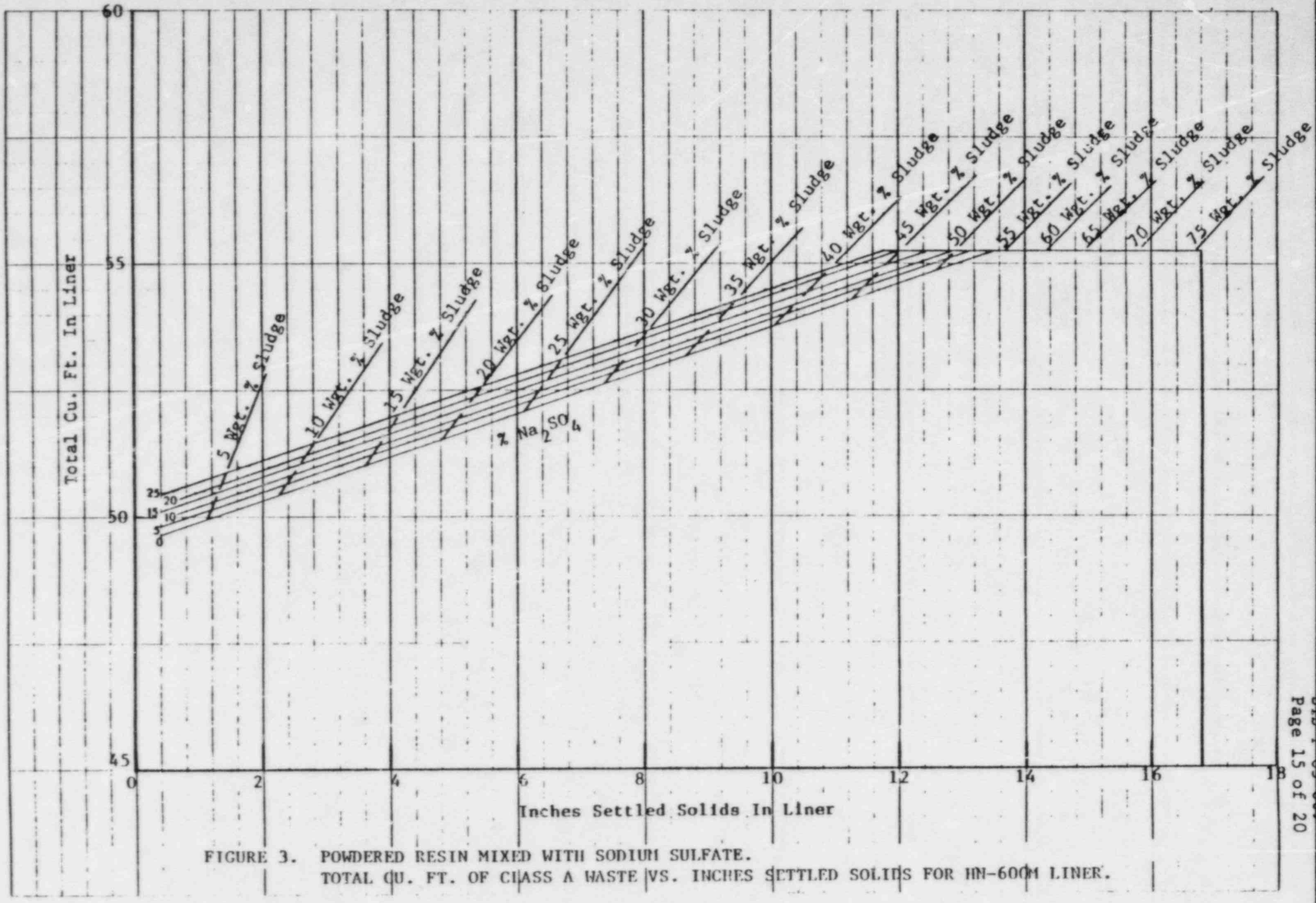

FIGURE 3. POWDERED RESIN MIXED WITH SODIUM SULFATE.
TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-600M LINER.

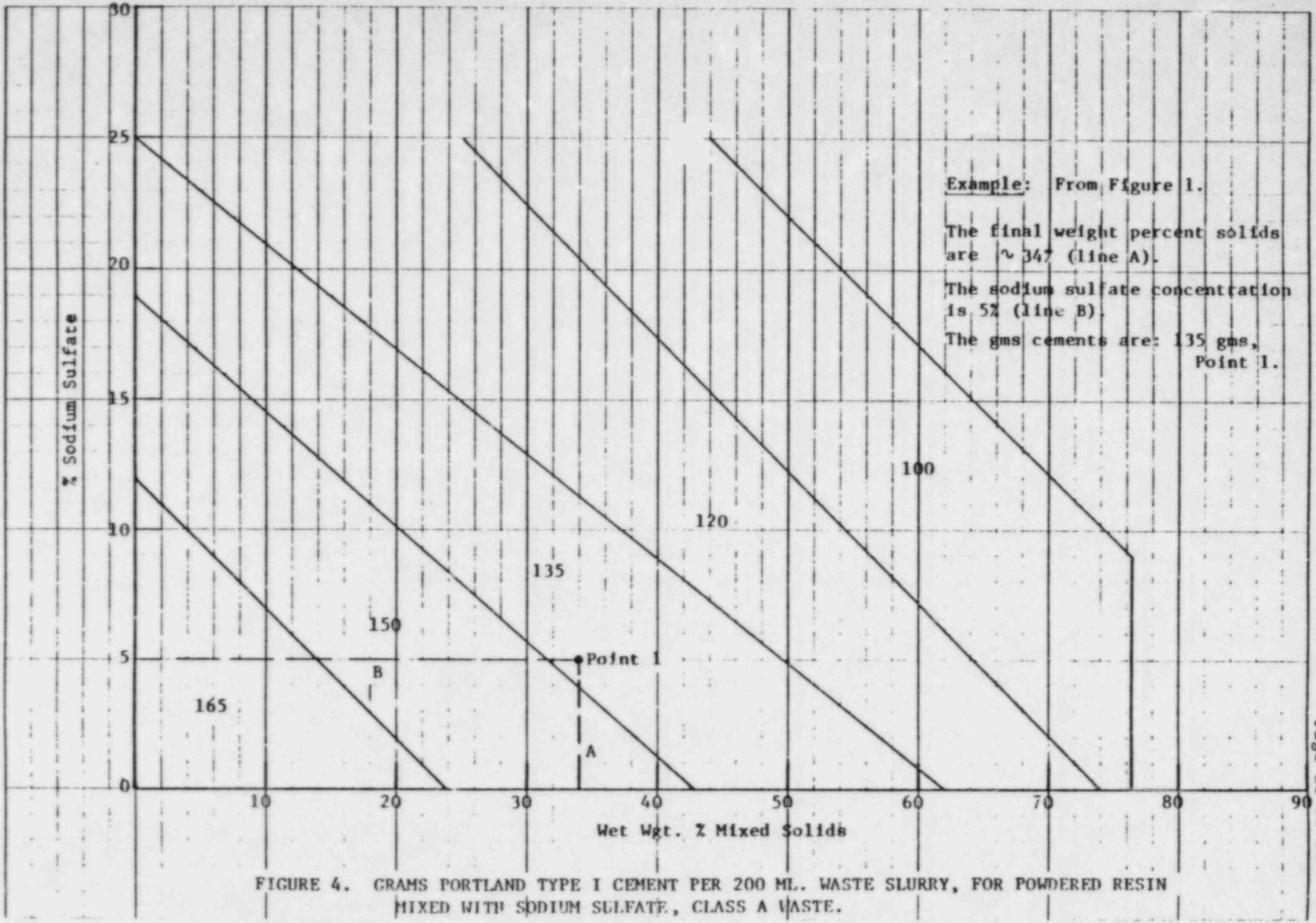

FIGURE 4. GRAMS PORTLAND TYPE I CEMENT PER 200 ML. WASTE SLURRY, FOR POWDERED RESIN MIXED WITH SODIUM SULFATE, CLASS A WASTE.

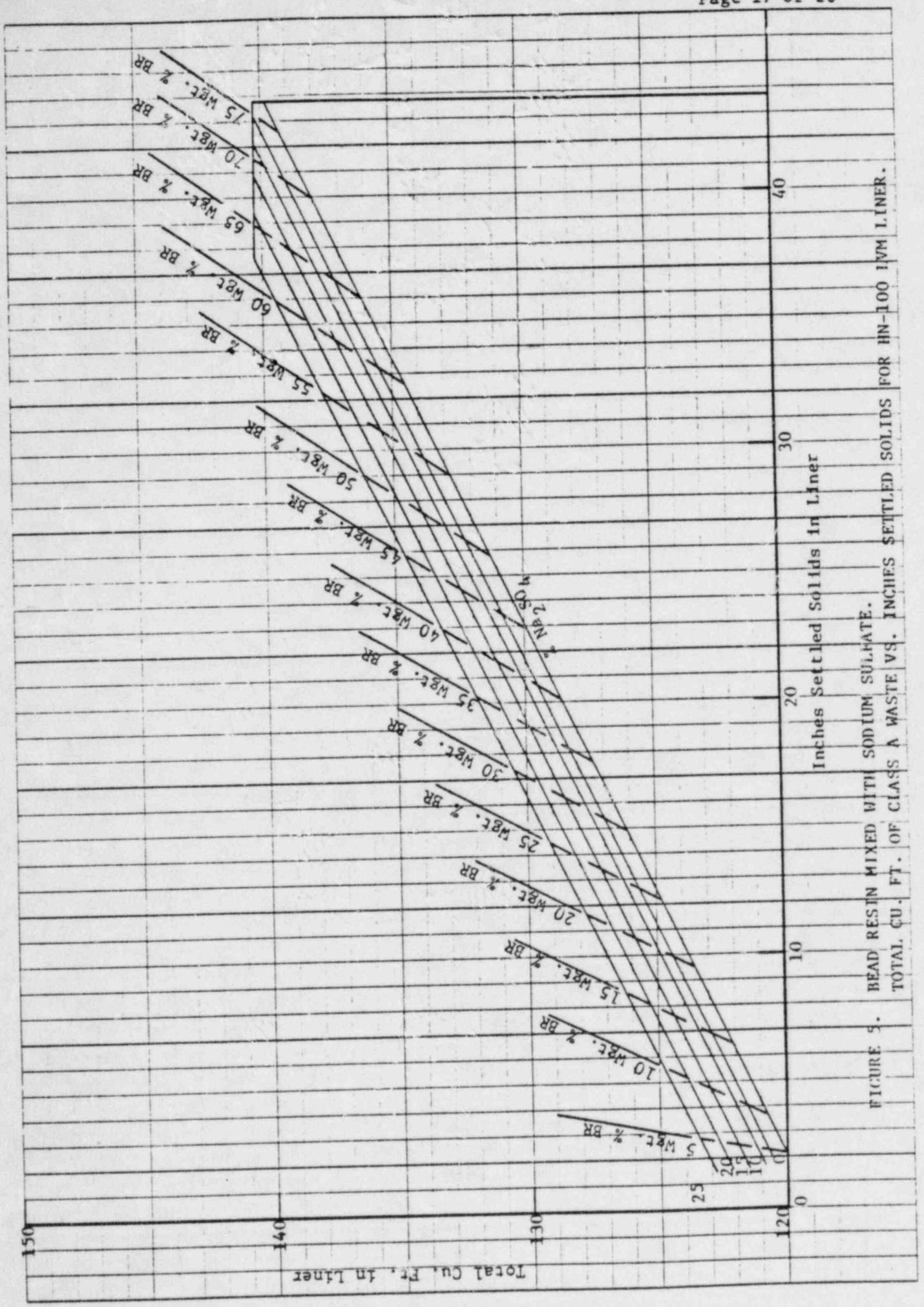

FIGURE 9. BEAD RESIN MIXED WITH SODIUM SULFATE.
TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-100 HVM LINER.

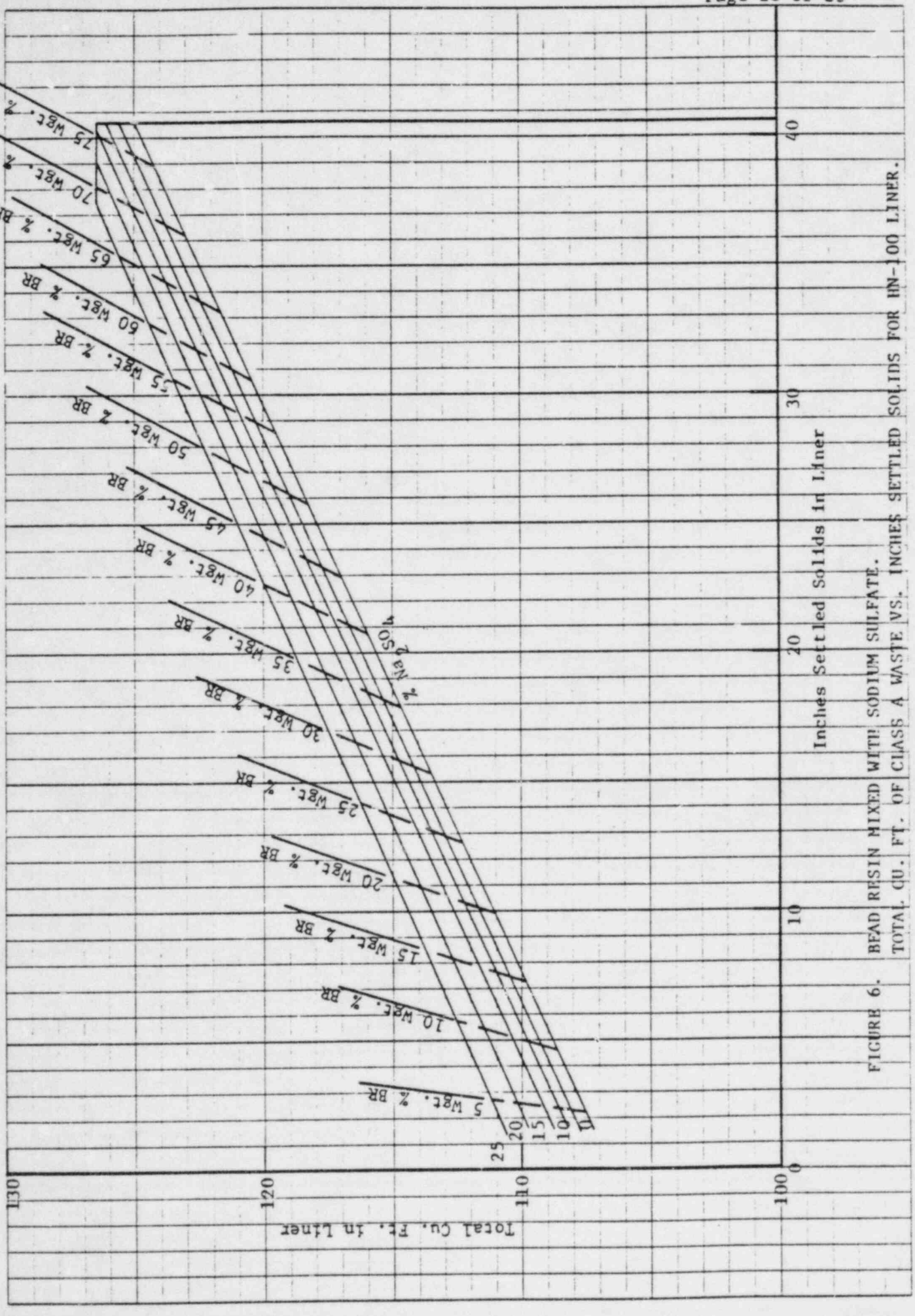

FIGURE 6. BEAD RESIN MIXED WITH SODIUM SULFATE.
TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-100 LINER.

46 0410

K·E 5 X 5 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO MADE IN U.S.A.

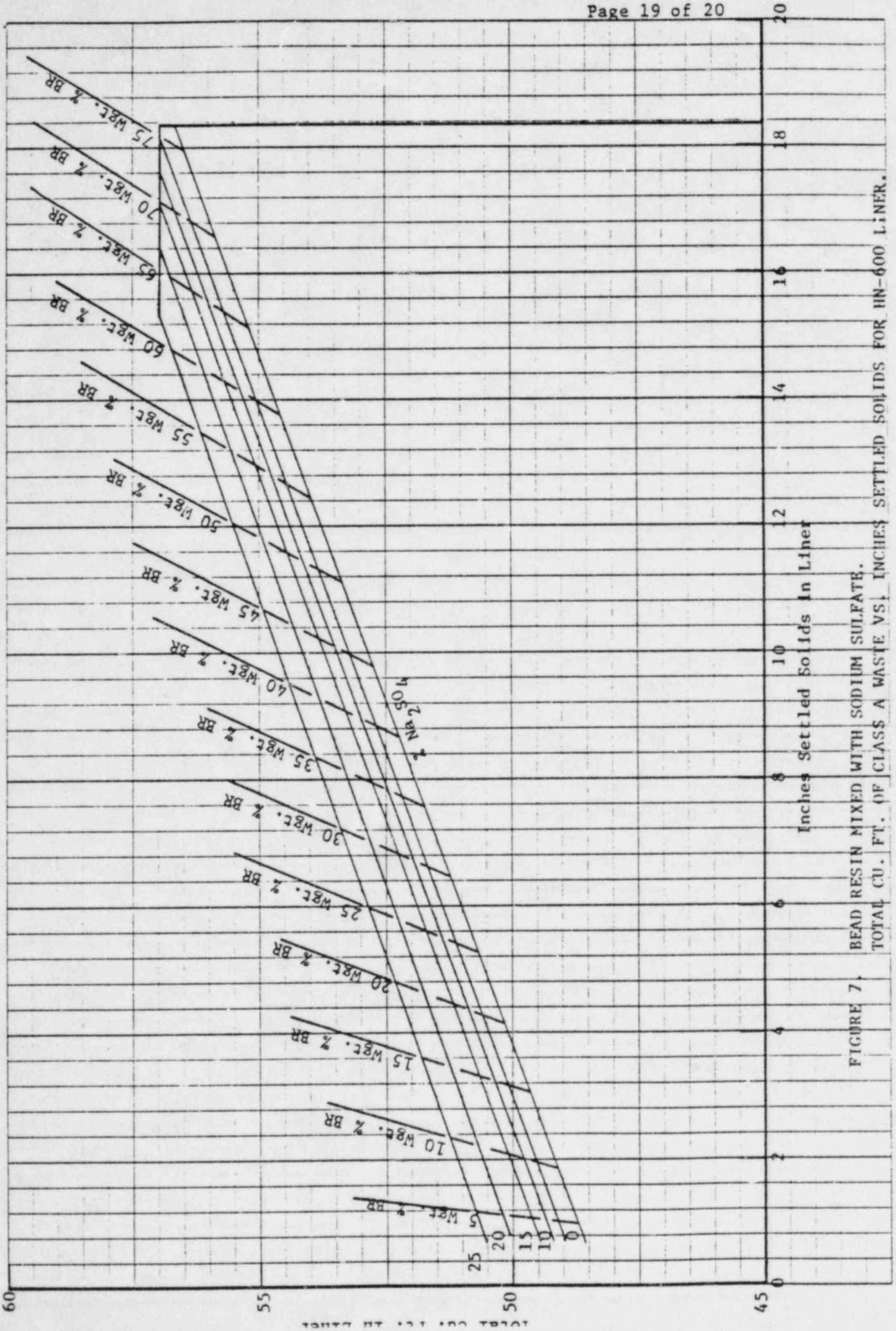

FIGURE 7. BEAD RESIN MIXED WITH SODIUM SULFATE.
TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-600 LINER.

46 0410

K•E 5 X 5 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

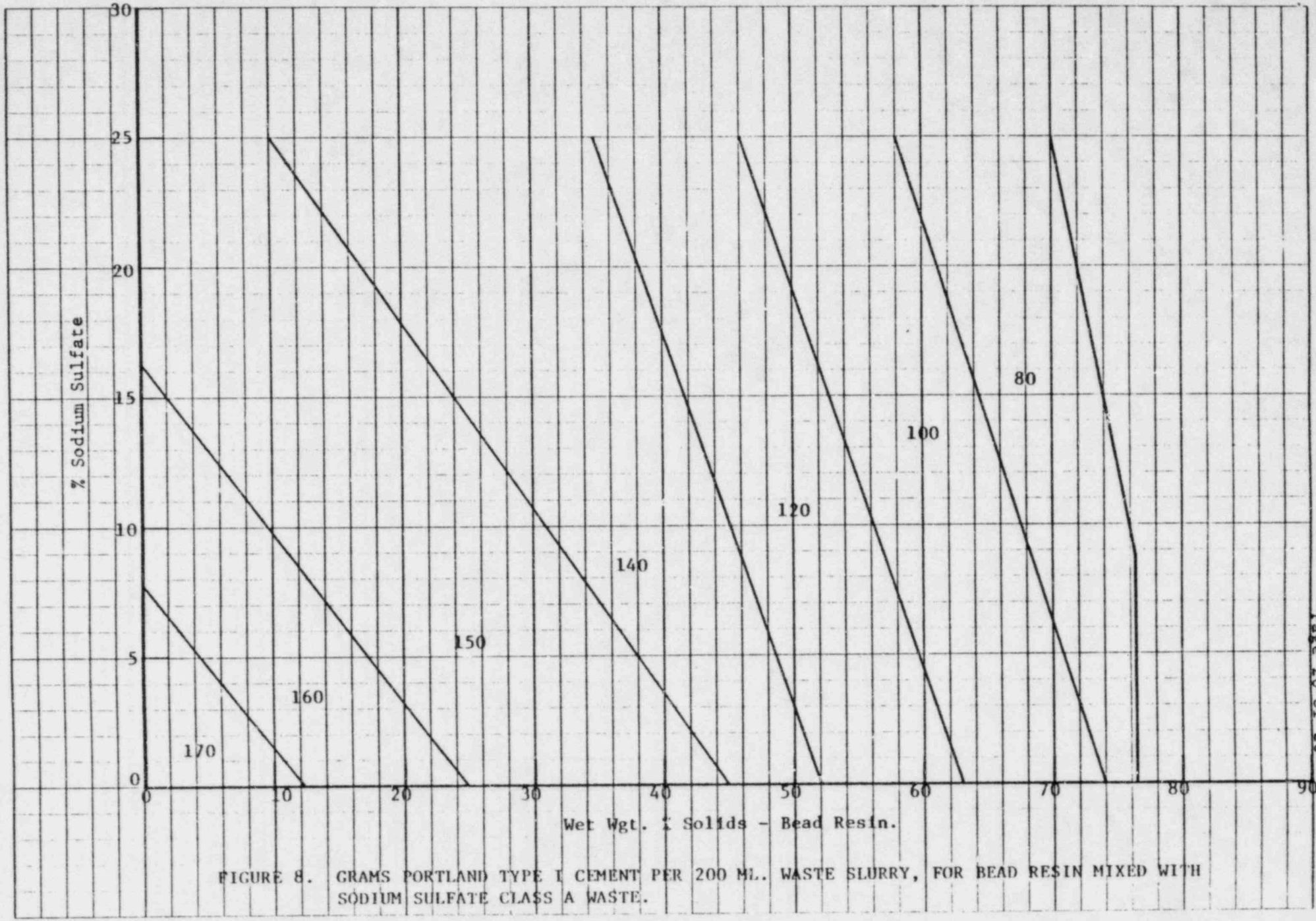

FIGURE 8. GRAMS PORTLAND TYPE I CEMENT PER 200 ML. WASTE SLURRY, FOR BEAD RESIN MIXED WITH SODIUM SULFATE CLASS A WASTE.

