Wolf Creek Generating Station

Docket No: 50-482
Facility Operating License No: NPF-42

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Report No: 7

Reporting Period: January 1, 1988, through June 30, 1988

Submitted by:
Wolf Creek Nuclear Operating Corporation

IE48

INTRODUCTION

This Semiannual Radioactive Effluent Release Report covers the period of January 1, 1988, through June 30, 1988, and satisfies the requirements specified in Technical Specification 6.9.1.7.

Section I provides a summary of the quantities of radioactive liquid and gaseous effluents for this reporting period. The format is similar to that provided in Regulatory Guide 1.21, Revision 1. An elevated release pathway does not exist at Wolf Creek Generating Station. Therefore, all airborne releases are considered to be ground level releases. The concurrent meteorological condition gaseous pathway dose determination is met by the Wolf Creek Offsite Dose Calculation Manual methodology of assigning all gaseous pathways to a hypothetical individual residing at the highest annual X/Q and D/Q location. This results in a conservative estimate of dose to a Member of the Public rather than determining each pathway dose for each release condition. A conservative error of thirty percent has been estimated in effluent data. Meteorological data for the period of January 1, 1988, through June 30, 1988, is available on site for review and inspection. There were four shipments of solid waste during this reporting period.

Section II provides Supplemental Information as described in Regulatory Guide 1.21, Revision 1.

Section III provides additional information required by Technical Specification 6.9.1.7.

SECTION I

Year 1988

REPORT OF RADIOACTIVE EFFLUENTS: LIQUID

	Unit	Quarter 1	Quarter 2
A. Fission and Activation Products			
1. Total Release (not including tritium, gases, alpha)	Ci	1.24E-01	6.04E-02
2. Average diluted concentration during period	uCi/ml	5.05E-08	3.23E-08
3. Percent of Applicable Limit	%	2.48E+00 (1)	1.21E+00
B. Tritium			
1. Total Release	Ci	3.80E+01	1.66E+02
2. Average diluted concentration during period	uCi/ml	1.77E-05	9.44E-05
3. Percent of Applicable Limit	%	5.90E-01 (2)	3.15E+00
C. Dissolved and Entrained Gases			
1. Total Release	Ci	2.62E-01	6.09E-01
2. Average diluted concentration during period	uCi/ml	1.51E-07	3.68E-07
3. Percent of Applicable Limit	%	7.55E-02 (3)	1.84E-01
D. Gross Alpha Radioactivity			
1. Total Release	Ci	0.00E+00	0.00E+00
E. Volume of waste released	liters	2.40E+06	1.57E+06
F. Volume of dilution water used	liters	7.61E+09	6.93E+09

1. The applicable limit for the Wolf Creek Generating Station is five (5) curies per year. The value printed here is derived by dividing the total release curies by 5 curies and then multiplying the result by 100.

2. This value is derived by the following formula:

$$\% \text{ applicable limit} = \frac{\text{(Average diluted concentration) (100)}}{\text{(MPC, Appendix B, Table II 10CFR20)}}$$

3. This value is derived by the following formula:

$$\% \text{ applicable limit} = \frac{\text{(Average diluted concentration) (100)}}{\text{(2E-4 from Technical Specification 3.11.1.1)}}$$

Year 1988

LIQUID EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 1	Continuous Mode Quarter 2	Batch Mode Quarter 1	Batch Mode Quarter 2
H-3	Ci	0.00E+00	0.00E+00	3.80E+01	1.66E+02
Cr-51	Ci	0.00E+00	0.00E+00	7.65E-03	9.93E-04
Mn-54	Ci	0.00E+00	0.00E+00	5.09E-03	3.87E-03
Fe-55	Ci	0.00E+00	0.00E+00	4.44E-03	1.42E-02
Fe-59	Ci	0.00E+00	0.00E+00	3.98E-03	3.02E-04
Co-58	Ci	0.00E+00	0.00E+00	5.14E-02	1.22E-02
Co-60	Ci	0.00E+00	0.00E+00	2.82E-02	1.98E-02
Zn-65	Ci	0.00E+00	0.00E+00	3.47E-04	0.00E+00
Rb-88	Ci	0.00E+00	0.00E+00	9.13E-04	0.00E+00
Sr-89	Ci	0.00E+00	0.00E+00	6.19E-04	1.98E-03
Sr-92	Ci	0.00E+00	0.00E+00	1.25E-04	3.15E-05
Zr-95	Ci	0.00E+00	0.00E+00	1.08E-03	7.22E-04
Nb-95	Ci	0.00E+00	0.00E+00	3.05E-03	1.80E-03
Mo-99	Ci	0.00E+00	0.00E+00	1.97E-03	3.82E-05
Tc-99M	Ci	0.00E+00	0.00E+00	0.00E+00	1.42E-06
Ag-110M	Ci	0.00E+00	0.00E+00	2.76E-03	5.13E-04
I-131	Ci	0.00E+00	0.00E+00	2.09E-04	2.89E-04
I-134	Ci	0.00E+00	0.00E+00	0.00E+00	3.67E-06
Cs-134	Ci	0.00E+00	0.00E+00	1.06E-04	2.53E-04