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-010	Rev: 1	Rev Date: 12-12-83
	Title: PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF 25 TO 30 WEIGHT PERCENT BORIC ACID		

Rev.	Rev Date	Prepared by	Responsible Engineer	Director Engineering	Manager Field Services	QA Manager	
0	8-16-82						EWR-82-418
1	12-12-83	X	X				ECN-83-279

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PROCESS CONTROL PROGRAM
IN-CONTAINER SOLIDIFICATION
FOR 25 to 30 WEIGHT PERCENT BORIC ACID

1.0 Purpose

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

The program consists of four major steps, which are:

(a) Procedures for collecting and analyzing samples;

(b) Procedures for solidifying samples;

(c) Criteria for process parameters for acceptance or rejection as solidified waste.

(d) Calculation of minimum and maximum quantities of cement and anhydrous sodium metasilicate to be used in full scale liner solidifications.

1.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the range of acceptable ratios of waste, additional water (if required), cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into minimum and maximum quantity of cement and additive that must be mixed with the waste. Assurance that quantities of cement and additive between these ranges are actually mixed with the waste is covered in the Field Solidification Operating Procedures.

2.0 System Description

To be added for each specific plant.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BRW's the PCP shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a disposable liner to the waste level indicator.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidifications. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, where handling of samples could result in personnel radiation exposures which are inconsistant with the ALARA principal, representative non-radioactive samples will be tested. These samples should be as close to the actual wastes' chemical properties as possible.

3.2 Collection of Samples

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

3.2.1 Radiological protection.

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by solidification in the disposal liner.

3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

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

3.2.2.1 The test sample data for concentrated waste will include, but not necessarily be limited to, the type of waste solidified, percent solids, pH, volume of sample, amount of oil in sample and the ratio of the sample volume to the final volume of the solidified product.

3.2.2.2 The waste solidification data sheet will include the Batch Number, Batch Volume, and Date Solidified, for each batch solidified based on sample described.

3.2.3 Collection of Samples

3.2.3.1 Evaporator bottoms shall be kept heated or reheated to 100°F prior to the adjustment of pH. The adjustment of pH will cause exothermic heating of the sample and may require cooling of the sample prior to solidificatin testing. Do not cool below 100°F before solidifying.

3.2.3.2 Two samples shall be taken for solidification. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.3 If possible, samples should be drawn at least six hours prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification.

3.2.3.4 The waste to be solidified should be mixed or recirculated in the tank for at least three volume changes prior to sampling to assure a representative sample.

3.2.3.5 If the contents of more than one tank are to be solidified in the same liner then representative

samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.2. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Analysis of Samples

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

Parameter	Acceptable Range
pH	>12*
Boric Acid or Boron	25 - 30 wgt % or 43,666 to 52,350 ppm
Detergents	No appreciable foaming
Oil	<1%

* After addition of sodium hydroxide.

4.0 Test Solidification and Acceptance Criteria

4.1. Waste Conditioning

4.1.1 Prior to the test sample solidification the pH of the sample shall be adjusted to greater than 12.0.

4.1.2 It is recommended that sodium hydroxide be used to adjust the pH. The amount of sodium hydroxide necessary for the pH adjustment shall be recorded.

4.1.3 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded.

4.1.4 If oil is present in quantities greater than 1% by volume, the oil shall be reduced to less than 1% by skimming. Emulsification agents should be used to break up the remaining oil. The quantity of any substance added to the sample for this purpose shall be recorded.

4.2 Test Solidification

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

4.2.2 Test Solidifications should be conducted using a 1000 ml. disposal beaker or similar size container. Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case for less than two (2) minutes.

4.2.3 For the test solidification of the borated wastes, measure into two mixing vessels 520 ml of waste each.

4.2.4 Measure out the required quantities of cement and anhydrous sodium metasilicate as shown below.

Waste	Grams Cement		Grams Anhydrous Sodium Metasilicate	
	Sample A	Sample B	Sample A	Sample B
25-30 wgt % Boric Acid	657.1	946.2	98.6	141.9

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

4.2.6 After mixing for approximately two (2) minutes once all cement and additive is added and homogeneous mixture is obtained, allow the waste to stand for a minimum of four hours.

4.3 Solidification Acceptability

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

4.3.1 The sample solidifications are considered acceptable if there is no visual or drainable free water.

4.3.2 The sample solidifications are considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration by a rigid stick.

4.3.3 The sample solidifications establish a range for the ratios of cement to waste that will result in an acceptable product.

4.4 Solidification Unacceptability

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

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

4.5 Alternate Solidification Parameters

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

(1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.

(2) Add additional caustic solution to raise the pH according to Section 4.1.1.

(3) If the waste is only partially solidified, use lower waste to cement ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate, reduce the waste sample volume to 495 ml and continue reducing the sample volume by 25 ml until the acceptability criteria of Section 4.3 are met.

Batch No.: _____
Sample No.: _____
Date: _____

WASTE SOLIDIFICATION DATA SHEET
for
Boric Acid

Sample Volume, ml: Sample A _____ Sample B _____ (1)

pH[1]:

Quantity of Oil %:

Quantity of Cement Added:

Sample A _____ gms
Sample B _____ gms

Cement Ratio[2] (#/ft^3 Waste)

Sample A _____ (2)
Sample B _____ (3)

Quantity of Additive[3] Added:

Sample A _____ gms
Sample B _____ gms

Additive Ratio[4] (#/ft^3 Waste)

Sample A _____ (4)
Sample B _____ (5)

Final Waste to Product Ratio: Sample A _____ Sample B _____ (6)

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

Sample B ___ Yes ___ No

Additional batches solidified based on this sample solidification:

Batch No.	Batch Vol.	Date	Batch No.	Batch Vol.	Date	Batch No.	Batch Vol.	Date
2			5			8		
3			6			9		
4			7			10		

Test Solidifications Performed by: _____ Date: _____
PCP Samples Approved by: _____ Date: _____

NOTES:

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

[2]For the ratios given in Section 4.2.4, cement-to-waste ratios are 78.8 to 113.5 pounds cement per cubic foot of boric acid.

[3]The additive used in this process is anhydrous sodium metasilicate as referenced in the text.

[4]For the ratios given in Section 4.2.4, additive-to-waste ratios are 11.8 to 17.0 pounds additive per cubic foot of boric acid.

SOLIDIFICATION CALCULATION SHEET

Waste Volume[1], ft^3: _____ (1)

Cement Ratio, $\#/ft^3$: Sample A _____ (2A)

Sample B _____ (2B)

Additive: _____

Additive Ratio, $\#/ft^3$: Sample A _____ (3A)

Sample B _____ (3B)

Cement Quantity[2]

_____ (1)[1] x _____ (2A) = _____ lbs. (4A)

_____ (1)[1] x _____ (2B) = _____ lbs. (4B)

Additive Quantity[2]

_____ (1) x _____ (3A) = _____ lbs. (5A)

_____ (1) x _____ (3B) = _____ lbs. (5B)

[1]The quantity of waste to be solidified in a single liner cannot exceed the maximum waste volume listed on the attached Solidification Data Tables.

[2]4A and 5A define the minimum quantity of cement and additive respectively that must be mixed with the waste to assure solidification. When these quantities of materials are mixed, additional cement and additive are to be mixed until further mixing is not possible or the values in 4B and 5B are reached.

SOLIDIFICATION DATA TABLES

For 25-30 wgt. % boric acid, the cask payload is limiting

I. For the Minimum Amount of Cement and Additive

	HN-100			HN-100S	HN-100 LVM
	Series 1	Series 2	Series 3		Series 3*
Usable Liner Volume, ft^3	143	143	143	143	160.0
Max. Solidified Waste Vol., ft^3	108.7	106	137.5	130.5	160.0
Max. Waste Vol. ft^3	74.3	72.6	94.05	89.27	109.4
Cement Added at Max. Waste Vol.					
Pounds	5864.0	5,723.3	7,149.0	7,042.2	8623.9
1 ft^3 bags	62.4	60.9	78.9	74.9	91.7
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Pounds	879.6	858.4	1,112.7	1,056.22	1291.4
1 ft^3 bags	8.8	8.6	11.1	10.6	12.9
Max. Radiation Level					
R/hr Contact	12	12	12	5	12

* For less than A_2 quantities of LSA waste.

II. For the Recommended Amount of Cement and Additive

	HN-100			HN-100S	HN-100 LVM
	Series 1	Series 2	Series 3		Series 3*
Usable Liner Volume, ft^3	143	143	143	143	160.0
Max. Solidified Waste Vol., ft^3	98.76	96.4	125	118.65	160.0
Max. Waste Vol. ft^3	60.05	58.61	76.0	72.14	97.3
Cement Added at Max. Waste Vol.					
Pounds	6,818.4	6,654.2	8,629.6	8,191.3	11,041.3
1 ft^3 bags	72.5	70.79	91.8	87.14	117.5
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Pounds	1,022.5	997.9	1,294.16	1,228.4	1,653.8
1 ft^3 bags	10.2	9.98	12.9	12.3	16.5
Max. Radiation Level R/hr Contact	12	12	12	5	12

* For less than A_2 quantities of LSA waste

John Pucilowski

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-014	Rev: 0	Rev Date: 10-5-82
	Title: Sodium Sulfate Solidification Procedure		

Rev.	Rev Date	Prepared by	Director Engineering	Manager Field Services	QA Manager		
0	10-5-82	E. Cloer					EWR-82-592

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SODIUM SULFATE SOLIDIFICATION PROCEDURE

FOREWARD

This manual provides guidelines and procedures for the solidification of sodium solfate solutions using the Hittman Nuclear and Development Corporation Incontainer Solidification System. The other parts of the Incontainer Solidification System are listed below and the applicable manuals and installation, operating and maintenance procedures for those parts being used in field operations should be available and used in conjunction with these procedures:

- Liner Loading Procedure - HNDC-TS-14000
- Mixer Drive Assembly Mounting Procedure - HNDC-TS-17000
- Flexicon Cement Feed System Procedure - HNDC-TS-13000
- Electric Mixer Drive Assembly Operation and Maintenance - HNDC-TS-19000
- Hydraulic Mixer Drive Assembly Operation and Maintenance - HNDC-TS-12000
- Power Distribution and Level Control Module - HNDC-TS-18000

1.0 Prerequisites

The following prerequisites should be completed prior to the actual incontainer solidification of sodium sulfate solutions:

1.1 The proper sampling and analysis of the waste to be solidified has been performed in accordance with the applicable Process Control Program.

1.2 The amount of waste transferred to the incontainer solidification liner has been established depending on the process to be used (i.e., volume limited or weight limited) and must include an allowance to assure that the limitation on contents are not exceeded and this amount has been transferred to the liner. This amount is established in accordance with the applicable Process Control Program.

1.3 The appropriate mixing ratios have been established in accordance with the Process Control Program and the necessary amounts of solidification agent(s) are available.

1.4 The waste has been allowed to cool to a temperature of 90°-100°F.

1.5 The liner mixer blade drive has been installed. The mixer head drive assembly may be electric or hydraulic for the solidification of sodium sulfate.

1.6 The liner has been positioned in such a way as to allow the cement feed system and the mixer head drive to be connected as prescribed in the Liner Loading Procedure.

1.7 The cement feed system has been installed in accordance with the Flexicon Cement Feed System Procedure. The correct quantities of cement and additive have been added to the hopper(s).

1.8 The cement inlet valve located on the mixer head drive assembly has been opened.

1.9 It is recommended that plain bottom liners (with mixing blades) be used for the solidification of sodium sulfate wastes. Should it be necessary, due to liner availability, to use a liner with an underdrain one of the following techniques must be used to ensure that no drainable liquid is present in the liner at the time of shipment from site:

a. At least twelve (12) hours prior to introduction of

waste into the liner pump a cement slurry into the underdrain through the underdrain stand pipe. The slurry should be made up using one cubic foot (94 pounds) of cement and approximately 10 gallons of water. Upon completion of the injection disconnect the hose from the liner and flush the pump and hoses.

b. If the above technique is not feasible, then during the solidification process, the liquid in the underdrain shall be re-circulated into the top of the liner as prescribed in Step 3.3 of this procedure. A final dewatering may be performed prior to shipment if desired provided the liner contains a final dewatering connection.

2.0 Introduction

The solidification procedure described below is the final step in the incontainer solidification process of sodium sulfate. The mixer head drive assembly is used to power the internal mixer blades and the cement feed system is used to deliver the cement and additive to the liner. The amount of each is predetermined and premeasured to assure correct mixing ratios.

3.0 Procedure

The following solidification procedure contains the necessary steps to be taken to assure an acceptable solidified produce of maximum allowable volume.

3.1 Start the mixer drive unit in the forward direction at solidification speed in accordance with the appropriate Mixer Drive Operating Procedure.

3.2 Follow the Cement Feed System Procedure. Start the cement feed system and run it until all cement and additive have been added.

3.3 For liners with underdrains that have not been sealed with a cement slurry the following steps shall be taken:

3.3.1 Place the dewatering pump discharge into the top of the liner, and when all the cement and additive has been added to the liner, run the dewatering pump to draw suction on the dewatering hose for three (3) minutes. Be careful not to obstruct

the mixing blade with the discharge hose. This will draw cement-laden liquid into the underdrain system and eliminate residual water to ensure complete solidification.

3.3.2 Immediately following the final dewatering of the underdrain, disconnect the dewatering pump suction hose from the liner and use it to pump ten (10) gallons of water into the top of the liner. This will flush the pump clean.

3.4 The mixing process is to continue for a minimum of 30 minutes or until the mixer stalls, whichever occurs first. If an electric drive is being used and the mixing blade stalls, immediately push the mixer stop button.

3.5 At this time, the screw conveyor of the cement feed system can be removed from the mixer head drive assembly, and the mixer head drive assembly can be removed from the liner and properly stored.

3.6 Cap the liner and replace the shield plug of the primary cask lid, if applicable.

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-015	Rev: 1	Rev Date: 12-12-83
	Title: PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF 20-25 WEIGHT PERCENT BORIC ACID		

Rev.	Rev Date	Prepared by	Supervisor Laboratory Services	Director Engineering	Manager Field Services	QA Manager	
0	11-5-82	K. McDavid	E. Clower				EWR-82-666
1	12-12-83	X	X				ECN-83-260

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No. 02

PROCESS CONTROL PROGRAM
IN-CONTAINER SOLIDIFICATION
FOR 20 to 25 WEIGHT PERCENT BORIC ACID

1.0 Purpose

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

The program consists of four major steps, which are:

(a) Procedures for collecting and analyzing samples;

(b) Procedures for solidifying samples;

(c) Criteria for process parameters for acceptance or rejection as solidified waste.

(d) Calculation of minimum and recommended quantities of cement and anhydrous sodium metasilicate to be used in full scale liner solidification.

1.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the range of acceptable ratios of waste, cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into minimum and recommended quantity of cement and additive that must be mixed with the waste. Assurance that quantities of cement and additive between these ranges are actually mixed with the waste is covered in the Field Services Weekly Report.

2.0 System Description

To be added for each specific plant.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BRW's the PCP shall be used to verify the solidification of one representative test specimen from at least every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a disposable liner to the waste level indicator.

3.1.3 If the initial test specimen from a batch of waste fails to verify solidification, representative test specimens shall be collected from consecutive batches of the same type of waste. When three consecutive test specimens demonstrate solidification using the initial solidification parameters, the testing may be suspended until every tenth batch.

3.1.4 If any test specimen from paragraph 3.1.3 fails to solidify using the initial solidification parameters, alternate parameters must be established. These new parameters will be tested until three consecutive batches demonstrate solidification.

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

3.2 Collection of Samples

3.2.1 Radiological protection.

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

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by solidification in the disposal liner after solidification.

3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

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

3.2.2.1 The test sample data for concentrated waste will include, but not necessarily be limited to, the type of waste solidified, percent solids, pH of waste, volume of sample, amount of oil in sample and the ratio of the sample volume to the final volume of the solidified product.

3.2.2.2 The waste solidification data sheet will include the Liner Number, Waste Volume, and Date Solidified, for each batch solidified.

3.2.3 Collection of Samples

3.2.3.1 Evaporator bottoms shall be kept heated or reheated to 130°F prior to the adjustment of pH. The adjustment of pH will cause exothermic heating of the sample and may require cooling of the sample prior to solidificatin testing. Do not cool below 100°F before solidifying.

3.2.3.2 Two samples shall be taken for solidification. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.3 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification, and to allow for retesting if necessary.

3.2.3.4 The waste to be solidified should be mixed by recirculating the tank for at least three volume changes prior to sampling to assure a representative sample.

3.2.3.5 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. The samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.2. If the contents of a particular tank represent x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Sample Analysis

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

Parameter	Acceptable Range
pH	>12*
Boric Acid or Boron	20 - 25 wgt % or 34,900 to 43,625 ppm
Detergents	No appreciable foaming
Oil	<1%

* After addition of sodium hydroxide.

4.0 Test Solidification and Acceptance Criteria

4.1. Waste Conditioning

4.1.1 Prior to the test sample solidification the pH of the sample shall be adjusted to greater than 12.0.

4.1.2 It is recommended that sodium hydroxide be used to adjust the pH. The amount of sodium hydroxide necessary for the pH adjustment shall be recorded.

4.1.3 If large quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded.

4.1.4 If oil is present in quantities greater than 1% by volume, the oil shall be reduced to less than 1% by skimming. Emulsification agents should be used to break up the remaining oil. The quantity of

any substance added to the sample for this purpose shall be recorded.

4.2 Test Solidification

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

4.2.2 Test Solidifications should be conducted using a 1000 ml. disposal beaker or similar size container. Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case for less than two minutes.

4.2.3 For the test solidification of the borated wastes, measure into two mixing vessels 520 ml of waste each.

4.2.4 Measure out the required quantities of cement and anhydrous sodium metasilicate as shown below

Waste	Grams Cement		Grams Anhydrous Sodium Metasilicate	
	Sample A	Sample B	Sample A	Sample B
20-25 wgt % Boric Acid	657.1	946.2	98.6	141.9

4.2.5 Mix the cement and additive together.

4.2.6 Slowly add the cement-anhydrous sodium metasilicate mixture to the test sample while it is being stirred.

4.2.7 After mixing for approximately two minutes, once all the cement and additive are added, and a homogeneous mixture is obtained allow the waste to stand for a minimum of 4 hours.

4.3 Solidification Acceptability

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

4.3.1 The sample solidifications are considered acceptable if there is no free standing water.

4.3.2 The sample solidifications are considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration.

4.3.3 The sample solidifications establish a range for the ratios of cement to waste that will result in an acceptable product.

4.4 Solidification Unacceptability

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

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

4.5 Alternate Solidification Parameters

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

(1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.

(2) Add additional caustic solution to raise the pH according to Section 4.1.1.

(3) If the waste is only partially solidified, use lower waste to cement ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate, reduce the waste sample volume to 495 ml and continue reducing the sample volume by 25 ml until the acceptability criteria of Section 4.3 are met.

Liner No.: _____
Sample No.: _____
Date: _____

WASTE SOLIDIFICATION DATA SHEET
For
20-25 Wgt. Percent Boric Acid

Sample Volume, ml: Sample A_____ Sample B_____

Sample pH: Volume NaOH solution used to adjust pH, ml:_____

Quantity of Oil %:_____

Quantity of Emulsifier (20% of vol. of oil), ml[1]:_____

Quantity of Anti-foaming Agent, ml:_____

Temperature at Solidification, °F:_____

Quantity of Cement Added: Cement Ratio[2] (#/ft^3 Waste)

Sample A_____ Sample A_____

Sample B_____ Sample B_____

Quantity Additive Added[3]: Additive Ratio[4] (#/ft^3 Waste):

Sample A_____ gms Sample A_____

Sample B_____ gms Sample B_____

Packaging Efficiency: $\frac{\text{Waste Volume}}{\text{Solidified Waste Volume}}$

Sample A_____

Sample B_____

Product Acceptable: Sample A____Yes____No (If no, refer to Section 4.5 and proceed as directed)

Sample B____Yes____No

Additional batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by_____ Date_____

NOTES:

[1]If emulsification is not accomplished, call HITTMAN.

[2]For the ratios given in Section 4.2.4, cement-to-waste ratios are 78.8 to 113.5 pounds cement per cubic foot of boric acid.

[3]The additive used in this process is anhydrous sodium metasilicate as references in the text.

[4]For the ratios given in Section 4.2.4, additive-to-waste ratios are 11.8 to 17.0 pounds additive per cubic foot of boric acid.

SOLIDIFICATION CALCULATION SHEET

Waste Volume[1], ft^3: _____ (1)

Cement Ratio, $\#/ft^3$: Sample A _____ (2A)

Sample B _____ (2B)

Additive: _____

Additive Ratio, $\#/ft^3$: Sample A _____ (3A)

Sample B _____ (3B)

Cement Quantity[2]

_____ (1)[1] x _____ (2A) = _____ lbs. (4A)

_____ (1)[1] x _____ (2B) = _____ lbs. (4B)

Additive Quantity[2]

_____ (1) x _____ (3A) = _____ lbs. (5A)

_____ (1) x _____ (3B) = _____ lbs. (5B)

[1]The quantity of waste to be solidified in a single liner cannot exceed the maximum waste volume listed on the attached Solidification Data Tables.

[2]4A and 5A define the minimum quantity of cement and additive respectively that must be mixed with the waste to assure solidification. When these quantities of materials are mixed, additional cement and additive are to be mixed until further mixing is not possible or the values in 4B and 5B are reached.

VI. SOLIDIFICATION DATA TABLE FOR CLASS A
SODIUM SULFATE, 22.5 TO < 27.5 W/O

LINER	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S	HN-100 LVM Series 3*	HN-600** S	HN-600** G	HN-600** S & G	HN-600** R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	106.6	104	122.3	122.3	136.8	51.0	55.2	49.3	55.2
Solidified Volume (cu.ft.)	124.6	121.6	143	143	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	3729.5	3638.9	4279.3	4279.3	4788	1783.5	1933.2	1726.7	1933.2
1 cu. ft. bags	39.7	38.7	45.5	45.5	50.9	19.0	20.6	18.4	20.6
Anhydrous Sodium Metasilicate Added									
lbs.	373	363.9	427.9	427.9	478.8	178.4	193.3	172.7	193.3
100 lb. bags	3.7	3.6	4.3	4.3	4.8	1.8	1.9	1.7	1.9
Max. Rad Level									
R/hr. contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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VII. SOLIDIFICATION DATA TABLE FOR CLASS A
SODIUM SULFATE, 27.5 to 30.0 W/O

LINER	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S	HN-100 LVM Series 3*	HN-600** S	HN-600** G	HN-600** S & G	HN-600** R
Usable Liner Vol. (cu.ft.)	143	143	143	143	160	59.6	64.6	57.7	64.6
Waste Volume (cu.ft.)	108.2	105.6	123.3	123.3	137.9	51.4	55.7	49.7	55.7
Solidified Volume (cu.ft.)	125.6	122.5	143	143	160	59.6	64.6	57.7	64.6
Cement Added									
lbs.	3366.2	3284.4	3833.6	3833.6	4289.3	1597.8	1731.8	1546.8	1731.8
1 cu. ft. bags	35.8	34.9	40.8	40.8	45.6	17	18.4	16.5	18.4
Anhydrous Sodium Metasilicate Added									
lbs.	336.6	328.4	383.4	383.4	428.9	159.8	173.2	154.7	173.2
100 lb. bags	3.4	3.3	3.8	3.8	4.3	1.6	1.7	1.5	1.7
Max. Rad Level									
R/hr. contact	12	12	12	3	12	100	100	100	100

* For less than A_2 quantities of LSA waste.

** S = Stackable
G = Grappable
S&G = Stackable & Grappable
R = Regular

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SOLIDIFICATION DATA TABLES

For 20-25 wgt. % boric acid, the cask payload is limiting

I. For the Minimum Amount of Cement and Additive

	HN-100			HN-100S	HN-100 LVM
	Series 1	Series 2	Series 3		Series 3*
Usable Liner Volume, ft^3	143	143	143	143	160.0
Max. Waste Vol. ft^3	74.4	72.5	93.7	89.4	108.6
Max. Solidified Waste Vol., ft^3	109.5	106.8	138.0	131.7	160.0
Cement Added at Max. Waste Vol.					
Pounds	5,858.9	5,716.5	7,381.7	7,044.9	8560.8
1 ft^3 bags	62.3	60.8	78.5	75.0	91.1
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Pounds	877.3	856.0	1,105.4	1,054.9	1282.0
1 ft^3 bags	8.8	8.6	11.1	10.6	12.8
Max. Radiation Level					
R/hr Contact	12	12	12	3	12

* For less than A_2 quantities of LSA waste.

II. For the Recommended Amount of Cement and Additive

	HN-100				HN-100 LVM
	Series 1	Series 2	Series 3		Series 3*
Usable Liner Volume, ft^3	143	143	143	143	160.0
Max. Waste Vol. ft^3	60	58.5	75.5	72.1	98.4
Max. Solidified Waste Vol., ft^3	97.5	95.1	122.8	117.2	160.0
Cement Added at Max. Waste Vol.					
Pounds	6,804.4	6,639.1	8,572.9	8,181.8	11168.4
1 ft^3 bags	72.4	70.6	91.2	87.0	118.8
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.					
Pounds	1,019.2	994.4	1,284.1	1,225.5	1672.8
1 ft^3 bags	10.2	9.9	12.8	12.3	16.7
Max. Radiation Level					
R/hr Contact	12	12	12	3	12

* For less than A_2 quantities of LSA waste.

HITTMAN NUCLEAR & DEVELOPMENT CORPORATION	Document Number: STD-P-05-021	Rev: 0	Rev Date: 7-5-83
	Title: Process Control Program for Incontainer Solidification of Decanted Diatomaceous Earth Filter Sludge		

Rev.	Rev Date	Prepared by	Supervisor Laboratory Services	Director Engineering	Manager Field Services	QA Manager	
0	7-5-83	K. McDaniel	E. Closen	J. Phillips			EWR-83-394

PROCESS CONTROL PROGRAM
for
INCONTAINER SOLIDIFICATION
of
DECANTED DIATOMACEOUS EARTH FILTER SLUDGE

1.0 Purpose

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

The program consists of four major steps, which are:

(a) Procedures for collecting and analyzing samples;
(b) Procedures for solidifying samples;
(c) Criteria for process parameters for acceptance or rejection as solidified waste;
(d) Calculation of minimum and recommended quantities of cement and anhydrous sodium metasilicate to be used in full scale liner solidification;

1.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the range of acceptable ratios of waste, cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into minimum and recommended quantities of cement and additive that must be mixed with the waste. Assurance that quantities of cement and additive between these ranges are actually mixed with the waste is covered in the Field Services Weekly Report.

2.0 System Description

To be added for each specific plant.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BWR's the PCP shall be used to verify the solidification of at least one representative test specimen from every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a dispcsable liner to the waste level indicator.

3.1.3 If the initial test specimen from a batch of waste fails to verify solidification, representative test specimens shall be collected from consecutive batches of the same type of waste. When three consecutive test specimens demonstrate solidification using the initial solidification parameters, the testing may be suspended until every tenth batch.

3.1.4 If any test specimen from paragraph 3.1.3 fails to solidify using the initial solidification parameters, alternate parameters must be established. These new parameters will be tested until three consecutive batches demonstrate solidification.

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

3.2 Collection of Samples

3.2.1 Radiological Protection

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

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste will be disposed of by placing in the disposal liner after solidification.

3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

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

3.2.2.1 The test sample data will include, but not necessarily be limited to, the type of waste solidified, pH of waste, volume of sample, amount of oil in sample and the ratio of sample volume to the final volume of the solidified product.

3.2.2.2 The Waste Solidification Data Sheet will include the Liner Number, Waste Volume, and Date Solidified, for each batch solidified.

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for solidification. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.2 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification, and to allow for retesting if necessary.

3.2.3.3 The waste to be solidified should be mixed or recirculated in the tank for at least three volume changes prior to sampling to assure a representative sample.

3.2.3.4 If the contents of more than one tank are to be solidified in the same liner, then representative samples of each tank should be drawn. The samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.1. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Analysis of Samples

This document only defines the parameters to be analyzed and not the methodology. This is left to the plant staff. These parameters are pH, detergents, oil and type of filter sludge.

4.0 Test Solidification and Acceptance Criteria

4.1 Waste Conditioning

4.1.1 If large quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded.

4.1.2 If oil is present in quantities greater than 1% by volume, the oil shall be reduced to less than 1% by skimming. Emulsification agents should be used to break up the remaining oil. The quantity of any substance added to the sample for this purpose shall be recorded.

4.1.3 If necessary, adjust pH to greater than 6 using a 50 weight percent sodium hydroxide solution. The quantity of sodium hydroxide added shall be recorded.

4.2 Test Solidification

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

4.2.2 Test solidifications should be conducted using a 1000 ml disposal beaker or similar size container. Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case less than two minutes.

4.2.3 For the test solidifications of filter sludge combination, measure 450 ml of decanted diatomaceous earth filter sludge. Add 223 ml of unconcentrated diatomaceous earth filter sludge ($\geq$ 12 weight percent).

4.2.4 Measure out the required quantities of cement and anhydrous sodium metasilicate as shown below.

	Grams Cement		Grams Anydrous Sodium Metasilicate	
Waste	Sample A	Sample B	Sample A	Sample B
Filter Sludge	539.6	583.0	54.0	58.3

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

4.2.6 After mixing for approximately two minutes once all the cement and additive are added and a homogeneous mixture is obtained, allow the waste to stand for a minimum of 4 hours.

4.3 Solidification Acceptability

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

4.3.1 The sample solidifications are considered acceptable if there is no free standing water.

4.3.2 The sample solidifications are considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration.

4.3.3 The sample solidifications establish a range for the ratios of cement to waste that will result in an acceptable product.

4.4 Solidification Unacceptability

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

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

4.5 Alternate Solidification Parameters

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

(1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.

(2) Add additional caustic solution to raise the pH above 8.

(3) If the waste is only partially solidified, use lower waste to cement and additive ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate reduce the amount

of decanted diatomaceous earth filter sludge to 425 ml. Reduce the amount of unconcentrated diatomaceous earth filter sludge to 211 ml. Continue reducing by these increments until the acceptability criteria of Section 4.3 are met.

Liner No: _____
Sample No: _____
Date: _____

WASTE SOLIDIFICATION DATA SHEET
For
Filter Sludge

Type of Filter Sludge: _____

Sample Volume, ml: Sample A _____ Sample B _____

Sample pH: _____ Volume NaOH solution used to adjust pH, ml: _____

Quantity of Oil %:

Quantity of Emulsifier (20% of vol. of oil), ml[1]: _____

Quantity of Anti-foaming Agent, ml: _____

Temperature at Solidification, °F: _____

Quantity of Cement Added:

Sample A _____ gms

Sample B _____ gms

Cement Ratio[2] (#/ft^3 Waste)

Sample A _____

Sample B _____

Quantity of Additive Added:

Sample A _____ gms

Sample B _____ gms

Additive Ratio[3] (#/ft^3 Waste)

Sample A _____

Sample B _____

Packaging Efficiency: $\frac{\text{Waste Volume}}{\text{Solidified Waste Volume}}$

Sample A _____

Sample B _____

Product Acceptable: Sample A ____Yes ____No (If no, refer to Section 4.5 and proceed as directed).

Sample B ____Yes ____No

Additional Batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by _____ Date _____

NOTES

[1]If emulsification is not accomplished, call HITTMAN.

[2]The cement ratio is defined as the pounds of cement required to solidify one cubic foot of waste. Ratios in this PCP yield cement ratios of 50.0 lbs/ft^3 and 54.0 lbs/ft^3 for samples A and B respectively.

[3]The additive ratio is defined as the pounds of additive required to solidify one cubic foot of waste. Ratios in this PCP yield additive ratios of 5.0 lbs/ft^3 and 5.4 lbs/ft^3 for samples A and B respectively.

SOLIDIFICATION CALCULATION SHEET

Waste Volume[1], ft^3: _____ (1)

Cement Ratio, $\#/ft^3$: Sample A _____ (2A)

Sample B _____ (2B)

Additive: _____ _____

Additive Ratio, $\#/ft^3$: Sample A _____ (3A)

Sample B _____ (3B)

Cement Quantity[2]

_____ (1)[1] x _____ (2A) = _____ lbs. (4A)

_____ (1)[1] x _____ (2B) = _____ lbs. (4B)

Additive Quantity[2]

_____ (1)[1] x _____ (3A) = _____ lbs. (5A)

_____ (1)[1] x _____ (3B) = _____ lbs. (5B)

[1]The quantity of waste to be solidified in a single liner cannot exceed the maximum waste volume listed on the attached Solidification Data Tables.

[2]4A and 5A define the minimum quantity of cement and additive respectively that must be mixed with the waste to assure solidification. The recommended quantities of cement and additive to use are represented by 4B and 5B.

Solidification Data Tables

I. For the Minimum Amount of Cement and Additive

	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S
Usable Liner Volume, (cu. ft.)	143	143	143	143
Max. Waste Vol. (cu. ft.)	95.4	93.1	109.1	109.1
Max. Solidified Waste Vol. (cu. ft.)	125	122	143	143
Cement Added at Max. Waste Vol.				
Weight (lbs.)	4768.0	4652.5	5455.5	5455.5
Volume (bags)	50.7	49.5	58.0	58.0
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.				
Weight (lbs.)	476.8	465.3	545.6	545.6
Volume (bags)	4.8	4.6	5.5	5.5
Max. Radiation Level R/hr Contact	12	12	12	3

Solidification Data Tables

II. For the Recommended Amount of Cement and Additive

	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S
Usable Liner Volume, (cu. ft.)	143	143	143	143
Max. Waste Vol. (cu. ft.)	92.2	90	106	106
Max. Solidified Waste Vol. (cu. ft.)	124.5	121.5	143	143
Cement Added at Max. Waste Vol.				
Weight (lbs.)	4980.6	4859.6	5722	5722
Volume (bags)	53	51.7	60.9	60.9
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.				
Weight (lbs.)	498.1	486	572.2	572.2
Volume (bags)	5.0	4.9	5.7	5.7
Max. Radiation Level R/hr Contact	12	12	12	3

WESTINGHOUSE HITTMAN NUCLEAR INCORPORATED	Document Number: STD-P-05-C22	Rev: 0	Rev Date: 2-9-84
	Title: Calcium Hydroxide Addition Procedure		

Rev.	Rev Date	Director Engr.	Project Manager	QA Manager			
0	2-9-84	J. Phillips for R.L.					

FORM-01(B)

CALCIUM HYDROXIDE ADDITION PROCEDURE

1.0 SCOPE

This procedure is applicable to all solidification operations using Hittman electric or hydraulic drive systems, with cement feed, where calcium hydroxide, $Ca(OH)_2$ is used as an additive.

2.0 PURPOSE

The purpose of this procedure is to provide generic instructions pertaining to how and at what point in the solidification operation the calcium hydroxide is to be added.

3.0 REFERENCES

3.1 TS-12000; Field Assembly and Operating Procedure for Hydraulic Mixer Drive Assembly.

3.2 TS-13000; Field Assembly and Operating for Flexicon Cement Feed System.

3.3 TS-19000; Field Assembly and Operating Procedure for Electric Mixer Head Drive Assembly.

4.0 EQUIPMENT

4.1 Hittman Electric or Hydraulic Drive System.

4.2 Hittman Cement Feed System.

4.3 Dust Collector.

5.0 SET-UP

5.1 Pre-requisites

The solidification system is set-up in accordance with the appropriate procedure for either the electric or hydraulic drive.

5.2 Precautions

None.

5.3 Assembly

5.3.1 Remove the cement hopper from the support scaffold.

NOTE: If the hopper cannot be removed, then the alternate procedure in 6.4 may be used.

6.0 $Ca(OH)_2$ ADDITION

6.1 Pre-requisites

6.1.1 The equipment is set-up in accordance with Section 5.3.1.

6.1.2 The correct quantity of waste is in the liner.

6.1.3 The test solidification has been performed and found acceptable.

6.1.4 The required quantity of calcium hydroxide is available as determined by the test solidification.

NOTE: Use one-half (1/2) extra bag to compensate for dead feed space in charging adaptor and carry over to dust collector.

6.2 Precautions

6.2.1 Be prepared to adjust the dust collector to eliminate any dusting that may occur.

6.2.2 Have dust masks available for use if needed.

6.3 Addition Through the Charging Adapter

6.3.1 SET dust collector opening at two (2) inches.

NOTE: If subsequent operations prove that a wider or narrower opening is desirable, use that size opening.

6.3.2 START dust collector.

6.3.3 START the cement feed system.

6.3.4 START the mixer.

6.3.5 CUT a small opening in the corner of the bag.

CAUTION: KEEP HANDS CLEAR OF SCREW CONVEYOR INSIDE CHARGING ADAPTOR.

6.3.6 START pouring the calcium hydroxide slowly into the charing adapter.

NOTE: If dusting occurs, open the discharge opening on top of the dust collector to draw more air.

6.3.7 STOP the cement feed system when the required quantity of calcium hydroxide has been added.

6.3.8 MIX the calcium hydroxide and waste for a minimum of fifteen (15) minutes prior to adding any cement.

NOTE: The following steps may be omitted if prepared to start the solidification operation.

6.3.9 STOP the mixer.

6.3.10 STOP the dust collector.

6.4 Addition Through the Cement Hopper

NOTE: Calcium hyroxide shall be added through the cement hopper only when large quantities are involved (more than 15 bags) or the cement hopper cannot be moved off the charging adaptor.

6.4.1 With the cement hopper top open, BLOCK OFF all but an 18" square opening.

6.4.2 SET-UP the dust collector to take suction near the top of the cement hopper where the calcium hydroxide is to be added.

6.4.3 SET the dust collector opening at two (2) inches.

NOTE: If subsequent operations prove that a wider or narrower opening is desirable, use that size opening.

6.4.4 START the dust collector.

6.4.5 CUT a small opening in the corner of the bag.

6.4.6 POUR the calcium hydroxide slowly into the cement hopper.

6.4.7 ADJUST the dust collector top opening to prevent spread of dust.

6.4.8 After the hopper is loaded, CLOSE the hopper.

6.4.9 RECONNECT the dust collector to the mixer fill head.

6.4.10 MOVE the hopper onto the support scaffold.

NOTE: This step is not necessary if the hopper is already in position.

6.4.11 OPEN the cement hopper discharge slide gate.

6.4.12 START the dust collector.

6.4.13 START the mixer.

6.4.14 START the cement feed system.

6.4.15 START the cement hopper vibrator if more than 500 pounds of calcium hydroxide are in the hopper.

6.4.16 When the cement hopper is empty, STOP the cement feed system.

6.4.17 STOP the cement hopper vibrator.

6.4.18 MIX the calcium hydroxide and waste for fifteen (15) minutes prior to adding any cement.

NOTE: The following steps may be omitted if prepared to start the solidification operation.

6.4.19 STOP the mixer.

6.4.20 STOP the dust collector.

PROCESS CONTROL PROGRAM

Incontainer Solidification of Dilute Filter Sludge

REVISION LOG

REV.	DATE	ENGINEERING	Q.A.	PROJ. MGR.	ECN #
0	8/19/81				----
1	12-20-82				ECN-82-279

PROCESS CONTROL PROGRAM
For
INCONTAINER SOLIDIFICATION
of
DILUTE FILTER SLUDGE

1.0 Purpose

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

The program consists of four major steps, which are:

(a) Procedures for collecting and analyzing samples;
(b) Procedures for solidifying samples;
(c) Criteria for process parameters for acceptance or rejection as solidified waste;
(d) Calculation of minimum and recommended quantities of cement and anhydrous sodium metasilicate to be used in full scale liner solidification;

1.2 This document shall be considered complete only when used in concert with the HNDC procedures for field solidification. This document describes the methodology for determining the range of acceptable ratios of waste, cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into minimum and recommended quantity of cement and additive that must be mixed with the waste. Assurance that quantities of cement and additive between these ranges are actually mixed with the waste is covered in the Field Services Weekly Report.

2.0 System Description

To be added for each specific plant.

3.0 Collection and Analysis of Samples

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BWR's the PCP shall be used to verify the solidification of at least one representative test specimen from every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a disposable liner to the waste level indicator.

3.1.3 If the initial test specimen from a batch of waste fails to verify solidification, representative test specimens shall be collected from consecutive batches of the same type of waste. When three consecutive test specimens demonstrate solidification using the initial solidification parameters, the testing may be suspended until every tenth batch.

3.1.4 If any test specimen from paragraph 3.1.3 fails to solidify using the initial solidification parameters, alternate parameters must be established. These new parameters will be tested until three consecutive batches demonstrate solidification.

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

3.2 Collection of Samples

3.2.1 Radiological Protection

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

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by placing in the disposal liner after solidification.

3.2.1.3 A Waste Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of wastes solidified based on each test sample.

3.2.2 Waste Solidification Data Sheet

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

3.2.2.1 The test sample data will include, but not necessarily be limited to, the type of waste solidified, pH of waste, amount of oil in sample, volume of sample and the ratio of the sample volume to the final volume of the solidified product.

3.2.2.2 The Waste Solidification Data Sheet will include the Liner Number, Waste Volume, and Date Solidified, for each batch solidified.

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for solidification. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.2 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification, and to allow for retesting if necessary.

3.2.3.3 The waste to be solidified should be mixed or recirculated in the tank for at least three volume changes prior to sampling to assure a representative sample.

3.2.3.4 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. The samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.1. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent X% of the composite samples.

3.3 Analysis of Samples

This document only defines the parameters to be analyzed and not the methodology. This is left to the plant staff. These parameters are pH, detergents, oil and the type of filter sludge.

4.0 Test Solidification and Acceptance Criteria

4.1 Waste Conditioning

4.1.1 If large quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded.

4.1.2 If oil is present in quantities greater than 1% by volume, the oil shall be reduced to less than 1% by skimming. Emulsification agents should be used to break up the remaining oil. The quantity of any substance added to the sample for this purpose shall be recorded.

4.1.3 If necessary, adjust pH to greater than 6 using a 50 weight percent sodium hydroxide solution. The quantity of sodium hydroxide added shall be recorded.

4.2 Test Solidification

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

4.2.2 Test solidifications should be conducted using a 1000 ml disposal beaker or similar size container. Mixing should be accomplished by stirring with a rigid stirrer until a homogeneous mixture is obtained, but in no case less than two minutes.

4.2.3 For the test solidifications of filter sludge, measure into two mixing vessels 560 ml of 12 dry weight percent slurry.

4.2.4 Measure out the required quantities of cement and anhydrous sodium metasilicate as shown below.

	Grams Cement		Grams Anhydrous Sodium Metasilicate	
Waste	Sample A	Sample B	Sample A	Sample B
Filter Sludge	754.3	880.0	75.4	88.0

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

4.2.6 After mixing for approximately two minutes once all cement and additive are added and a homogeneous mixture is obtained, allow the waste to stand for a minimum of 4 hours.