Year 1988

LIQUID EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 1	Continuous Mode Quarter 2	Batch Mode Quarter 1	Batch Mode Quarter 2
Cs-137	Ci	0.00E+00	0.00E+00	1.11E-04	7.49E-04
Cs-138	Ci	0.00E+00	0.00E+00	3.25E-04	0.00E+00
La-140	Ci	0.00E+00	0.00E+00	0.00E+00	1.59E-05
Ce-141	Ci	0.00E+00	0.00E+00	1.02E-04	<7.85E-04
Ce-144	Ci	0.00E+00	0.00E+00	1.36E-03	1.03E-04
Kr-85M	Ci	0.00E+00	0.00E+00	2.28E-04	0.00E+00
Kr-85	Ci	0.00E+00	0.00E+00	1.06E-01	0.00E-00
Kr-88	Ci	0.00E+00	0.00E+00	5.47E-05	0.00E+00
Xe-131M	Ci	0.00E+00	0.00E+00	4.45E-03	1.01E-02
Xe-133M	Ci	0.00E+00	0.00E+00	1.22E-03	4.00E-03
Xe-133	Ci	0.00E+00	0.00E+00	1.42E-01	5.94E-01
Xe-135M	Ci	0.00E+00	0.00E+00	1.62E-03	0.00E+00
Xe-135	Ci	0.00E+00	0.00E+00	6.51E-03	4.28E-04
Ar-41	Ci	0.00E+00	0.00E+00	1.40E-04	0.00E+00
Sr-90	Ci	0.00E+00	0.00E+00	7.28E-06	2.32E-05
Co-57	Ci	0.00E+00	0.00E+00	3.27E-04	1.50E-04
Hf-181	Ci	0.00E+00	0.00E+00	1.39E-04	9.46E-05
Sn-117M	Ci	0.00E+00	0.00E+00	5.38E-06	0.00E+00
Sn-113	Ci	0.00E+00	0.00E+00	1.33E-03	2.41E-04

Year 1988

LIQUID EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 1	Continuous Mode Quarter 2	Batch Mode Quarter 1	Batch Mode Quarter 2
Sb-124	Ci	0.00E+00	0.00E+00	7.91E-04	1.57E-04
Sb-125	Ci	0.00E+00	0.00E+00	6.06E-03	1.53E-03
Nb-97	Ci	0.00E+00	0.00E+00	1.19E-03	2.73E-04
Gross Alpha	Ci	0.00E+00	0.00E+00	<2.40E-04	<1.57E-04

Note: Less than values are calculated using the lower limit of detection (LLD) values obtained at the Wolf Creek Generating Station multiplied by the volume of waste discharged during the respective quarter.

Year 1988

LIQUID CUMULATIVE DOSE SUMMARY
TABLE 1

	ODCM CALCULATED DOSE	TECHNICAL[1] SPECIFICATION LIMIT	% OF LIMIT
UNIT 1, QUARTER 1 OF 1988			
TOTAL DOSE (MREM) FOR BONE	1.65E-03	5.00E+00	3.30E-02
TOTAL DOSE (MREM) FOR LIVER	6.95E-03	5.00E+00	1.39E-01
TOTAL DOSE (MREM) FOR TOTAL BODY	6.31E-03	1.50E+00	4.21E-01
TOTAL DOSE (MREM) FOR THYROID	4.79E-03	5.00E+00	9.58E-02
TOTAL DOSE (MREM) FOR KIDNEY	5.09E-03	5.00E+00	1.02E-01
TOTAL DOSE (MREM) FOR LUNG	4.45E-03	5.00E+00	8.90E-02
TOTAL DOSE (MREM) FOR GI-LLI	6.81E-02	5.00E+00	1.36E+00
UNIT 1, QUARTER 2 OF 1988			
TOTAL DOSE (MREM) FOR BONE	5.31E-03	5.00E+00	1.06E-01
TOTAL DOSE (MREM) FOR LIVER	2.06E-02	5.00E+00	4.12E-01
TOTAL DOSE (MREM) FOR TOTAL BODY	1.88E-02	1.50E+00	1.25E+00
TOTAL DOSE (MREM) FOR THYROID	1.46E-02	5.00E+00	2.92E-01
TOTAL DOSE (MREM) FOR KIDNEY	1.61E-02	5.00E+00	3.22E-01
TOTAL DOSE (MREM) FOR LUNG	1.47E-02	5.00E+00	2.94E-01
TOTAL DOSE (MREM) FOR GI-LLI	4.24E-02	5.00E+00	8.48E-01
UNIT 1, TOTALS FOR 1988			
TOTAL DOSE (MREM) FOR BONE	6.96E-03	1.00E+01	6.96E-02
TOTAL DOSE (MREM) FOR LIVER	2.76E-02	1.00E+01	2.76E-01
TOTAL DOSE (MREM) FOR TOTAL BODY	2.51E-02	3.00E+00	8.37E-01
TOTAL DOSE (MREM) FOR THYROID	1.94E-02	1.00E+01	1.94E-01
TOTAL DOSE (MREM) FOR KIDNEY	2.12E-02	1.00E+01	2.12E-01
TOTAL DOSE (MREM) FOR LUNG	1.92E-02	1.00E+01	1.92E-01
TOTAL DOSE (MREM) FOR GI-LLI	1.11E-01	1.00E+01	1.11E+00

1 Based on Technical Specification 3.11.1.2 which restricts dose to the whole body to less than or equal to 1.5 mrem per quarter and 3.0 mrem per year. Dose restriction to any organ is less than or equal to 5 mrem per quarter and 10 mrem per year.

Year 1988

LIQUID CUMULATIVE DOSE SUMMARY
TABLE 2

A. Fission & Activation Products	Quarter 1	Quarter 2	Total
1. Total Release - (not including H-3, gases, alpha) Ci	1.24E-01	6.04E-02	1.84E-01
2. Maximum Organ Dose (mrem)	6.38E-02	2.83E-02	9.21E-02
3. Organ Dose Limit (mrem)	5.00E+00	5.00E+00	1.00E+01
4. % of Limit	1.28E+00	5.66E-01	9.21E-01
B. Tritium			
1. Total Release Ci	3.80E+01	1.66E+02	2.04E+02
2. Maximum Organ Dose (mrem)	4.26E-03	1.41E-02	1.84E-02
3. Organ Dose Limit (mrem)	5.00E+00	5.00E+00	1.00E+01
4. % of Limit	8.52E-02	2.82E-01	1.84E-01

This table is included to show the correlation between curies released and the associated calculated maximum organ dose. Wolf Creek ODCM methodology is used to calculate the maximum organ dose which assumes that an individual drinks the water and eats fish from the discharge point. Technical Specification 3.11.1.2 organ dose limits are used.

Year 1988

REPORT OF RADIOACTIVE EFFLUENTS: AIRBORNE

	Unit	Quarter 1	Quarter 2
A. Fission & Activation Gases			
1. Total Release	Ci	4.44E+02	1.06E+02
2. Average release rate for period	uCi/sec	2.29E+02	1.08E+02
3. Percent of Technical Specification Limits	%	2.26E-01	1.23E-01
B. Iodines			
1. Total Iodine-131	Ci	4.04E-06	0.00E+00
2. Average release rate for period	uCi/sec	5.14E-07	0.00E+00
3. Percent of Technical Specification Limits	%	4.04E-04	0.00E+00
C. Particulates			
1. Particulates with half-lives > 8 days	Ci	3.18E-06	0.00E+00
2. Average release rate for period	uCi/sec	4.04E-07	0.00E+00
3. Percent of Technical Specification Limits	%	2.24E-05	0.00E+00
4. Gross Alpha radioactivity	Ci	0.00E+00	8.05E-08
D. Tritium			
1. Total Release	Ci	1.51E+01	9.62E+01
2. Average release rate for period	uCi/sec	1.97E+00	1.33E+01
3. Percent of Technical Specification Limits	%	1.44E-01	9.15E-01

The percent of Technical Specification Limits for fission and activation gases is calculated using the following methodology:

$$\text{\% of Technical Specification Limit} = \frac{\text{(Quarterly Total Gamma Airdose)(100)}}{\text{5 mrad}}$$

The percent of Technical Specification Limits for Iodine is calculated using the following methodology:

$$\text{\% of Technical Specification Limit} = \frac{\text{(Total Curies of Iodine-131)(100)}}{\text{1 curie}}$$

The percent of Technical Specification Limits for particulates is calculated using the following methodology:

$$\% \text{ of Technical Specification Limit} = \frac{(\text{Highest Organ Dose due to Particulates})(100)}{7.5 \text{ mrem}}$$

The percent of Technical Specification Limits for tritium is calculated using the following methodology:

$$\% \text{ of Technical Specification Limit} = \frac{(\text{Highest Organ Dose due to H-3})(100)}{7.5 \text{ mrem}}$$

This type of methodology is used since the Wolf Creek Technical Specifications tie releases to doses rather than Curie release rates.