4.3 Solidification Acceptability

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

4.3.1 The sample solidifications are considered acceptable if there is no free standing water.

4.3.2 The sample solidifications are considered acceptable if upon visual inspection the waste appears that it would hold its shape if removed from the beaker and it resists penetration.

4.3.3 The sample solidifications establish a range for the ratios of cement to waste that will result in an acceptable product.

4.4 Solidification Unacceptability

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

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

4.5 Alternate Solidification Parameters

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

(1) Mix equal volumes of dry cement and water to ensure that the problem is not a bad batch of cement.

(2) Add additional caustic solution to raise the pH above 8.

(3) If the waste is only partially solidified, use lower waste to cement and additive ratios. Using the recommended quantities of cement and anhydrous sodium metasilicate, reduce the waste sample volume to 535 ml and continue reducing the sample volume by 25 ml until the acceptability criteria of Section 4.3 are met.

Liner No: _____
Sample No: _____
Date: _____

WASTE SOLIDIFICATION DATA SHEET
for
Dilute Filter Sludge

Sample Volume, ml: Sample A _____ Sample B _____

Sample pH: _____ Volume NaOH solution used to adjust pH, ml: _____

Quantity of Oil %: _____

Quantity of Emulsifier (20% of vol. of oil), ml[1]: _____

Quantity of Anti-foaming Agent, ml: _____

Temperature at Solidification, °F: _____

Quantity of Cement Added:

Sample A _____ gms

Sample B _____ gms

Cement Ratio[2] (#/ft^3 Waste)

Sample A _____

Sample B _____

Quantity of Additive Added:

Sample A _____ gms

Sample B _____ gms

Additive Ratio[3] (#/ft^3 Waste)

Sample A _____

Sample B _____

Packaging Efficiency: $\frac{\text{Waste Volume}}{\text{Solidified Waste Volume}}$

Sample A _____

Sample B _____

Product Acceptable: Sample A ____ Yes ____ No (If no, refer to Section 4.5 and proceed as directed).

Sample B ____ Yes ____ No

Additional Batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by _____ Date _____

NOTES:

[1]If emulsification is not accomplished, call HITTMAN.

[2]The cement ratio is defined as the pounds of cement required to solidify one cubic foot of waste. Ratios in this PCP yield cement ratios of 84.0 lbs/ft^3 and 98.0 lbs/ft^3 for samples A and B respectively.

[3]The additive ratio is defined a the pounds of additive required to solidify one cubic foot of waste. Ratios in this PCP yield additive ratios fo 8.4 lbs/ft^3 and 9.8 lbs/ft^3 for samples A and B respectively.

SOLIDIFICATION CALCULATION SHEET

Waste Volume[1], ft^3: _____ (1)

Cement Ratio, $\#/ft^3$: Sample A _____ (2A)

Sample B _____ (2B)

Additive: _____

Additive Ratio, $\#/ft^3$: Sample A _____ (3A)

Sample B _____ (3B)

Cement Quantity[2]

_____(1)[1] x _____(2A) = _____lbs. (4A)

_____(1)[1] x _____(2B) = _____lbs. (4B)

Additive Quantity[2]

_____(1)[1] X_____(3A) = _____lbs. (5A)

_____(1)[1] x_____(3B) = _____lbs. (5B)

[1]The quantity of waste to be solidified in a single liner cannot exceed the maximum waste volume listed on the attached Solidification Data Tables.

[2]4A and 5A define the minimum quantity of cement and additive respectively that must be mixed with the waste to assure solidification. The recommended quantities of cement and additive to use are represented by 4B and 5B.

SOLIDIFICATION DATA TABLE

I. For the Minimum Amount of Cement and Additive

	HN-100 Series 1	HN-100 Series 2	HN-100 Series 3	HN-100S
Usable Liner Volume, (cu. ft.)	143	143	143	143
Max. Waste Vol., (cu. ft.)	77.5	75.6	97.1	93.2
Max. Solidified Waste Vol. (cu. ft.)	114.2	111.4	143	137.3
Cement Added at Max. Waste Vol.				
Weight (lbs.)	6,512.2	6,354.1	8,156.2	7,830.5
Volume (bags)	69.3	67.6	86.8	83.3
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.				
Weight (lbs.)	651.2	635.4	815.6	783.1
Volume (bags)	6.5	6.4	8.2	7.8
Max. Radiation Level R/hr Contact	12	12	12	3

SOLIDIFICATION DATA TABLE

II. For the Recommended Amount of Cement and Additive

	HN-100			HN-100S
	Series 1	Series 2	Series 3	
Usable Liner Volume, (cu. ft.)	143	143	143	143
Max. Waste Vol., (cu. ft.)	70.7	69	89.1	85
Max. Solidified Waste Vol. (cu. ft.)	108.6	106	136.8	130.6
Cement Added at Max. Waste Vol.				
Weight (lbs.)	6,927.9	6,759.6	8,728.6	8,330.3
Volume (bags)	73.7	71.9	92.9	88.6
Anhydrous Sodium Metasilicate Added at Max. Waste Vol.				
Weight (lbs.)	692.8	676	872.9	833
Volume (bags)	6.9	6.8	8.7	8.3
Max. Radiation Level R/hr Contact	12	12	12	3

WESTINGHOUSE HITTMAN NUCLEAR INCORPORATED	Document Number: STD-P-05-025	Rev: 0	Rev Date: 2-17-84
	Title: PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF SODIUM SULFATE SLURRIES CONTAINING MIXED SOLIDS		

Rev.	Rev Date	Director Engr.	Project Manager	QA Manager			
0	2-17-84						EWR-84-032

DOCUMENT CONTROL
CONTROLLED COPY
No. 015

PROCESS CONTROL PROGRAM FOR INCONTAINER SOLIDIFICATION OF SODIUM SULFATE SLURRIES CONTAINING MIXED SOLIDS

1.0 SCOPE

This procedure is applicable to the solidification of sodium sulfate slurries containing mixed solids having powdered resin and diatomaceous earth as the major constituents. The remainder of the constituents may be bead crud, dirt, solka floc, or similar materials. This procedure is applicable to wastes classified as either Class A, Class B or Class C under the requirements of 10 CFR 61.55, Waste Classification.

2.0 PURPOSE

2.1 The purpose of the Process Control Program (PCP) for incontainer solidification of sodium sulfate slurries containing mixed solids is to provide a program which will assure a solidified product which meets the requirements of 10 CFR 61.56, Waste Characteristics.

The program consists of four major steps, which are:

(a) Procedure for determining proper ratio of solids to sodium sulfate;

(b) Procedures for collecting, analyzing and pretreating samples;

(c) Procedures for solidifying samples;

(d) Criteria for process parameters for acceptance or rejection as solidified waste.

2.2 This document shall be considered complete only when used in concert with the Westinghouse Hittman Nuclear Incorporated procedures for field solidification. This document describes the methodology for determining the acceptable ratio of waste, cement and additive that will result in an acceptable product for transportation and burial. The Solidification Data Sheet then converts these ratios into the recommended quantity of cement and additive that must be mixed with the waste. Assurance that the proper quantity of cement and additive is actually mixed with the waste is covered in the Field Solidification Operating Procedures.

3.0 COLLECTION AND ANALYSIS OF SAMPLES

3.1 General Requirements

3.1.1 As required by the Radiological Effluent Technical Specifications for PWR's and BWR's the PCP shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste.

3.1.2 For the purpose of the PCP a batch is defined as the quantity of waste required to fill a disposable liner with the appropriate quantity of waste prior to solidification.

3.1.3 If any test specimen fails to solidify, the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative solidification parameters can be determined in accordance with the Process Control Program, and a subsequent test verifies solidification. Solidification of the batch may then be resumed using the alternate solidification parameters determined.

3.1.4 If the initial test specimen from a batch of waste fails to verify solidification, then representative test specimens shall be collected from each consecutive batch of the same type of waste until three (3) consecutive initial test specimens demonstrate solidification. The Process Control Program shall be modified as required to assure solidification of subsequent batches of waste.

3.1.5 For high activity wastes, where handling of samples could result in personnel radiation exposures which are inconsistent with the ALARA principle, representative non-radioactive samples will be tested. These samples should be as close to the actual wastes' chemical properties as possible. Typical unexpended powdered resin, diatomaceous earth, etc., shall be used, with the appropriate anion to cation mix to simulate used material.

3.2 Collection of Samples

3.2.1 Radiological Protection

3.2.1.1 Comply with applicable Radiation Work Permits.

3.2.1.2 Test samples which use actual waste shall be disposed of by placing in the solidified liner.

3.2.1.3 A Test Solidification Data Sheet will be maintained for each test sample solidified. Each data sheet will contain pertinent information on the test sample and the batch numbers of waste solidified based on each test sample.

3.2.2 Test Solidification Data Sheet

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

3.2.2.1 The test sample data for sodium sulfate slurries containing mixed solids will include, but not necessarily be limited to, the type of waste solidified, volume of sample and the quantity of any additives used to precondition the waste.

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

3.2.3 Collection of Samples

3.2.3.1 Two samples shall be taken for analysis. If the radioactivity levels are too high to permit full size samples to be taken then smaller samples shall be taken with the results corrected accordingly. Sample sizes shall be determined by the plant Health Physics Staff.

3.2.3.2 If possible, samples should be drawn at least two days prior to the planned waste solidification procedure to allow adequate time to complete the required testing and verification of solidification. Approximately 28 hours are required to perform and verify the test solidification, and to allow for retesting, if necessary.

3.2.3.3 The waste to be solidified should be mixed for 10 minutes, or recirculated in the tank for at least three volume changes, prior to sampling to assure a representative sample.

3.2.3.4 If the contents of more than one tank are to be solidified in the same liner then representative samples of each tank should be drawn. These samples should be of such size that when mixed together they form samples of standard size as prescribed in Section 3.2.3.1. If the contents of a particular tank represents x% of the total waste quantity to be solidified then the sample of that tank should be of such size to represent x% of the composite samples.

3.3 Analysis of Samples

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

Parameter	Acceptable Range
(a) pH	>5
(b) Detergents	No Appreciable Foaming
(c) Oil	<1%

4.0 CLASS A WASTE

4.1 Determination of Liner Contents

4.1.1 Based on the depth of the settled solids in the liner and the concentration of sodium sulfate to be transferred, DETERMINE from Figure 1, 2, or 3 the following:

4.1.1.1 The total volume of sodium sulfate that can go into the liner and RECORD on Form STD-P-05-025-01, Class A Test Solidification Data Sheet.

4.1.1.2 The weight percent solids that will be in the liner after the transfer. RECORD on Form STD-P-05-025-01, Class A Test Solidification Data Sheet.

NOTE: Figure 1 must be used for the HN-100 LVM liner. Figure 2 must be used for the HN-100M liner. Figure 3 must be used for the HN-600M liner.

4.1.2 USE the weight percent solids determined from Step 4.1.1.2 and the percent sodium sulfate from Chemistry to determine the grams of Portland Type I cement to use for a 200 ml sample using Figure 4. (See example using Figures 1 and 4).

4.1.3 TRANSFER the volume of sodium sulfate determined in Step 4.1.1.1, per the appropriate plant procedure, to the liner.

4.1.4 Sample the contents of the liner after mixing for 10 minutes using proper radiological procedures.

4.2 Pretreatment of Waste

4.2.1 Waste Conditioning

4.2.1.1 MEASURE 200 ml of the waste slurry into a 1,000 ml disposable beaker or similar size container.

4.2.1.2 RECORD the sample volume on the Class A Test Solidification Data Sheet (Form STD-P-05-025-01).

4.2.1.3 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded on the Class A Test Solidification Data Sheet (Form STD-P-05-025-01).

4.2.1.4 If oil is present in quantities greater than 1% by volume, the oil should either be removed by skimming or emulsification agents should be used to break up the oil. The quantity of any substance added to the sample for this purpose shall be recorded on the Class A Test Solidification Data Sheet (Form STD-P-05-025-01).

NOTE: Waste with oil greater than 1% by volume may not be shipped to Barnwell, South Carolina, but must be shipped to Hanford, Washington. Emulsification agents need not be used until the volume of oil exceeds 3% of the waste volume. Oil in concentrations greater than 12% by volume may not be solidified under this procedure.

4.2.2 pH Conditioning

4.2.2.1 For Class A wastes if the pH is < 5.0, it shall be adjusted to greater than 5.0 by the addition of a 50 weight percent solution of sodium hydroxide. The quantity of sodium hydroxide added to the sample shall be recorded on the Class A Test Solidification Data Sheet (Form STD-P-05-025-01).

4.3 Test Solidification

4.3.1 MEASURE the required quantity of Portland Type I cement and anhydrous sodium metasilicate into separate beakers.

4.3.2 RECORD the quantities on Form STD-P-05-025-01, Class A Test Solidification Data Sheet.

NOTE: The quantity of anhydrous sodium metasilicate is 10 percent of the weight of cement.

4.3.3 Slowly ADD the cement to the test sample while it is being mixed.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade until a homogeneous mixture is obtained. Approximately one minute or less if mixture begins to set.

4.3.4 After all the cement is added, slowly ADD the anhydrous sodium metasilicate to the test sample while it is being mixed.

4.3.5 MIX the sample for 2 minutes after all the cement and anhydrous sodium metasilicate is added so that a homogeneous mixture is obtained.

4.3.6 SEAL the sample and cure for 24 hours at 120 ± 5°F.

NOTE: If at any time during the 24-hour cure time, the sample meets the acceptance criteria, the liner solidification may proceed. However, no test solidificaton shall be disqualified without at least 24 hours of cure.

5.0 CLASS B OR CLASS C WASTES

5.1 Determination of Liner Contents

5.1.1 Based on the depth of the settled solids in the liner and the concentration of sodium sulfate to be transferred, DETERMINE from Figures 5, 6 or 7 the following:

5.1.1.1 The total volume of sodium sulfate that can go into the liner and RECORD on Form STD-P-05-025-03, Class B or C Test Solidification Data Sheet.

5.1.1.2 The weight percent solids that will be in the liner after the transfer. RECORD on Form STD-P-05-025-03, Class B or C Test Solidification Data Sheet.

NOTE: Figure 5 must be used for the HN-100 LVM liner. Figure 6 must be used for the HN-100M liner. Figure 7 must be used for the HN-600M liner.

5.1.2 USE the weight percent solids determined from Step 5.1.1.2 and the percent sodium sulfate from Chemistry to determine the grams of Portland Type I cement to use for a 200 ml sample using Figure 8.

5.1.3 TRANSFER the volume of sodium sulfate determined in Step 5.1.1.1, per the appropriate plant procedure, to the liner.

5.1.4 Sample the contents of the liner after mixing 10 minutes using proper radiological procedures.

5.2 Pretreatment of Waste

5.2.1 Waste Conditioning

5.2.1.1 MEASURE 200 ml of the waste in a 1,000 ml disposable beaker or similar size vessel.

5.2.1.2 RECORD the sample volume on the Class B and C Test Solidification Data Sheet (Form STD-P-05-025-03).

5.2.1.3 If large (i.e., foam causing) quantities of detergents are present, the sample should be treated with an anti-foaming agent. The quantity of anti-foaming agent required shall be recorded on the Test Solidification Data Sheet (Form STD-P-05-025-03).

5.2.1.4 If oil is present in quantities greater than 1% by volume, the oil should either be removed by skimming or emulsification agents should be used to break up the oil. The quantity of any substance added to the sample for this purpose shall be recorded on the Test Solidification Data Sheet (Form STD-P-05-025-03).

NOTE: Waste with oil greater than 1% by volume may not be shipped to Barnwell, South Carolina, but must be shipped to Hanford, Washington. Emulsification agents need not be used until the volume of oil exceeds 3% of the waste volume. Oil in concentrations greater than 12% by volume may not be solidified under this procedure.

5.2.2 pH Conditioning

5.2.2.1 pH conditioning of Class B and Class C wastes is accomplished as part of the solidification process.

5.3 Test Solidification

5.3.1 MEASURE the required quantity of Portland Type I cement into a separate beaker.

5.3.2 RECORD the quantity on Form STD-P-05-025-03, Class B Test Solidification Data Sheet.

5.3.3 Slowly ADD calcium hydroxide, also known as hydrated lime, to the mixing vessel in two (2) gram increments. MIX for three (3) minutes between additions until the pH is at least 11.0. ADD an additional three (3) grams of calcium hydroxide. This final addition may or may not alter the pH of the slurry.

NOTE: The pH may be measured using narrow range pH paper.

5.3.4 RECORD the quantity of calcium hydroxide added to the slurry and the final pH on the Class B and C Test Solidification Data Sheet, Form STD-P-05-025-03.

5.3.5 Slowly ADD the cement to the test sample while it is being mixed.

NOTE: Mixing should be accomplished by stirring with an electric mixing motor with blade.

5.3.6 MIX for two (2) minutes after all the cement is added to obtain a homogeneous mixture.

5.3.7 SEAL the sample and CURE for 24 hours at 120 ± 5°F.

NOTE: If at any time during the 24-hour cure time, the sample meets the acceptance criteria, the liner solidification may proceed. However, no test solidification shall be disqualified without at least 24 hours of cure.

6.0 SOLIDIFICATION ACCEPTABILITY

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

6.1 The sample solidifications are considered acceptable if there is no visual or drainable free water, and

6.2 If upon visual inspection the waste appears that it would hold its shape if removed from the mixing vessel, and

6.3 It resists penetration.

7.0 SOLIDIFICATION UNACCEPTABILITY

7.1 If the waste fails any of the criteria set forth in Section 6.0, the solidification will be termed unacceptable and a new set of solidification parameters will need to be established under the procedures in Section 8.0.

7.2 If the test solidification is unacceptable then the same test procedures must be followed on each subsequent batch of the same type of waste until three (3) consecutive test samples are solidified.

8.0 ALTERNATE SOLIDIFICATION PARAMETERS

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

8.1.1 Class A Wastes

(a) Mix equal weights of dry cement and water to ensure that the problem is not a bad batch of cement.

(b) If the waste is only partially solidified, use lower waste to cement and additive ratios. Continue using the recommended quantities of cement and additive. If the mix is thin, reduce the waste sample volume to 175 ml, and if the mix is too thick, increase the waste sample volume to 225 ml. Continue changing the sample volume by 25 ml until the acceptability criteria of Section 6.0 are met.

(c) If an acceptable product is still not achieved, or if additional information is needed, contact Hittman.

8.1.2 Class B or C Wastes

Contact Hittman for specific instructions.

Solidification No: _____
Liner No: _____
Sample No: _____
Date: _____

CLASS A TEST SOLIDIFICATION DATA SHEET
for Sodium Sulfate Slurries Containing Mixed Solids

I. DETERMINATION OF LINER CONTENTS

Depth of Solids in Liner, inches: _____ (1)

Weight % Sodium Sulfate from Chemistry: _____ (2)

Total Quantity of Waste in Liner, _____ (From Figure 1, 2, or 3) (3)
After Liquid Transfer, ft^3

Weight % Solids After Liquid Transfer: _____ (From Figure 1, 2 or 3) (4)

II. PRETREATMENT OF SAMPLE

Sample Volume, ml: _____ (5)

pH[1]: _____ (6A) Volume NaOH solution used to adjust pH, ml: _____ (6B)

pH After Adjustment (if required): _____ (6C)

Quantity of oil %: _____ (7)

Quantity of emulsifier (20% by volume of oil), ml: _____ (8)

Quantity of anti-foaming agent, ml: _____ (9)

III. SOLIDIFICATION

Quantity of Cement Added:

Sample _____ gms (10A)
From Figure 4

Cement Ratio[2] (lb/ft^3 Waste)

Sample _____ (10B)

Quantity of Additive Added:

Sample _____ gms (11A)
(Item 11A x 0.10)

Additive Ratio[3] (lb/ft^3 Waste)

Sample _____ (11B)

Product Acceptable: Sample _____Yes_____No (If no, refer to Section 4.6 and proceed as directed).

Additional batches solidified based on this sample solidification:

Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date	Liner No.	Waste Vol.	Date

PCP Performed by: _____ Date _____

Acceptance Verified by: _____ Date _____

FOOTNOTES:

[1]If pH adjustment is required to bring pH >5.0, note chemical used, quantity used and pH after adjustment.

[2]The cement ratio in pounds per cubic foot of waste slurry may be calculated by multiplying the grams of cement necessary to solidify 200 ml of waste by 0.312.

[3]The additive ratio in pounds per cubic foot of waste slurry may be calculated by multiplying the grams of additive necessary to solidify 200 ml of waste by 0.312.

CLASS 'A' WASTE SOLIDIFICATION CALCULATION SHEET

Waste Volume to be Solidified ft^3: _____ (1)
(Item 3 - Form STD-P-05-025-01)

Cement Ratio, lb/ft^3: Sample: _____ (2)
(Item 10B - Form STD-P-05-025-01)

Additive Ratio, lb/ft^3: Sample: _____ (3)
(Item 11B - Form STD-P-05-025-01)

Cement Quantity[1]

_____ (1) x _____ (2) = _____ lbs. (4)
Waste Volume lb/ft^3

Additive Quantity[1]

_____ (1) x _____ (3) = _____ lbs. (5)
Waste Volume lb/ft^3

Quantities of additional additives that must be added to the liner are found by multiplying the volume of the additive used in the test solidification, in ml, by 0.0374 and then by the volume of waste to be solidified. Volumes of additional additives are taken from items 6B, 8, and 9 on Form STD-P-05-025-01:

_____ ml x 0.0374 x _____ (1) = _____ gallons[2] (6)
(Item 6B, 8, 9)
Form STD-P-05-025-01

[1]4 and 5 define the recommended quantity of cement and additive respectively that must be mixed with the waste to assure solidification.

[2]Reduce the quantity of liquid waste in the liner by 1 ft^3 for every 10 gallons of additional additive.

Solidification No: _____
Batch No: _____
Sample No: _____
Date: _____

CLASS B AND C TEST SOLIDIFICATION DATA SHEET
for Sodium Sulfate Slurries Containing Mixed Solids

I. DETERMINATION OF LINER CONTENTS

Depth of Solids in Liner, inches: _____ (1)

Weight % Sodium Sulfate from Chemistry: _____ (2)

Total Quantity of Waste in Liner After Liquid Transfer, ft^3 _____ (3)

Weight % Solids After Liquid Transfer: _____ (4)

II. PRETREATMENT OF SAMPLE

Sample Volume, ml: _____ (5)

Initial pH: _____ (6)

Quantity of oil[1], %: _____ (7)

Quantity of emulsifier (20% by volume of oil), ml: _____ (8)

Quantity of anti-foaming agent, ml: _____ (9)

III. SOLIDIFICATION

Quantity of $Ca(OH)_2$ to raise pH,[2] gms: _____ (10)

Final pH: _____ (11)

Quantity of Portland Type I Cement added, gms: _____ (12)
From Figure 8

IV. SAMPLE INSPECTION

Sample at 120 ± 5°F: Hours cured[3]: _____

_____ _____
Verified by Date

Sample contains "No Free Liquid":

_____ _____
Verified by Date

Form STD-P-05-025-03
Sheet 1 of 2

Sample is "Free Standing Monolith":

_____ _____
Verified by Date

IV. PARAMETERS FOR FULL SCALE SOLIDIFICATION:

Quantity of $Ca(OH)_2$: _____ (10) gms $Ca(OH)_2$ from above times
0.312 = _____ lb. $Ca(OH)_2$ per ft^3 of waste. (13)

Quantity of Cement: _____ (12) gms Cement from above times
0.312 = _____ lb. Portland Type I Cement per ft^3 of waste (14)

[1]Must be ≤1% of waste volume.

[2]Added in accordance with Section 5.3.4.

[3]If the sample is qualified in less than 24 hours cure time, note the total hours cured.

CLASS B AND C WASTE SOLIDIFICATION CALCULATION SHEET

Waste Volume to be Solidified ft^3: _____ (1)
(Item 3 - Form STD-P-05-025-03)

$Ca(OH)_2$ Ratio; lb/ft^3: _____ (Item 13, Form STD-P-05-025-03) (2)

Cement Ratio; lb/ft^3: _____ (Item 14, Form STD-P-05-025-03) (3)

Quantity of Calcium Hydroxide ($Ca(OH)_2$) to be added:

_____ (1) x _____ (2) = _____ lbs. (4)
Waste Volume lb/ft^3

Quantity of Cement (Portland Type I) to be added:

_____ (1) x _____ (3) = _____ lbs. (5)
Waste Volume lb/ft^3

Quantities of additional additives that must be added to the liner are found by multiplying the volume of the additive used in the test solidification, in ml, by 0.0374 and then by the volume of waste to be solidified. Volumes of additional additives are taken from items 8 and 9 on Form STD-P-05-025-03.

_____ ml x 0.0374 x _____ (1) = _____ gallons[1]
Item 8 or 9
Form STD-P-05-025-03

[1]Reduce the quantity of liquid waste in the liner by 1 ft^3 for every 10 gallons of additional additives.

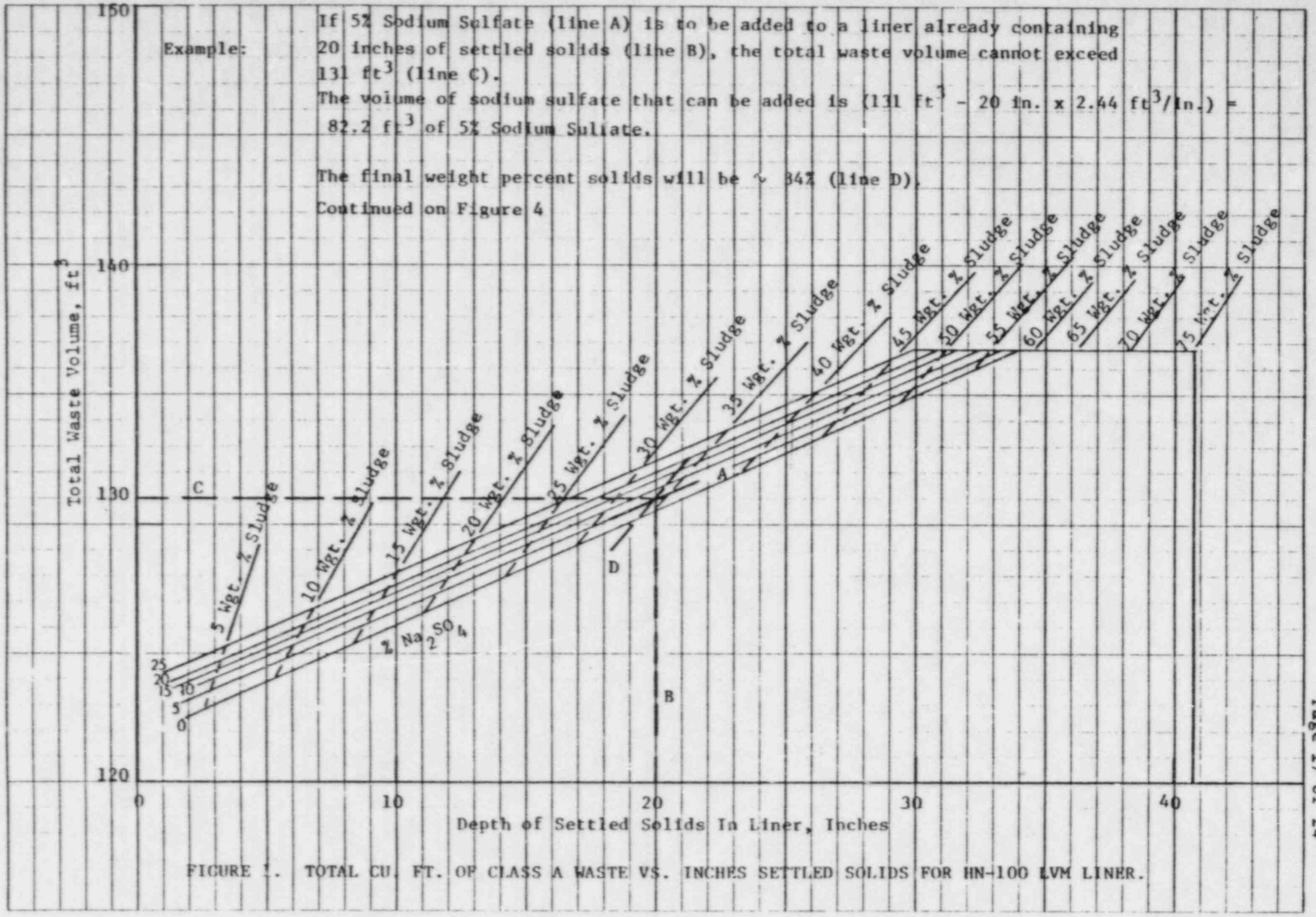

FIGURE 3. TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-100 LVM LINER.

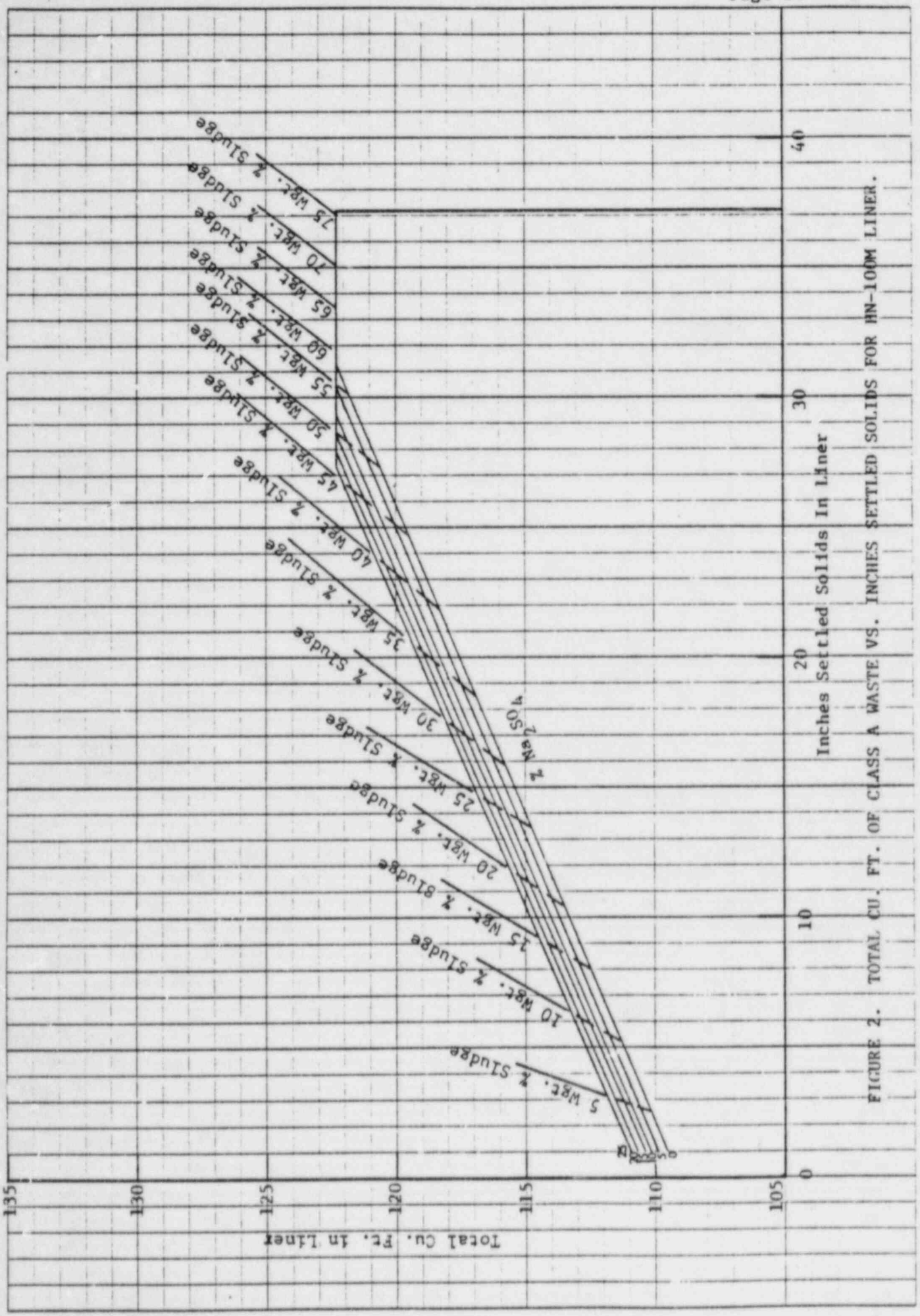

FIGURE 2. TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-100M LINER.

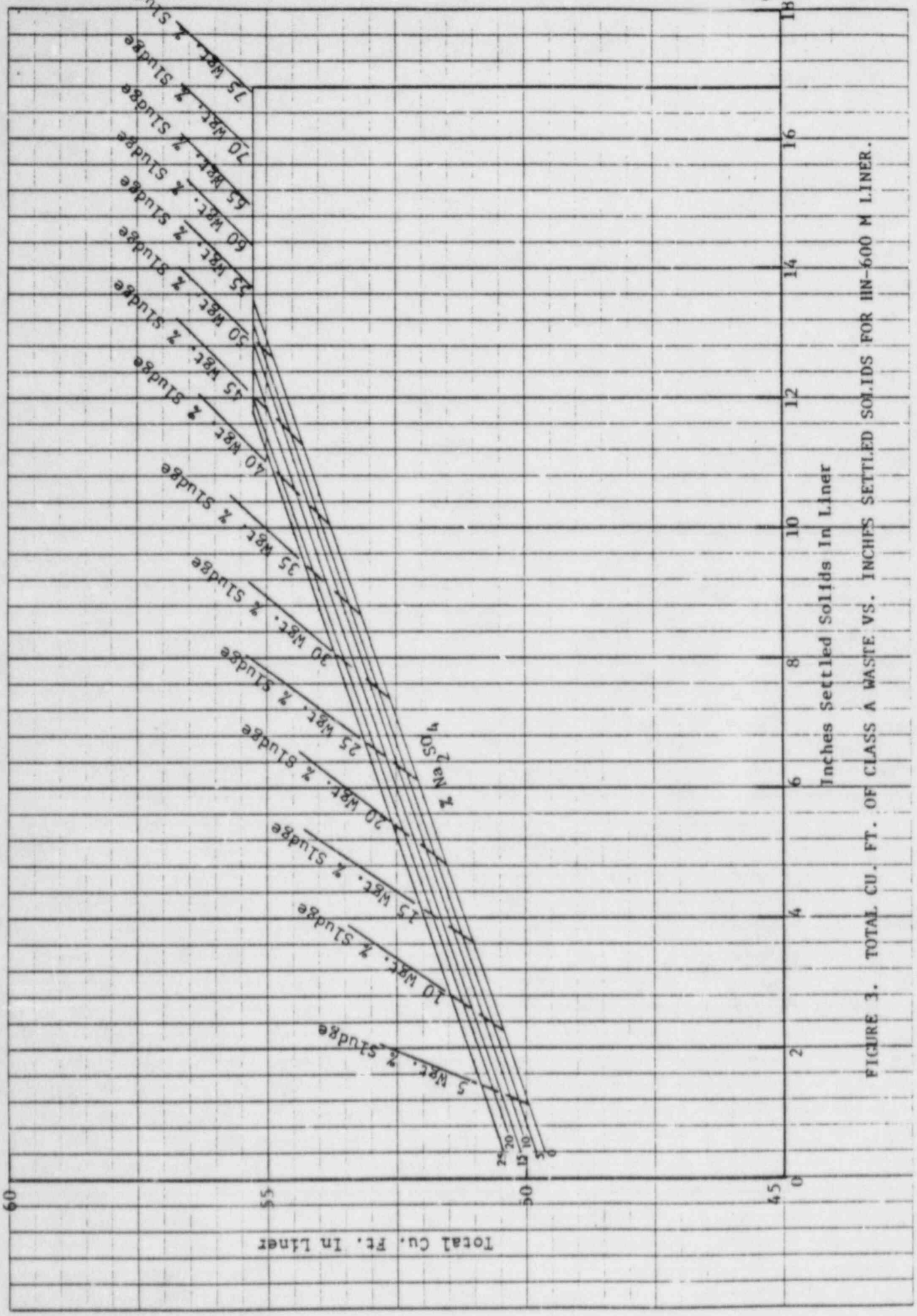

FIGURE 3. TOTAL CU. FT. OF CLASS A WASTE VS. INCHES SETTLED SOLIDS FOR HN-600 M LINER.

46 0410

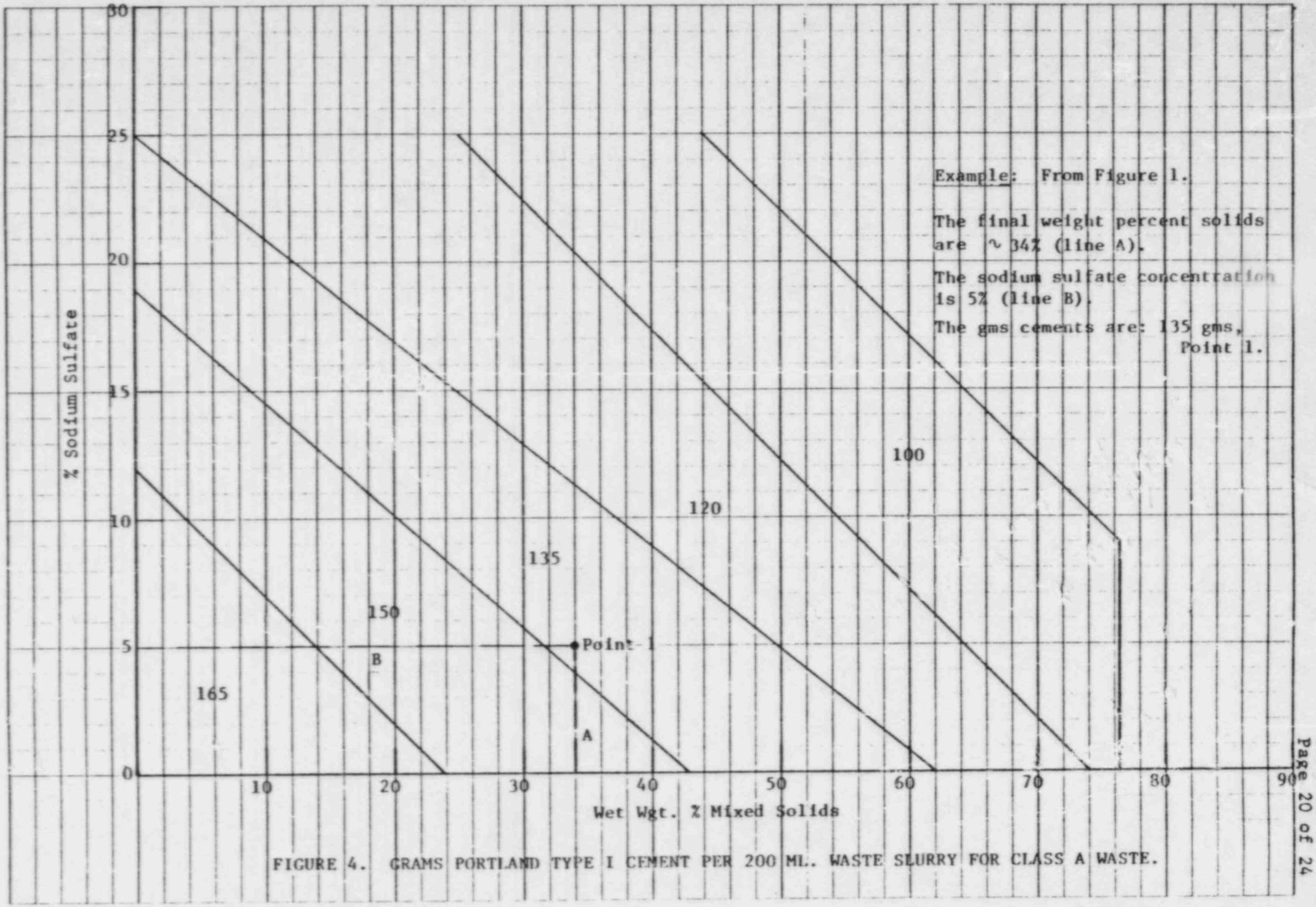

FIGURE 4. GRAMS PORTLAND TYPE I CEMENT PER 200 ML. WASTE SLURRY FOR CLASS A WASTE.

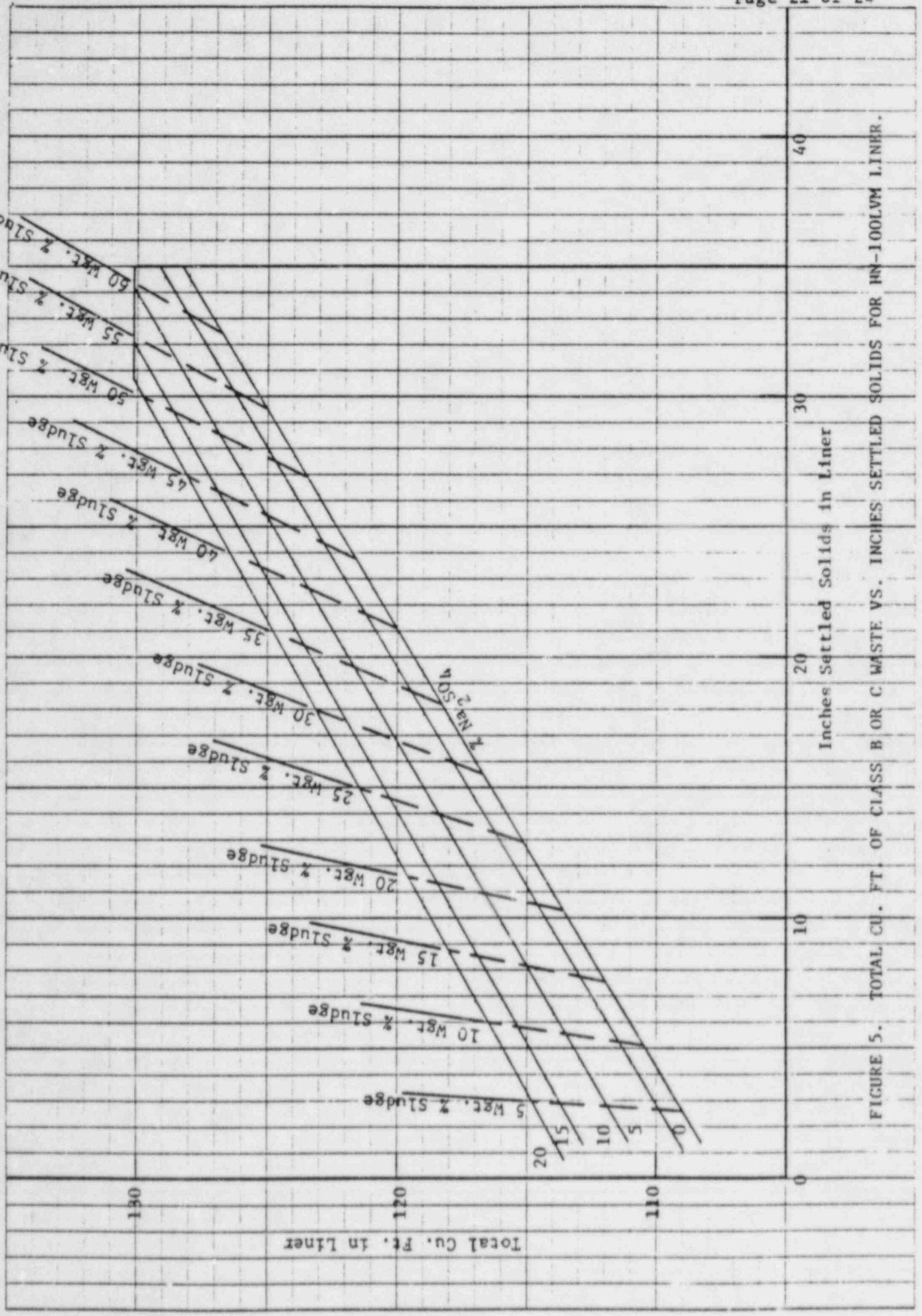

FIGURE 5. TOTAL CU. FT. OF CLASS B OR C WASTE VS. INCHES SETTLED SOLIDS FOR HN-100LVM LINER.

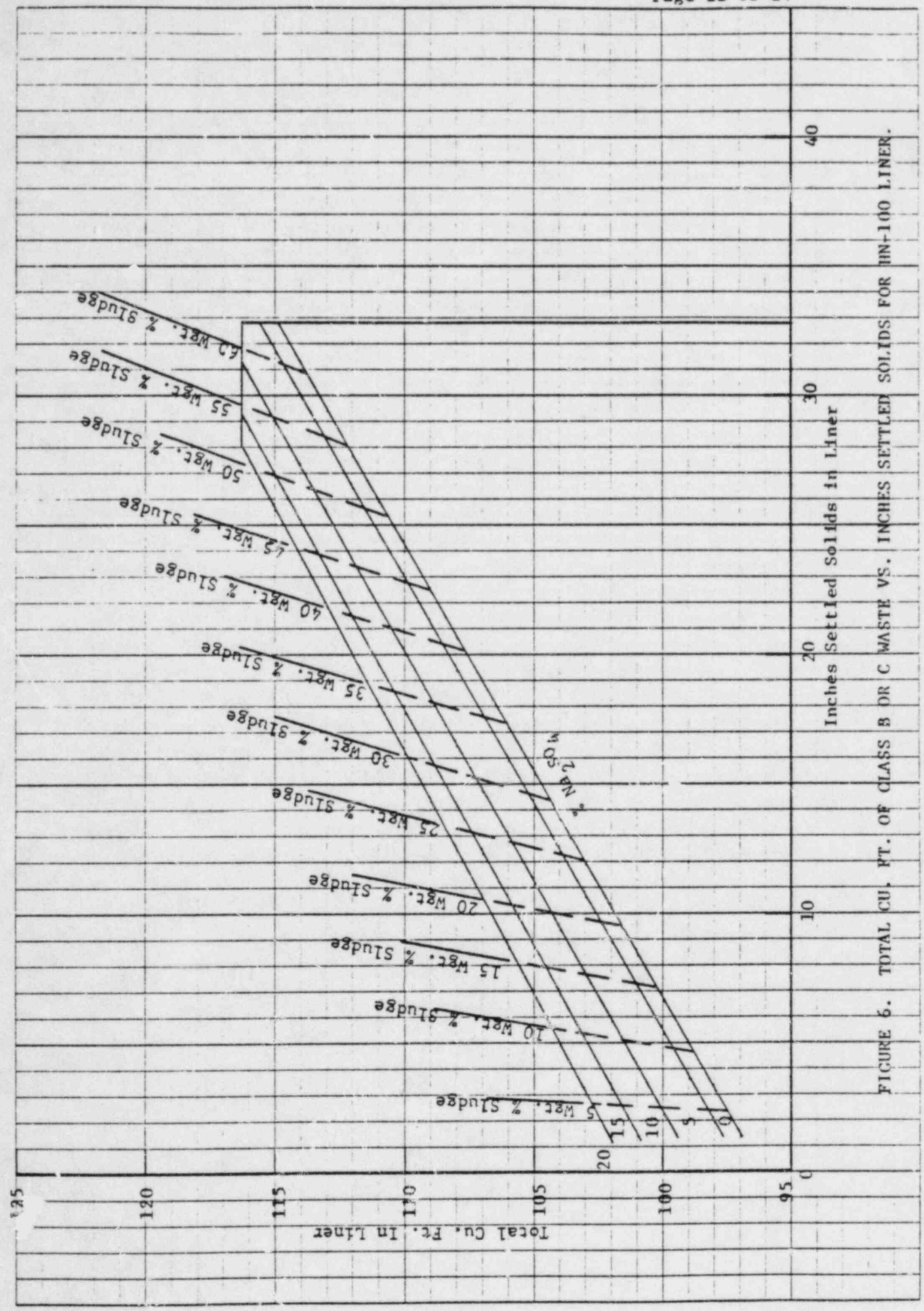

FIGURE 6. TOTAL CU. FT. OF CLASS B OR C WASTE VS. INCHES SETTLED SOLIDS FOR HN-100 LINER.

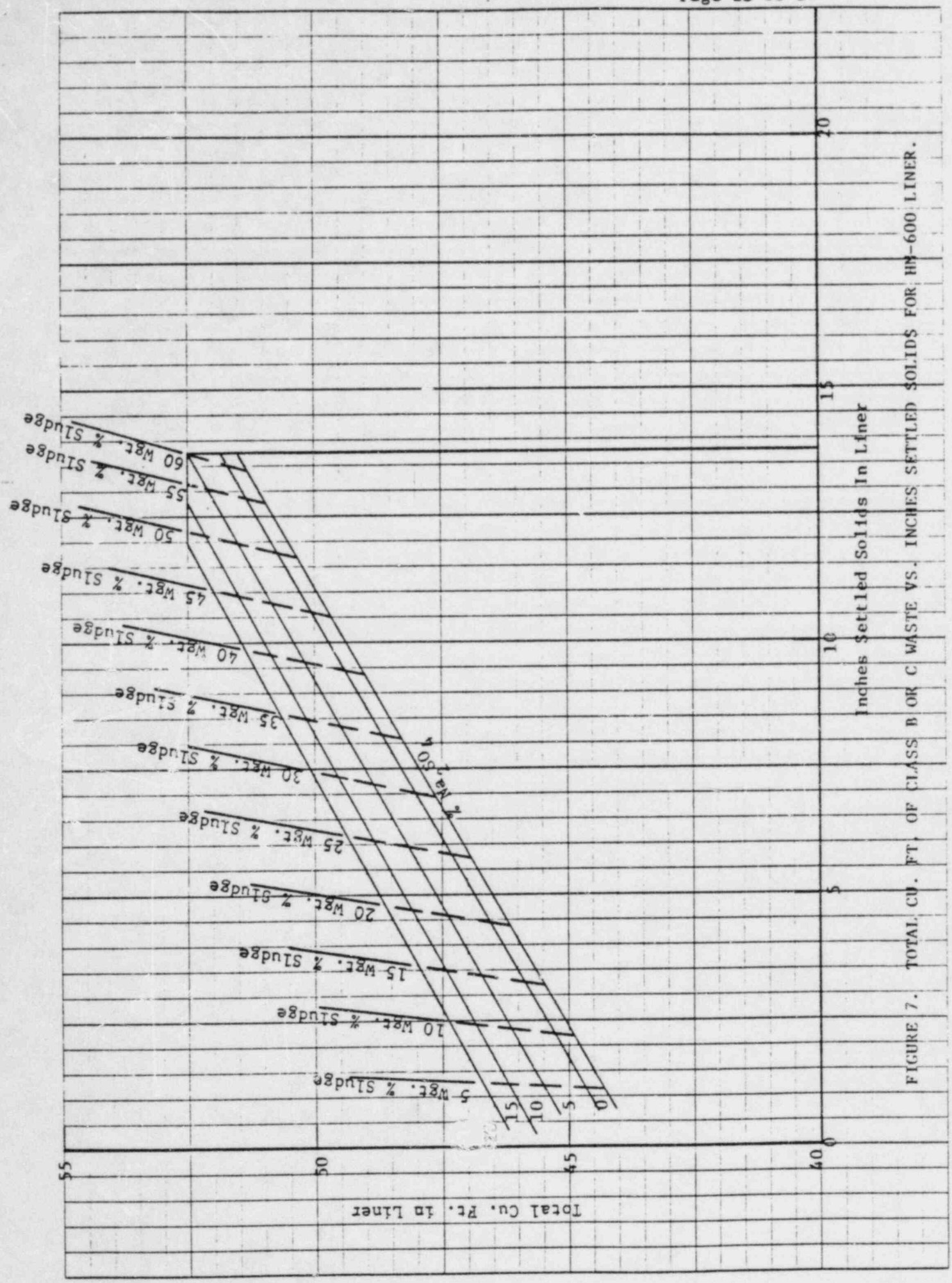

FIGURE 7. TOTAL CU. FT. OF CLASS B OR C WASTE VS. INCHES SETTLED SOLIDS FOR HN-600 LINER.

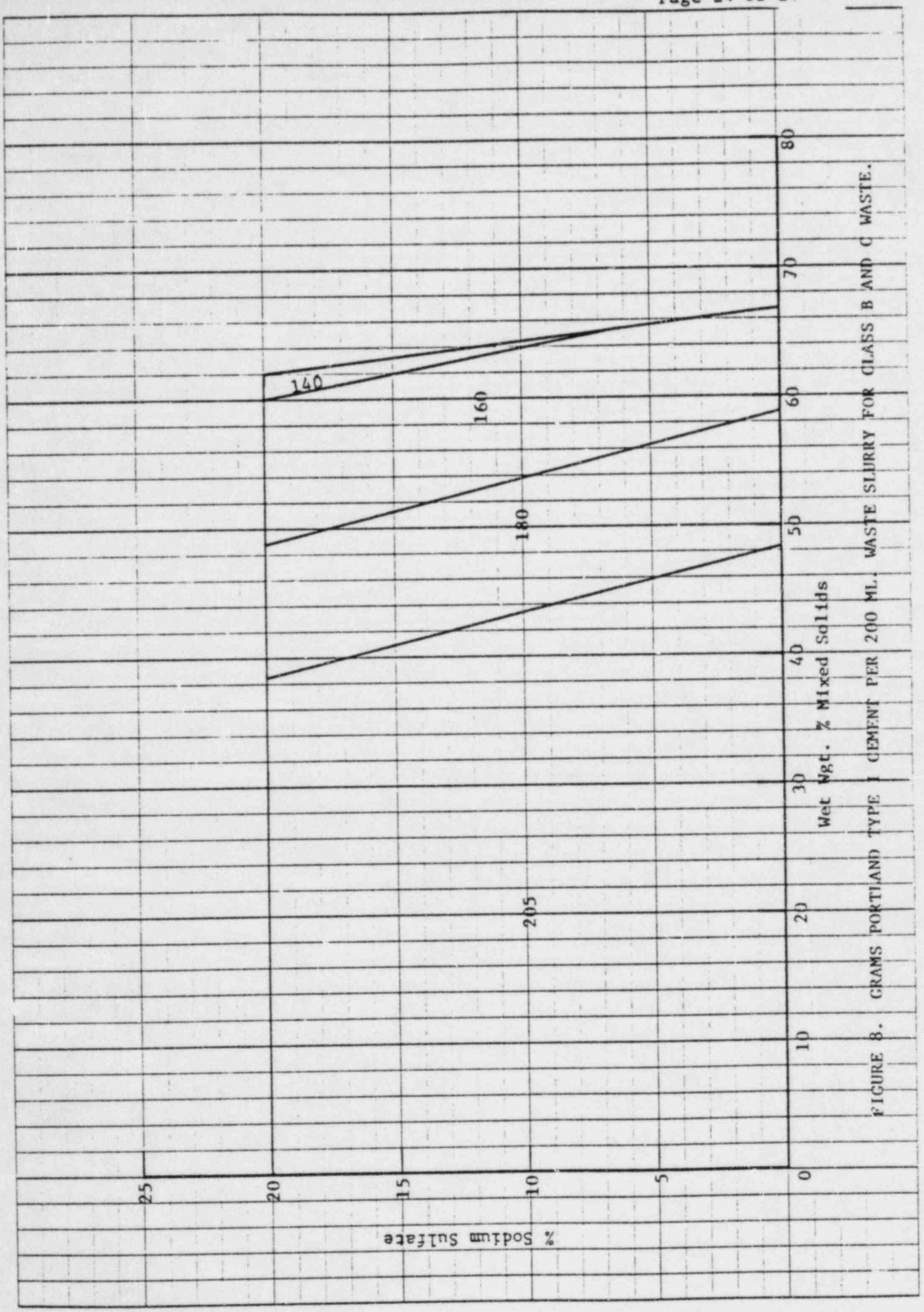

FIGURE 8. GRAMS PORTLAND TYPE I CEMENT PER 200 ML. WASTE SLURRY FOR CLASS B AND C WASTE.

ATTACHMENT B

PCP CHANGE RATIONAL AND COMFORMANCE EVALUATION

WESTINGHOUSE HITTMAN NUCLEAR INCORPORATED

TOPICAL REPORT

CEMENT SOLIDIFIED WASTES TO MEET THE STABILITY REQUIREMENTS OF 10CFR61

Revision 0

STD-R-05-007

April 1984

Prepared by:

Westinghouse Hittman Nuclear Incorporated
9151 Rumsey Road
Columbia, Maryland 21045

TABLE OF CONTENTS

I. INTRODUCTION

This Topical Report, prepared by Westinghouse Hittman Nuclear Incorporated, presents the results of testing performed on simulated low-level radioactive waste to demonstrate compliance with the stability requirements of 10CFR61.56 Waste Qualification, and the Branch Technical Position on Waste Forms. This report represents the culmination of several years of experimentation and testing of Portland Type I Cement for the solidification of LWR wastes.

The program conducted by Hittman included seventeen wastes commonly found in U.S. light water reactors in addition to a "blank" and a "grout" for encapsulation of filters and other scrap material. This compendium of wastes is the most comprehensive program of its kind currently being pursued today.

Hittman is currently under contract to supply mobile solidification services to 23 power plants throughout the country. The first mobile cement solidification system went into service over seven years ago and since that time has always produced acceptable products using Portland Type I or Type II cement. In 1983 alone, over 1,000 large liners were solidified and shipped for burial.

The formulations used to produce the samples tested for the program were made using Portland Type I cement as the major component in the solidification process. The exact formulations of waste to cement and additives are provided as Proprietary Data in Attachment A.

Section VII, Test Results provides specific data on the samples put through the various tests required to show product stability. The final leach testing of one waste type is still in progress. A supplement to this report will be provided when this data is available.

In addition, three of the long-term immersion tests performed as part of the Scale Up Testing, Section VIII, and on the grout formulation, are still in progress. This data will also be supplied with the supplemental information.

The last of the aforementioned tests will be completed on June 13, 1984. The supplement will be submitted, to complete the entire document, by June 22, 1984.

II. BACKGROUND

On December 27, 1982, the U.S. Nuclear Regulatory Commission issued, in the Federal Register, a new paragraph 311, Transfer for disposal and manifests, to 10CFR20, Standards for Protection Against Radiation. Section (d)(1) of 20.311 requires that a licensee shall "prepare all wastes so that the waste is classified according to paragraph 61.55 and meets the waste characteristics requirements in paragraph 61.56 of this chapter." The referenced paragraphs, contained in 10CFR61, Licensing Requirements for Land Disposal of Radioactive Wastes, are, paragraph 61.55, Waste Classification and paragraph 61.56, Waste Characterization.

Under the definitions presented in paragraph 61.55 certain wastes, classified as Class B and Class C wastes must meet certain "rigorous requirements on waste form to ensure stability after disposal." These rigorous requirements are defined in paragraph 61.56 with further guidance being provided by the NRC in the Branch Technical Position on Waste Forms issued in May 1983.

In response to these regulations, Westinghouse Hittman Nuclear Incorporated instituted a program to qualify specific solidification formulations, to the requirements of a stable waste form per paragraph 61.56.

The formulations are all based on Portland Type I cement with additives. Specific additives are a function of the waste stream and its chemistry. While many of these additives are commonly known to be used in the solidification of specific wastes certain other additives are proprietary.

In developing the qualification program certain alternate test methods were identified which differed slightly from the test methods specified in the Branch Technical Position on Waste Forms. These alternate test methods were discussed with the NRC staff prior to incorporation in this program. This program was submitted to the NRC for review. A subsequent letter from the NRC stated that the test program was "acceptable for demonstrating compliance with the waste stability requirements of 10CFR Part 61".

The program undertaken involved the testing of nine separate waste types, a blank and a grout. Some of these waste types were then combined at various combinations of concentrations to yield an additional six waste types. Liquid concentrates were also tested at two separate concentrations for a total of nineteen waste types. A complete listing of the waste types tested is shown at the beginning of Section IV. As can be seen, these waste types cover all of the waste streams commonly found in most PWRs and BWRs and thus comprises the most extensive and comprehensive test program undertaken to date for the qualification of solidified wastes to these criteria.

III. SUMMARY AND CONCLUSION

Based on the analyses performed on the waste types listed in Tables 1 and 2, the formulations tested possess superb structural stability far exceeding the requirements specified in the BTP on Waste Forms. Table 1 gives the compressive strength of the sample(s) after each of the stability tests were completed. Table 2 gives the leachability index after the completion of the 90-day leach test.

Two blank formulations, i.e., samples made using Portland Cement with different additives and no waste, were tested as control samples for the biodegradation test, leach tests, thermal cycling test, and long-term immersion in water. These test results verify the stability of this formulation for use in encapsulating Class B or C filters. Results of these tests are also in Tables 1 and 2.

The scale-up testing conclusively demonstrates that the product quality of wastes solidified in the Hittman mobile solidification system can be extrapolated from laboratory size samples. The tests performed on the core drilled samples has also shown that the product strength throughout the solidified liner is homogeneous. Visual inspections of the liners has shown that there are no voids or other areas where complete mixing does not occur.

Table 1

Compressive Strength After Testing, psi

Waste Type	Initial Strength	90-Day Immersion	90-Day Non-Immersion	Thermal Cycling	Biodegradation Bacteria	Biodegradation Fungus	Irradiation
Bead Resin	1,500	1,960	1,340	300	1,570	1,860	670
Powdered Resin	700	670	1,040	880	1,010	770	600
Diatomaceous Earth	1,000	1,140	1,200	1,300	3	3	1,400
Filter Sludge	710	1,240	1,290	1,100	3	3	[illegible]
8% Boric Acid	130	400	290	270	470	340	140
20% Boric Acid	130	330	230	400	3	3	140
10% Sodium Sulfate	530	540	1,170	1,470	3	3	630
20% Sodium Sulfate	830	1,050	910	1,400	3	3	1,540
Oil	140	340	190	210	230	200	290
Grit	280	500	210	360	3	3	340

Table 1

Compressive Strength After Testing, psi

Waste Type	Initial Strength	90-Day Immersion	90-Day Non-Immersion	Thermal Cycling	Biodegradation Bacteria	Biodegradation Fungus	Irradiation
Bead Resin	1,500	1,960	1,340	300	1,570	1,360	670
Powdered Resin	700	670	1,040	880	1,010	770	600
Diatomaceous Earth	1,000	1,140	1,200	1,300	3	3	1,400
Filter Sludge	710	1,240	1,290	1,100	3	3	670
8% Boric Acid	130	400	290	270	470	340	140
20% Boric Acid	130	330	230	400	3	3	140
10% Sodium Sulfate	530	540	1,170	1,470	3	3	630
20% Sodium Sulfate	830	1,050	910	1,400	3	3	1,540
Oil	140	340	190	210	230	200	290
Grit	280	500	210	360	3	3	340

Table 1 - (Cont'd.)

Compressive Strength After Testing, psi

Waste Type	Initial Strength	90-Day Immersion	90-Day Non-Immersion	Thermal Cycling	Biodegradation Bacteria	Biodegradation Fungus	Irradiation
5% Boric Acid - 30% Bead Resin	140	490	140	130	3	3	160
16% Boric Acid - 30% Bead Resin	170	280	120	280[5]	3	3	110
16% Boric Acid - 62% Bead Resin	260	370	120	300	3	3	210
5% Sodium Sulfate - 30% Mixed Solids	850	1,040	1,490	1,720	3	3	1,400
20% Sodium Sulfate - 30% Mixed Solids	1,120	460	1,340	1,850	3	3	890

Table 1 - (Cont'd.)

Compressive Strength After Testing, psi

Waste Type	Initial Strength	90-Day Immersion	90-Day Non-Immersion	Thermal Cycling	Biodegradation Bacteria	Biodegradation Fungus	Irradiation
20% Sodium Sulfate - 62% Mixed Solids	660	1,210	1,600	1,070	1,610	1,310	1,070
Blank	300	480	590	240	530	730	[3]
Decon Solution	340	460	230	200	200	200	200
Grout	1,540	1,290[1]	[2]	[3]	[3]	[3]	[3]
Acceptance Criteria	>50	>50	[4]	>50	>50	>50	>50

[1] Interim Strength - testing not complete
[2] In progress
[3] Not tested
[4] Not required
[5] Inadvertently crushed 5 days early

Table 2

Leach Test Summary

Average Leachability Index

Waste Type	Sample 1				Sample 2			
	Co-60	Cs-137	Sr-89	Ce-144	Co-60	Cs-137	Sr-89	Ce-144
Bead Resin	12.9	7.5	8.9	>11.6	13.0	7.5	8.9	>11.6
Powdered Resin	12.4	7.0	8.9	>11.4	12.3	7.0	8.5	>11.5
Diatomaceous Earth	13.2	6.5	8.4	>12.7	13.1	6.5	8.4	>12.7
Filter Sludge	11.8	6.5	7.8	>11.3	12.2	6.5	7.9	>11.3
8% Boric Acid	10.8	6.3	8.9	>12.6	10.7	6.3	8.9	>12.6
20% Boric Acid	11.1	6.6	9.3	>12.7	10.8	6.5	9.2	>12.7
10% Sodium Sulfate	13.6	6.6	8.7	>11.3	13.6	6.7	8.9	>11.3
20% Sodium Sulfate	13.2	6.6	8.7	>11.4	13.5	6.6	8.7	>11.3
Oil	10.8	7.3	10.0	>12.7	10.5	6.7	9.2	>12.5
Grit	11.1	6.9	8.6	>12.6	11.3	6.8	8.6	>12.5
Decon Solution[1]	10.7	5.9	7.9	>12.3	10.8	5.9	7.9	>12.5

Table 2 - (Cont'd.)

Leach Test Summary

Average Leachability Index

Waste Type	Sample 1 Co-60	Cs-137	Sr-89	Ce-144	Sample 2 Co-60	Cs-137	Sr-89	Ce-144
5% Boric Acid w/ 30% Bead Resin	11.6	6.8	8.9	>12.2	11.4	6.6	9.0	>12.1
16% Boric Acid w/ 30% Bead Resin	12.1	7.5	9.7	>12.8	12.1	6.9	9.6	>12.7
16% Boric Acid w/ 62% Bead Resin	12.5	7.1	9.8	>11.4	12.4	7.1	9.8	>11.5
5% Sodium Sulfate w/ 30% Mixed Solids	12.9	6.8	8.8	>11.2	13.2	6.8	8.8	>11.3
20% Sodium Sulfate w/ 30% Mixed Solids	13.6	6.7	9.0	>11.4	13.2	6.6	8.8	>11.3
20% Sodium Sulfate w/ 62% Mixed Solids	11.3	6.5	8.2	>11.5	11.4	6.3	8.1	>11.3
Blank	10.9	6.4	8.3	>12.3	11.1	6.4	8.2	>12.5
Acceptance Criteria	>6.0	>6.0	>6.0	>6.0	>6.0	>6.0	>6.0	>6.0

[1]Subsequent testing with a proprietary additive has resulted in Cs-137 leach indices of 6.91 and 6.93 for two new samples after 8 leach intervals.

IV. WASTE QUALIFICATION PROGRAM DESCRIPTION

Scope

The program undertaken by Hittman covered eight basic types of liquid and solid wastes typically found in a nuclear power plant. These are:

- Mixed Bed Bead Ion-Exchange Resin
- Mixed Powdered Ion-Exchange Resin
- Diatomaceous Earth (DE)
- Filter Sludge (a mixture of powdered resin, DE, iron oxide and dirt).
- Oil
- Boric Acid (8% and 20%)
- Sodium Sulfate (10% and 20%)
- Grit (from abrasive decontamination processes)

As indicated two concentrations of both boric acid and sodium sulfate were tested to demonstrate the ability to produce qualified products over a range of concentrations. Additionally, three combinations of boric acid and bead resin and three combinations of sodium sulfate and a mixture of bead resin, powdered resin and diatomaceous earth were tested. Figures 1 and 2 give a graphical presentation of the relative concentrations tested.

The shaded areas in both figures represents the combinations of liquid chemical wastes and wet solids that can be solidified to the stability requirements of the BTP on Waste Forms as demonstrated by the test data in this report.

The last two samples tested contained no physical wastes but were cement slurries each using one of the two major additives used with the basic waste forms. One of these is identified as the "Blank" and the other as "Grout". The latter can be used as a pumpable grout slurry for encapsulation of cartridge filters. Both formulations also provide a data point for the extrapolation of formulations for wastes at zero concentration. For example, the Blank waste, using the same additives as boric acid can be used to develop solidification parameters below eight weight percent.

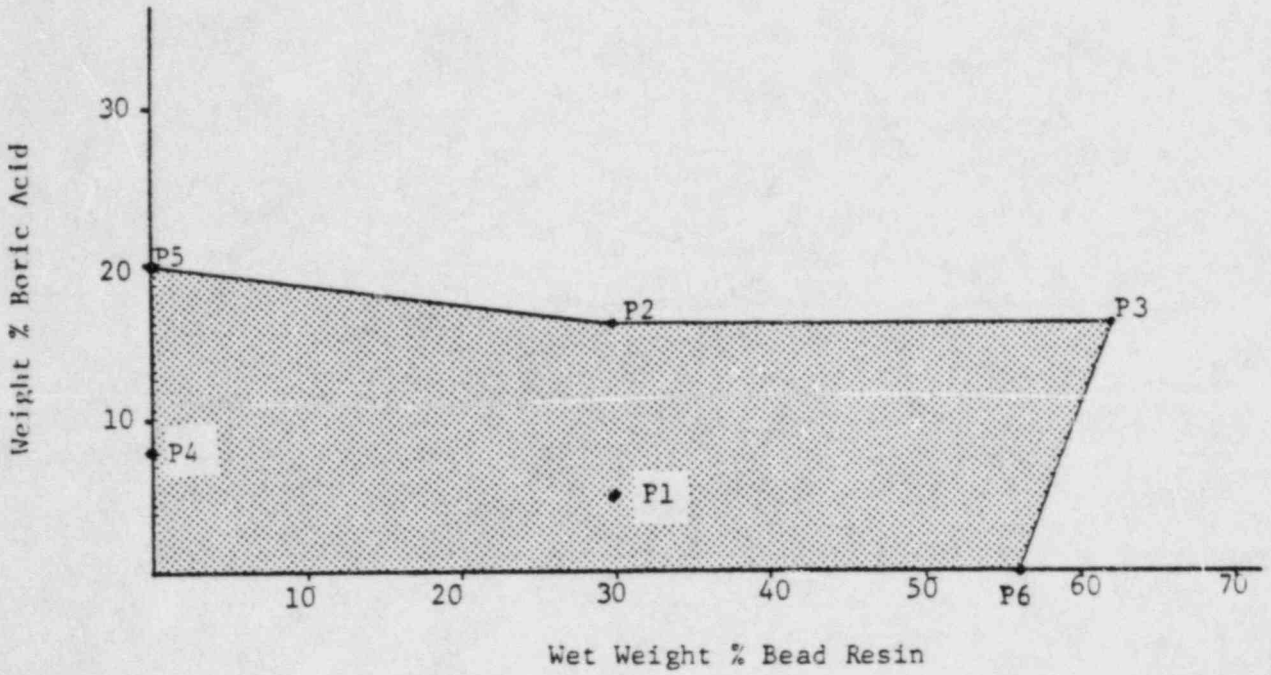

Figure 1
Bead Resin with Boric Acid

- Points P1, P2 and P3 in Figure 1 are the mixed boric acid and bead resin where:
- P1 is 30% bead resin and the liquid is a 5% boric acid solution;
- P2 is also 30% bead resin but the liquid is a 16% boric acid solution;
- P3 is 62% bead resin with again a 16% boric acid solution;
- Points P4 and P5 are the pure boric acid samples at 8% and 20% concentrations respectively.
- Point P6 is a plain bead resin sample at 57.6 wet weight percent solids and no boric acid.

Figure 2 is similar to Figure 1 with slightly modified concentrations.

- Points S1, S2 and S3 in Figure 2, are the mixed sodium sulfate and mixed solids (powdered resin, bead resin, and diatomaceous earth) where:
- S1 is 30% mixed solids and 5% sodium sulfate;
- S2 is 30% mixed solids and 20% sodium sulfate;
- S3 is 62% mixed solids with, again, 20% sodium sulfate;
- Points S4 and S5 are the pure sodium sulfate concentrations of 10% and 20% respectively;
- Point S6 represents plain mixed solids at 66 wet weight percent solids.

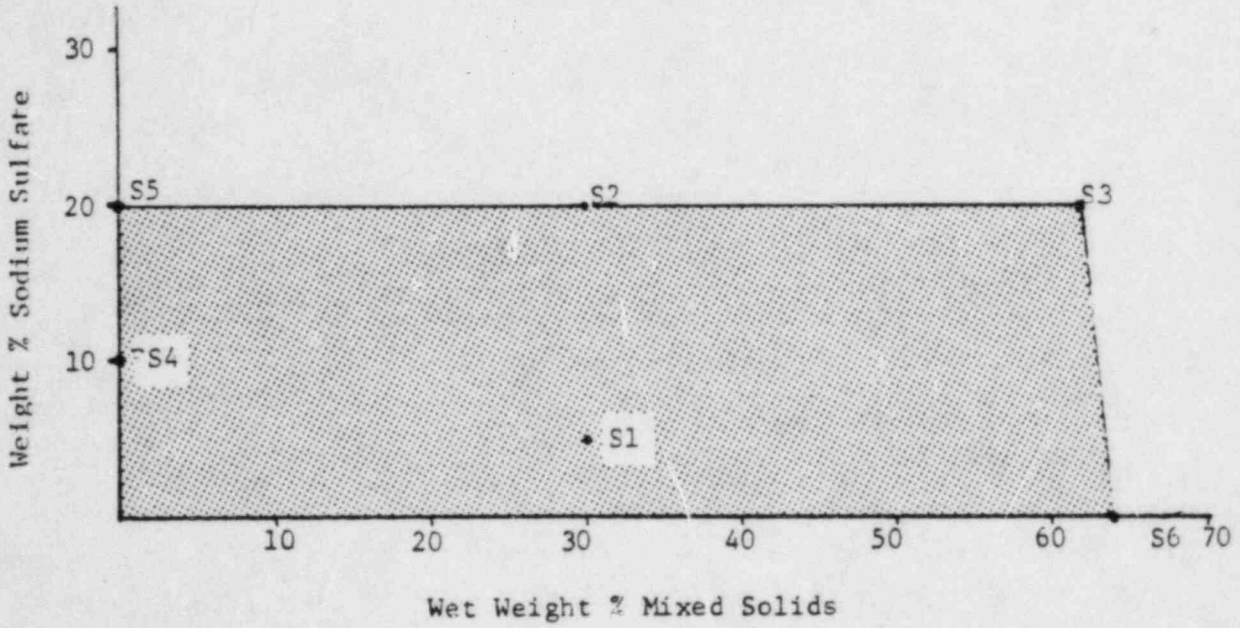

Figure 2
Mixed Solids with Sodium Sulfate

V. SAMPLE PRODUCTION

Individual samples for initial testing were prepared in 1,000 ml plastic beakers using a standard laboratory mixer with a three inch diameter mixing blade. These blades are made specifically for this purpose and are shaped in the same configuration as the full scale in-container mixing system. As specific mixes were identified for complete testing a large scale laboratory mix was prepared. Each of these large scale lab mixes was formulated to produce a sufficient batch of waste to fill sixteen three (3) inch diameter by six (6) inch high molds. These mixes were prepared in a five gallon can using a mixer blade shaped to recreate the same basic mixing action as a full scale in-container mixing system. The motor used was a variable speed motor which permitted adjusting the speed to hold a tip speed on the mixing blade at the same tip speed experienced with the Hittman in-container mixing system.

As soon as the samples were molded they were placed in sealed plastic bags, one sample per bag, to prevent moisture loss due to evaporation. All of the samples were then placed in an oven at 120°F for twenty-four hours to simulate the elevated curing temperature experienced in full scale operations due to the exothermic reaction as cement cures. After the samples were removed from the oven they were marked and put into storage while they awaited additional testing.

If samples were stored for prolonged periods prior to being used for one of the tests a companion sample from that batch was corpressively tested to provide an adjusted base line against which to judge the effects of the test. In those cases where this additional test was performed it is so noted and the compressive strength of the additional sample is listed.

Samples for leach testing were prepared by the Westinghouse R & D Center. These samples were cured for one week in the same manner as the other test samples described above. Leach testing for all the waste types was performed on two identical samples measuring one (1) inch in diameter by two (2) inches long. Samples were produced using water containing Co-60, Cs-137, Sr-85 and Ce-144 in concentrations of approximately 1μCi/gm each[1]. Demineralized water was used as the leachate for all samples except bead resin and powdered resin which were leached in synthetic sea water.

1/ Due to a packaging error by the isotope vendor, approximately half of the samples had Cs-137 concentrations approximately ten times higher than the other isotopes. This has no impact on the leach index as the calculation is based on the fraction leached and not the absolute quantity leached.

VI. TESTS AND TEST METHODS

The tests performed and the methods of testing are given in Attachment A, Waste Qualification Program. This program differs from the program outlined in the BTP for the thermal cycling and the biodegradation testing. These differences are described below.

A. Thermal Cycling:

The ASTM Standard B-355 referenced in the BTP was not used for three reasons. First, the rapid cycling time is not representative of the actual environmental conditions that wastes will be subjected to. Second, the temperature ranges specified are not available in normal laboratory equipment designed for the large number of samples required. Third, unpublished results of tests performed by a national lab indicate that the large temperature difference, -40°C to 60°C, and the rapid cycling prevents the centerline of the samples from ever reaching the requisite temperature extremes.

The method selected used more realistic temperature extremes of -18°C and 48°C (0°F and 120°F respectively). The test chamber was set to alternate between these two temperatures on a 24-hour cycle. During each cycle, the 0°F and 120°F temperatures are maintained for 8 hours each with a 4-hour transition time.

Each sample was tested for a total of 50 cycles, or 50 days.

Following completion of the test, the samples were compressively tested to demonstrate a minimum of 50 psi compressive strength.

B. Biodegradation:

The ASTM Standards G21 and G22 referenced in the BTP were modified slightly as follows. Both tests are designed to use samples approximately one-quarter inch thick and to be incubated in a shallow petri dish. In order to be able to use samples that could be compressively tested upon completion of the test, samples three (3) inches in diameter by six (6) inches high were used. Each sample was placed in a beaker and covered with the non-nutrient salt and injected with the appropriate bacteria and fungus.

Testing for degradation due to fungus growth was modified by replacing penicillium funiculosum with penicillium jenseni. This substitution was made because of the strict sterilization requirements imposed on any item that comes in contact with penicillium funiculosum which is a plant pathogen.

Due to an adverse reaction between the bead resin sample and the agar this test was conducted using the recommended salts dissolved in water without the agar.

Upon completion of the test, the samples were inspected for growth of the fungus or bacteria and then compressively tested to demonstrate a minimum compressive strength of 50 psi.

VII. TEST RESULTS

The results of the testing on individual waste types are as follows:

1. Bead Resin

Samples of solidified bead resin were prepared using chemically depleted mixed bed ion exchange resin. The initial average compressive strength of the lab mixed samples was 1,090 psi while the drum mixed samples had an average strength of 1,500 psi. After 90 days immersion the average strength of two samples tested was over 1,960 psi.

The formulation tested in the irradiation, thermal cycling and leach tests was slightly different from the final reference formulation. By comparison, the original formulation had an average initial compressive strength of 740 psi compared to 1,090 psi for the reference formulation. The difference in these two formulations is in the water to cement ratio while maintaining identical volumetric waste loading. Therefore, the test results for the original formulation are conservative in both strength and leach characteristics compared to the reference formulation and additional, or repeat testing of the reference formulation was not required.

The thermal cycling tests on the original formulation resulted in an average compressive strength of 300 psi. The sample irradiated to the 10^8 Rad had a compressive strength of 670 psi. The average leachability index for each of the four radionuclides tested is given in Table 2 for both samples. The two samples used in the biodegradation tests showed no visible signs of bacteria or fungus growth. The compressive strengths were 1,570 psi and 1,860 psi after exposure to the bacteria and fungus respectively. Table 3 contains the data for the individual bead resin samples tested.

Table 3

Compressive Strength Summary

Bead Resin, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	1,260	1,660	1,340	1,570[1]	270	670
Sample 2	1,740	2,260	--	1,860[2]	330	--

[1]Bacterial Attack.

[2]Fungus Attack.

2. Powdered Resin

The initial strength of two powdered resin samples measured 630 psi and 770 psi with little change seen after 90 days immersion in water. The immersed samples had strengths of 630 psi and 700 psi. Over the same time period the non-immersed sample increased in strength to 1,040 psi.

The sample irradiated to 10^8 Rad exhibited a compressive strength of 600 psi after irradiation. The samples tested for biodegradation had strengths of 1,010 psi after bacterial attach and 770 psi after fungus attach. There was no visual growth of bacteria or fungus on either sample. Thermal cycling tests on two samples resulted in compressive strengths of 860 psi and 900 psi.

Leach testing of powdered resin was also conducted using synthetic sea water. The average leachability index for each of the four radionuclides tested is given in Table 2 for both samples.

Table 4

Compressive Strength Summary

Powdered Resin, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	770	630	1,040	1,010[1]	860	600
Sample 2	630	700	--	770[2]	900	--

[1]Bacterial Attack

[2]Fungus Attack

3. Diatomaceous Earth

The initial compressive strength of two samples of solidified diatomaceous earth are 1,300 psi and 970 psi. The 90-day immersion strengths were 1,140 psi for both samples with a non-immersed sample testing at 1,200 psi. The two samples used in the thermal cycling tests had strengths of 1,640 psi and 1,150 psi. The irradiated sample was 1,400 psi. This data is summarized in Table 5.

Average leachability indices for the four radionuclides tested are given in Table 2 for both samples. The leachate for DE was demineralized water.

Table 5

Compressive Strength Summary

Diatomaceous Earth, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	970	1,140	1,200	NT[1]	1,640	1,400
Sample 2	1,030	1,140	--	NT	1,150	--

[1]Not tested

4. Filter Sludge

The initial compressive strengths of the filter sludge solidifed samples were 510 psi and 910 psi. After 90 days of immersion the strengths were 1,200 psi and 1,270 psi with a non-immersed sample having a compressive strength of 1,290 psi. After irradiation to 10^8 rad the compressive strength of a single sample was 670 psi. Thermal cycling tests resulted in compressive strengths of 1,070 psi and 1,140 psi. Biodegradation tests were not conducted on solidified filter sludge. This information is summarized in Table 6.

Table 6

Compressive Strength Summary

Filter Sludge, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	510	1,200	1,290	NT	1,070	670
Sample 2	910	1,270	--	NT	1,140	--

Leach testing of filter sludge were conducted in demineralized water. The average leachability indices for the four radionuclides tested are given in Table 2 for both samples.

5. 8% Boric Acid

The initial compressive strengths of the 8% boric acid samples were 140 psi and 110 psi. Following irradiation to 10^8 rad, the sample still exhibited a strength of 140 psi, while the samples exposed to bacterial and fungus attach had strength of 470 psi and 340 psi respectively. Neither sample showed any visible signs of bacteria or fungus growth. After 90 days immersion the compressive strengths of two samples were 370 psi and 430 psi. Thermal cycling tests resulted in compressive strengths of 270 psi for both samples. This data is summarized in Table 7.

Leach testing of 8% boric acid was conducted using demineralized water. The average leachability indices for the four radionuclides tested are given in Table 2 for both samples.

Table 7

Compressive Strength Summary

8% Boric Acid, psi

	Initial Test	90-Day Immersion[1]	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	140	430	130	470[1]	270	130
Sample 2	110	370	--	340[2]	270	--

[1]Bacterial Attack

[2]Fungus Attack

6. 20% Boric Acid

After 90 days immersion, the compressive strength of two samples were 310 psi and 340 psi. Prior to immersion, the compressive strengths were 140 psi and 110 psi, while a non-immersed sample had a compressive strength of 230 psi after 90 days. After exposure to a gamma radiation source to a total centerline dose of 10^8 Rad, the compression strength of a single sample was 140 psi.

Due to an earlier failure of one sample to pass the thermal cycling test, four additional samples were tested. These four samples had strengths following testing of 410 psi, 440 psi, 410 psi and 330 psi. The average of these four samples is shown for Sample 2.

Table 8

Compressive Strength Summary - 20% Boric Acid, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	110	310	230	NT	140	140
Sample 2	140	340	--	NT	400[1]	--

[1]The average of four samples.

Leach testing was conducted using demineralized water. The average leachability index is shown in Table 2 for each of the four radionuclides tested for both samples.

7. 10% Sodium Sulfate

The initial compressive strengths of the 10% sodium sulfate samples were 570 psi and 490 psi. The samples used in the 90-day immersion test had compressive strengths of 690 psi and 390 psi. After exposure of 10^8 Rads, the strength of a single sample was 630 psi. Thermal cycling test resulted in sample strengths of 1,410 psi and 1,530 psi. Since sodium sulfate is a non-nutrient salt it was not considered necessary to test this waste form for biodegradation. These data are summarized in Table 9.

Leach testing of the 10% sodium sulfate samples was conducted using demineralized water. The average leach indices for the four radionuclides tested are given in Table 2 for both samples.

Table 9

Compressive Strength Summary

10% Sodium Sulfate, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	490	690	1,170	NT	1,410	630
Sample 2	570	390	--	NT	1,530	--

8. 20% Sodium Sulfate

The initial compressive strength of both 20% sodium sulfate samples was 830 psi. The samples used in the 90-day immersion test had compressive strengths of 1,000 psi and 1,100 psi. The thermal cycling test resulted in sample strengths of 1,280 psi and 1,530 psi. Following irradiation to 10^8 rads, the strength of a single sample was 1,540 psi. Biodegradation tests are not being performed as stated under 10% sodium sulfate. See Table 10 for a summary of these data.

Leach testing was conducted in demineralized water. The average leach indices for the four radionuclides tested are given in Table 2 for both samples.

Table 10

Compressive Strength Summary

20% Sodium Sulfate, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	830	1,000	910	NT	1,280	1,540
Sample 2	830	1,100	--	NT	1,530	--

9. Oil

Samples solidified contained used motor and turbine lube oil diluted in water and emulsified with a proprietary emulsifier.

The initial compressive strengths after 7 days of cure were 140 psi and 130 psi. After 90 days immersion in water, both samples had compressive strengths of 340 psi. A single non-immersed sample from the same batch exhibited a compressive strengh of 190 psi.

After exposure to a gamma radiation source to a total center-line dose of 10^8 rads, the compressive strength of a single sample was 290 psi. Both samples used in the thermal cycling tests had compressive strengths of 210 psi. The samples tested for biodegradation had strengths of 230 psi after bacterial attack and 200 psi after fungus attack. There was no visual growth of bacteria or fungus on either sample. Table 11 provides a summary of the testing discussed above.

Table 2 contains the leach indices for solidified oil for the four radionuclides tested, for both samples. Demineralized water was used for the leachate.

Table 11

Compressive Strength Summary - Oil, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	140	340	190	230[1]	210	290
Sample 2	130	340	--	200[2]	210	--

[1]Bacterial Attack

[2]Fungus Attack

10. Grit

The grit used in these samples is aluminum oxide; however, due to the inert nature of the material, the results of these tests are considered applicable to other similar materials such as magnetite and steel grits at comparable waste loadings.

Prior to immersion, the average compressive strength was 280 psi. Samples immersed for 90 days had an average compressive strengths of 390 psi and 610 psi while a non-immersed sample of the same age had a compressive strength of 210 psi. Due to the inert nature of the waste, biodegradation testing was not considered necessary.

A single irradiated sample had a compressive strength of 340 psi after irradiation in a gamma field to a centerline dose of 10^8 Rads. The samples used in the thermal cycling test had strengths of 400 psi and 320 psi. This data is summarized in Table 12.

Table 12

Compressive Strength Summary - Grit, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	280	390	210	NT	400	340
Sample 2	270	610	--	NT	320	--

Table 2 shows the leach indices for the solidified grit, for all four radionuclides for both samples. The leachate for this waste type was also demineralized water.

11. 5% Boric Acid and 30% Bead Resin

This waste form consists of a slurry which, if separated by dewatering, would be 30% by weight dewatered resin and the liquid would be a 5% boric acid solution.

Prior to immersion, the compressive strength of both samples was 140 psi. Ninety-one days later, the compressive strength of a non-immersed sample was unchanged, at 140 psi. The compressive strength of the immersed samples at 90 days was 490 psi. Biodegradation testing was not performed since both bead resin and boric acid were tested separately.

Following irradiation to 10^8 Rads, the compressive strength was 160 psi. Samples used in the thermal cycling tests had compressive strengths of 120 psi and 140 psi. Table 13 provides a summary of the testing discussed above.

Table 13

Compressive Strength Summary - 30% Resin, 5% Boric Acid, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	140	490	140	NT	140	160
Sample 2	140	490	--	NT	120	--

Leach testing was performed using demineralized water. The average leachability indices for each of the four radionuclides for both samples are shown in Table 2.

12. 16% Boric Acid with 30% Bead Resin

The initial compressive strength of both samples was 170 psi. After 90 days immersion the two samples tested has compressive strengths of 230 psi and 330 psi. During the same period a non-immersed sample had a strength of 120 psi. Following irradiation to 10^8 rads, the compressive strength of a single sample was 110 psi. Biodegradation testing was not performed since both boric acid and bead resin were tested separately. Thermal cycling tests resulted in compressive strengths of 270 psi and 290 psi. This data is summarized in Table 14.

Table 14

Compressive Strength Summary

16% Boric Acid with 30% Bead Resin, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	170	230	120	NT	270	110
Sample 2	170	330	--	NT	290	--

Leach testing of the 16% boric acid with 30% bead resin samples were conducted in demineralized water. The average leach indices for the four radionuclides tested are given in Table 2 for both samples.

13. 16% Boric Acid with 62% Bead Resin

The initial compressive strengths of both samples tested was 260 psi. After 90 days immersion the two samples tested had strengths of 430 psi and 310 psi. After 90 days the non-immersed sample had a strength of 120 psi. After exposure to 10^8 rad the irradiated sample had a strength of 210 psi. Biodegradation tests are not being performed since both boric acid and bead resin were tested separately. Both of the thermal cycling samples had compressive strengths of 300 psi. These data are summarized in Table 15.

Table 15

Compressive Strength Summary

16% Boric Acid with 62% Bead Resin, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling[1]	Irradiation 10^8 Rad.
Sample 1	260	430	120	NT	300	210
Sample 2	260	310	--	NT	300	--

[1]Inadvertently crushed at 45 days.

Leach testing was conducted in demineralized water. The average leach indices for the four radionuclides being tested are given in Table 2 for both samples.

14. 5% Sodium Sulfate with 30% Mixed Solids

The initial compressive strengths for the two samples tested were 700 psi and 1,000 psi. The 90-day immersion test samples had compressive strengths of 660 psi and 1,430 psi. After the same period, a non-immersed sample had a compressive strength of 1,490 psi. The thermal cycling test samples had strengths of 1,730 psi and 1,720 psi. The single sample exposed to 10^8 Rad had a strength of 1,400 psi. Biodegradation tests were performed on the 20% sodium sulfate with 62% mixed solids samples. Table 16 provides a summary of these data.

Leach testing on the 5% sodium sulfate with 30% mixed solids was conducted in demineralized water. The average leach indices for the four radionuclides tested are given in Table 2 for both samples.

Table 16

Compressive Strength Summary

5% Sodium Sulfate with 30% Mixed Solids, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	700	660	1,490	NT	1,730	1,400
Sample 2	1,000	1,430		NT	1,720	--

15. 20% Sodium Sulfate with 30% Mixed Solids

The initial compressive strengths for two samples of this waste type were 1,000 psi and 1,230 psi for lab samples and 830 psi and 1,230 psi for samples from the drum mix. The 90-day immersion test on the drum samples resulted in compressive strengths of 660 psi and 960 psi. After 90 days of curing a non-immersed sample had a compressive strength of 1,340 psi. Following irradiation to 10^8 Rads, a single sample had a strength of 890 psi. The thermal cycling test samples had compressive strengths of 1,820 psi and 1,880 psi. Biodegradation tests were performed on the 20% sodium sulfate with 62% mixed solids samples. These data are summarized in Table 17.

Leach testing was conducted using demineralized water. The average leach indices for the four radionuclides tested are given in Table 2 for both samples.

Table 17

Compressive Strength Summary

20% Sodium Sulfate with 30% Mixed Solids, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	830	660	1,340	NT	1,820	890
Sample 2	1,230	960	--	NT	1,880	--

16. 20% Sodium Sulfate with 62% Mixed Solids

The initial compressive strengths of these two samples were 660 psi and 670 psi. After 90 days immersion the strengths of two samples were 1,140 psi and 1,280 psi. A non-immersed sample after the same time interval had a strength of 1,600 psi. After exposure to 10^8 rads, the strength of a single sample was 1,070 psi. The samples subjected to biodegradation testing had compressive strengths of 1,610 psi and 1,310 psi after bacterial attack and fungus attack respectively. There was no visible growth of bacteria or fungus on either sample. The thermal cycling test samples had compressive strengths of 1,060 psi and 1,080 psi. These data are summarized in Table 18.

Leach testing for the 20% sodium sulfate with 62% mixed solids samples was conducted using demineralized water. The average leach indices for the four radionuclides tested are given in Table 2 for both samples.

Table 18

Compressive Strength Summary

20% Sodium Sulfate with 62% Mixed Solids, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	660	1,140	1,600	1,610[1]	1,060	1,070
Sample 2	670	1,280	--	1,310[2]	1,080	--

[1]Bacterial Attack

[2]Fungus Attack

17. Miscellaneous Chemical Wastes

The initial compression strength of the miscellaneous chemical waste samples was 340 psi for both samples. Following 90 days immersion in water, the samples had compressive strengths of 430 psi and 490 psi. A non-immersed sample had a strength of 230 psi after 90 days. The samples used in the thermal cycling test both had strengths of 200 psi, as did the samples used in the radiation test, the bacterial attack test and the fungus attack test. There was no visible growth of bacteria or fungus on either sample. Table 19 provides a summary of this data.

Table 19

Compressive Strength Summary, psi

Miscellaneous Chemical Waste

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	340	430	230	200[1]	200	200
Sample 2	340	490	--	200[2]	200	--

[1]Bacterial Attack

[2]Fungus Attack

Leach tests using demineralized water as the leachate resulted in average leach indices after 90 days of greater than 6.0 for three of the four isotopes as shown in Table 2. The average leachability index for Cs-137 was slightly below 6.0 for both samples. Subsequent retesting using a proprietary additive for Cs retention is presently in progress with a scheduled completion date of June 5, 1984. Through the eighth leach interval, the average cesium leachability indices are 6.91 and 6.93.

18. Blank and Grout

Two blank cement formulations were tested for qualification as a Class B waste form for the encapsulation of cartridge filters or other non-dispersable wastes. The initial strengths were 310 psi and 290 psi for the formulation identified as "Blank". For the "Grout" formulation, the initial strengths were 2,070 psi and 1,000 psi. The blank formulation was used in the biodegradation tests, and the thermal cycling tests. Following thermal cycling tests, the blank samples had compressive strengths of 240 psi and 250 psi. After completion of the bacterial and fungus attack tests, the blank sample strengths were 530 psi and 730 psi, respectively. Following the 90-day immersion tests on the blank formulation, the two samples had compression strengths of 460 psi and 500 psi. The 90-day immersion test on the grout formulation is in progress. After six weeks immersion, a single grout sample had a strength of 1,290 psi. Due to the common use of cement in radiation environments these tests were not considered necessary. Table 20 provides a summary of this data.

Leach testing of this waste form was performed on the blank with the same four radionuclides dispersed throughout the sample as in all the other waste types. Table 2 lists the individual leachability indices for the four radionuclides tested.

Table 20

Compressive Strength Summary

Blank Waste, psi

	Initial Test	90-Day Immersion	90-Day Non-Imm.	Biodegradation	Thermal Cycling	Irradiation 10^8 Rad.
Sample 1	310	460	590	530[1]	240	NT
Sample 2	290	500	--	730[2]	250	NT

[1]Bacterial Attack

[2]Fungus Attack

VIII. SCALE-UP TESTING

A. Solidification Testing and Sample Compression Strength

As recommended by the NRC Branch Technical Position on Waste Forms, additional testing was performed, culminating in a full scale liner solidification, to demonstrate the scale-up of product quality from the lab size samples used for testing to the full size product. Both the Hydraulic Drive and Electric Drive In-Container Solidification systems are proven systems and have been in use for over seven years. In 1983, Hittman solidified over 1,000 large liners, never once failing to produce an acceptable product using Portland Type I or Portland Type II Cement.

In developing the scale-up program, the real impetus was to scale down from the full scale system to lab and drum scale mixes. In performing these calculations, four parameters were analyzed. These were:

- Mixing blade diameter to container diameter. This ratio was held constant, ± 5%, and used to define the mixing blade diameter for the drum and lab scale mixes.
- Horsepower per cubic foot. This ratio was used to define mixer motor horsepower for the drum and lab scale mixes.
- Total BTU input. With the mixer horsepower defined, this was used to determine the interval over which the solidification ingredients would be added and the total mix time.
- Mixing blade tip speed. This was used to determine the appropriate gear reducer for the drum scale mixing system, and the appropriate mixing speeds for the lab scale mixes.

As discussed in Section V, the sample production utilized both individual lab mixed samples and large lab mixes. The individual lab samples were prepared in 1,000 ml containers, preparing sufficient product to fill a 3" diameter by 6" high mold. The large lab mixes were prepared to supply sufficient product to fill up to seventeen of the same molds. These samples were used in the immersion, biodegradation, thermal cycling and irradiation tests.

Following completion of these tests, drum scale tests were performed on four of the mixes. The selected mixes were:

- Bead Resin
- 20% Boric Acid
- 20% Sodium Sulfate

- 30% Mixed Solids with 20% Sodium Sulfate

Each mix was prepared in a 55-gallon drum using an in-drum mixing system specifically designed for these tests. This design was based on the scaling factors outlined above. At the completion of the mix cycle, some of the product was removed from the drum and used to fill several 3" diameter by 6" molds. These samples were then cured in a manner identical to the large lab sample mixes. After the initial cure period, two samples were tested for initial compression strength. Additional samples were immersed in water for duplication of the 90-day immersion tests.

After the samples had been taken from the drums, each drum was sealed with a standard drum lid and bolt-closure ring. Samples and drums were examined at 24 hours to check for final set and free liquid. At this check, all samples and drums were hard and contained no liquid, drainable or otherwise. To complete the scale-up testing, two liners were solidified. The first was an HN-100 LVM (large volume mixer) containing 30 percent mixed solids and a 20 percent sodium sulfate solution. This liner is an upsized standard HN-100 designed to maximize the usable internal volume. The second liner solidification was a standard HN-100 UM (underdrain mixer) containing bead resin.

Both solidifications were performed using a Hittman Hydraulic Drive In-Container Solidification System. The HN-100 LVM was solidifed at the normal mixing speed of a hydraulic drive system. The waste type solidified in this liner is representative of a BWR, and, therefore would be solidified in the field using this system. A reduced mixing speed, representative of the electric drive, was used for the bead resin solidification in the HN-100 UM.

During both solidifications, the hydraulic pressure was monitored. At no time in either solidification did the system pressure exceed 20 percent of the stall pressure. By comparison to an electric drive system this would still be only a fraction of the motor capacity. In this instance, the higher mixing speed of the hydraulic drive system does not appear to have resulted in a stronger product since the initial strength of the liner samples from the HN-100 LVM are very similar to the initial strength of the lab and drum scale samples. It can then be concluded that both waste types tested could also have been solidified with an Electric Drive System with similar results.

Comparisons of the initial sample strengths and the immersed sample strengths are provided in Table 21 for the four waste types tested in the scale-up program. Dipped samples taken at the completion of the mixing cycle were cured in the liners for seven days prior to being removed for testing.

Table 21

Individual Scale-Up Testing Sample Strengths

	Compressive Strength, psi		
	Lab Sample	Drum Sample	Liner Sample
Bead Resin			
Initial Strength	1260, 1740	830, 1660	770, 1430, 860
Immersion Strength	1660, 2260	In Progress	In Progress
30% Mixed Solids With 20% Sodium Sulfate			
Initial Strength	1230, 1000	830, 1230	1200, 700
Immersion Strength	460	660, 960	In Progress
20% Boric Acid			
Initial Strength	110, 140	200, 200	Not Tested
Immersion Strength	310, 340	260, 400	Not Tested
20% Sodium Sulfate			
Initial Strength	830, 830	570, 460	Not Tested
Immersion Strength	1000, 1100	570, 570	Not Tested

A closer examination of the individual sample strengths in Table 21 gives a clearer impression of the curing process:

1. Bead Resin. While the average initial strength of the three bead resin liner samples is lower than the average lab strength, one of the three liner samples falls between the two lab samples. Similarly, for the drum samples, one had a strength close to the stronger of the two lab samples, while the other was close to the two lower strength liner samples.

The range of strengths experienced here is not unexpected. Previous testing, as part of this and other programs has demonstrated a significant distribution of sample strengths for cement solidified wastes. In particular, tests conducted as part of this program showed an average initial compression strength for 16 identical samples, of 960 psi with a standard deviation of 210 psi for the 30% mixed solids with 20% sodium sulfate waste type. While the seven initial bead resin strengths are higher than those in this test, they do follow the same general distribution.

Following the 90-day immersion test, the two bead resin lab samples had compression strength of 1,660 psi and 2,260 psi. Final immersion testing of the drum scale samples and liner samples will be completed in the near future and supplied with the June supplement.

2. 30% Mixed Solids With 20% Sodium Sulfate. Drum scale and full size liner tests were also performed on the 30% mixed solids with 20% sodium sulfate. The data for the samples of this waste type is also shown in Table 21. A comparison of the initial sample strengths from the lab, drum and liner samples with the previously mentioned data on the distribution of sample compressive strength shows good correlation between the two sets of data. Although one of the lab samples was cracked at the end of the 90-day immersion test and was not tested, both drum samples had compression tests well in excess of the minimum 50 psi. Final verification of the liner samples will be available shortly and provided with the supplemental data.

For consistency within the process control program with other combinations of mixed solids and sodium sulfate, the final formulation selected for this particular combination has been increased in cement by approximately 8.5%. To demonstrate that this formulation does not result in a weaker product than the formulation tested, a drum scale test solidification was performed. Dipped samples were taken for testing. The initial sample strengths were 860 psi and 1,430 psi compared to the original drum samples of 830 psi and 1,230 psi. The results of the immersion testing will be reported with the supplemental information.

3. 20% Boric Acid and 20% Sodium Sulfate. Two other waste types, 20% boric acid and 20% sodium sulfate were taken to the drum scale tests. The similarity in strengths for the 20% boric acid samples shows good scale-up from the lab mixes to the drum size mix. For the sodium sulfate samples the strengths of the drum samples, although lower than the lab mixes, are an order of magnitude higher than minimum recommended strength of 50 psi. And, as shown in Table 10, the sample strength can be expected to increase as additional curing occurs.

B. Homogeneity of Liner

In addition to testing samples taken from the two full scale liners prior to setting of the cement product, both liners were core drilled to demonstrate the homogeneity of the product. Two cores were taken from each liner. One core was on a horizontal plane from the outer wall to the center of the liner. The second core was vertical from the top down to the bottom of the liner. Core samples were removed in 9 to 20 inch sections and then cut into six inch segments for compression testing. While these are considered nominal three inch diameter core samples, the actual diameter of the samples was 2.75 inches.

Five samples were cut from the vertical cores and three from the horizontal cores. Each sample was capped and tested for compression strength. These results are shown in Table 22.

Table 22

Compression Strengths of Core Drilled Samples

	Compression Strength, psi	
	Bead Resin Liner	30% Mixed Solids with 20% Sodium Sulfate
Horizontal Core		
Outer Edge	1780	1720
Middle	1630	740
Center	1430	1010
Vertical Core		
Top	2120	1480
Middle Top	2220	840
Middle	1950	1350
Middle Bottom	1110	960
Bottom	2120	1650

As the data demonstrates, the variation in sample strengths is random, following the same pattern of distribution found previously. The mixed solids with sodium sulfate strengths are very similar to those reported in Table 21 for initial strengths. The bead resin strengths are, on the average, higher than the initial liner strength. While this too may also be a function of the normal distribution of strength, it may also be an indication that the solidified product continued to cure and strengthen beyond the initial seven-day period used for the initial strength testing. This theory is supported by the fact that after the seven-day curing, the internal temperature of the liner was still at 100°F having peaked at 180°F at 24 hours. The temperature of the waste prior to solidification was approximately 65°F.

Visual examinations of the liners has also confirmed complete mixing within the liners. Two removable plates along the bottom of the HN-100 UM were removed subsequent to the core drilling. Examination of the corner formed by the liner wall and the underdrain found a complete homogeneous mix of waste and cement with no unmixed solids.

These examinations and tests conclusively demonstrate that the product quality throughout the liners is completed homogeneous with no voids or other areas of unmixed wastes.

ATTACHMENT C

PLANT OPERATIONS REVIEW COMMITTEE (PORC) REVIEW OF PCP CHANGE

12.0 1

PROCEDURE REQUEST FORM FNP-0-AP-1

1. Procedure Number FNP-0-M-030 Revision Number 0
Procedure Title Process Control Program

☐ Safety Related ☒ Non-Safety Related
☒ New Procedure Request
☐ Procedure Revision, New Revision Number ____
☐ Temporary Procedure Change, Effective until next permanent change, TCN ____
☐ Temporary Procedure Change, Req'd. by Plant Conditions. TCN ____
☐ Temporary Procedure Change, One Time Use, TCN ____
☐ Delete procedure

2. Change Summary
2.1 Procedure Page Numbers Affected by Change ____

2.2 Description of Changes ____

2.3 Reason for Change ____

SUPERCEDED

3. Prepared By [signature] (Signature) Radiwaste Supv (Title) April 2 1984 (Date)

4. Reviewed By [signature] (Signature) HP Supervisor (Title) 4-2-84 (Date)

5. Cross-Disciplinary/PORC Review

Group	Signature	Title	Date
PORC	[signature]	ALM	4-2-84
____	____	____	____
____	____	____	____

6. Temporary Change Approval (Signature/Date)

☐ Member Group Staff ____ / ____
☐ Shift Foreman ____ / ____
☐ Senior Reactor Operator ____ / ____
☐ Plant Manager ____ / ____

7. Final Approval (Signature/Date, required within 60 days of temporary approval)

☐ Group Supervisor ____ ____
☑ Plant Superintendent [signature] 4-2-84
☐ MSAER ____ ____
☐ Vice President - Nuclear Generation ____ ____
☐ ____ ____ ____
☑ Plant Manager [signature] 4-2-84

Figure 1 Gen. Rev. 13

FARLEY NUCLEAR PLANT
NUCLEAR SAFETY EVALUATION CHECK LIST
10 CFR 50.59

(1) UNIT 1 & 2
(2) CHECK LIST APPLICABLE TO: ENP-0-M-030 Revision 0 TCN _____
(3) SAFETY EVALUATION - PART A

The procedure, procedure change or modification to which this evaluation is applicable represents:

(3.1) Yes _____ No ✓ A change to the plant as described in the FSAR?
(3.2) Yes _____ No ✓ A change to procedures as described in the FSAR?
(3.3) Yes _____ No ✓ A test or experiment not described in the FSAR?
(3.4) Yes _____ No ✓ A change to the Technical Specifications or Operating License?

If the answer to question 3.1, 3.2 or 3.3 is "YES," complete Item (4) and attach a 10 CFR 50.59 evaluation. If the answer to all of the above is "No," omit Item (4) and Item (9). If the answer to question 3.4 is "Yes," complete a 10 CFR 50.92 check list.

(4) SAFETY EVALUATION - PART B

(4.1) Yes _____ No _____ Will the probability of an accident previously evaluated in the FSAR be increased?
(4.2) Yes _____ No _____ Will the consequences of an accident previously evaluated in the FSAR be increased?
(4.3) Yes _____ No _____ May the possibility of an accident which is different than any already evaluated in the FSAR be created?
(4.4) Yes _____ No _____ Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.5) Yes _____ No _____ Will the consequences of a malfunction of equipment important to safety different than any already evaluated in the FSAR be increased?
(4.6) Yes _____ No _____ May the possibility of a malfunction of equipment important to safety different than any already evaluated in the FSAR be created?
(4.7) Yes _____ No _____ Will the margin of safety as defined in the basis to any Technical Specification be reduced?

If the answer to any of the above questions is "Yes," an unreviewed safety question is involved. Explain the basis for each answer provided in Section -

(5) REMARKS: (Attach additional pages if necessary) This new Process Control Program does not reduce the overall conformance of the ENP solidified waste to existing criteria for solid wastes.

(6) PREPARED BY: _____ DATE 2 Copies FAX
(7) REVIEWED BY: _____ DATE 4-2-84
(8) PORC REVIEW: _____ DATE 4-2-84
(9) NCRB REVIEW: _____ DATE _____

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R. P. McDonald
Senior Vice President
Flintridge Building

84 SEP 20 P1:01

PRP
OFFICIAL COPY

Alabama Power
the southern electric system

September 14, 1984

Docket Nos. 50-348
50-364

Mr. James P. O'Reilly
Regional Administrator
U. S. Nuclear Regulatory Commission
Suite 3100
101 Marietta Street, N.W.
Atlanta, GA 30303

RE: Joseph M. Farley Nuclear Plant
Radioactive Effluent Release Report

Dear Mr. O'Reilly:

The Joseph M. Farley Nuclear Plant Semi-Annual Radioactive Effluent Release Report for January - June 1984 is herewith submitted in accordance with the Unit 1 and Unit 2 Technical Specifications, Section 6.9.1.8. Also, this submittal documents changes to the Farley Nuclear Plant Process Control Program as required by Technical Specification Section 6.13.2.

If you have any questions, please advise.

Yours very truly,

R. P. McDonald

RPM/KWM:sam
Enclosure

xc: Director
Office of Nuclear Reactor Regulation
Director
Office of Inspection and Enforcement
Mr. L. B. Long
Mr. G. F. Trowbridge
Mr. W. H. Bradford
Mr. E. A. Reeves

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