Year 1988

GASEOUS EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 1	Continuous Mode Quarter 2	Batch Mode Quarter 1	Batch Mode Quarter 2
1. Fission and Activation Gases					
Ar-41	Ci	Ø.ØØE+ØØ	4.33E-Ø1	5.76E-Ø2	3.51E-Ø1
Kr-85	Ci	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ	1.57E-Ø1
Kr-85M	Ci	Ø.ØØE+ØØ	7.56E-Ø1	Ø.ØØE+ØØ	9.3ØE-Ø3
Kr-87	Ci	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ
Kr-88	Ci	Ø.ØØE+ØØ	1.Ø9E+ØØ	Ø.ØØE+ØØ	8.28E-Ø3
Xe-131M	Ci	Ø.ØØE+ØØ	Ø.ØØE+ØØ	3.71E+ØØ	2.39E-Ø1
Xe-133	Ci	7.8ØE+Ø1	7.79E+Ø1	3.51E+Ø2	1.63E+Ø1
Xe-133M	Ci	2.ØØE+ØØ	Ø.ØØE+ØØ	5.52E+ØØ	1.24E-Ø1
Xe-135	Ci	1.39E-Ø1	8.62E+ØØ	3.31E+ØØ	8.8ØE-Ø2
Xe-135M	Ci	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ
Xe-138	Ci	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ
Total	Ci	8.Ø2E+Ø1	8.88E+Ø1	3.64E+Ø2	1.73E+Ø1
2. Halogens (Gaseous)					
I-131	Ci	4.Ø4E-Ø6	<2.59E-Ø4	<1.12E-Ø5	<2.68E-Ø7
I-133	Ci	<2.46E-Ø[illegible]	<2.59E-Ø2	<1.12E-Ø3	<2.68E-Ø5
I-135	Ci	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ
Br-82	Ci	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ
Total	Ci	4.Ø4E-Ø6	Ø.ØØE+ØØ	Ø.ØØE+ØØ	Ø.ØØE+ØØ

Note: Less than values are calculated using the lower limit of detection (LLD) values obtained at Wolf Creek Generating Station multiplied by the volume of air discharged during the respective quarter.

Year 1988

GASEOUS EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 1	Continuous Mode Quarter 2	Batch Mode Quarter 1	Batch Mode Quarter 2
3. Particulates					
Co-58	Ci	3.1ΩE-Ø6	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
H-3	Ci	1.5ØE+Ø1	9.6ØE+Ø1	1.1ØE-Ø1	2.Ø4E-Ø1
Co-6Ø	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Mn-54	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Fe-59	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Zn-65	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Mo-99	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Cs-134	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Cs-137	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Ce-141	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Ce-144	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Sr-89	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Sr-9Ø	Ci	<2.46E-Ø3	<2.59E-Ø3	<1.12E-Ø4	<2.68E-Ø6
Gross Alpha	Ci	<2.46E-Ø3	8.Ø5E-Ø8	<1.12E-Ø4	<2.68E-Ø6

Note: Less than values are calculated using the lower limit of detection (LLD) values obtained at Wolf Creek Generating Station multiplied by the volume of air discharged during the respective quarter.

Note: On two occasions small quantities of gross alpha were indicated on the unit vent particulate filters. It is beleived that paint fumes contributed to these positive indications.

Year 1988

GASEOUS CUMULATIVE DOSE SUMMARY
Table 1

		TECHNICAL SPECIFICATION LIMIT[1]	% OF LIMIT
QUARTER 1 OF 1988			
DOSE FROM RADIOIODINES, PARTICULATES, AND TRITIUM AT CONTROLLING LOCATION:			
TOTAL DOSE (MREM) FOR BONE	7.69E-06	7.50E+00	1.03E-04
TOTAL DOSE (MREM) FOR LIVER	1.08E-02	7.50E+00	1.44E-01
TOTAL DOSE (MREM) FOR TOTAL BODY	1.08E-02	7.50E+00	1.44E-01
TOTAL DOSE (MREM) FOR THYROID	1.31E-02	7.50E+00	1.75E-01
TOTAL DOSE (MREM) FOR KIDNEY	1.08E-02	7.50E+00	1.44E-01
TOTAL DOSE (MREM) FOR LUNG	1.08E-02	7.50E+00	1.44E-01
TOTAL DOSE (MREM) FOR GI-LLI	1.08E-02	7.50E+00	1.44E-01
QUARTER 2 OF 1988			
DOSE FROM RADIOIODINES, PARTICULATES, AND TRITIUM AT CONTROLLING LOCATION:			
TOTAL DOSE (MREM) FOR BONE	0.00E+00	7.50E+00	0.00E+00
TOTAL DOSE (MREM) FOR LIVER	6.86E-02	7.50E+00	9.15E-01
TOTAL DOSE (MREM) FOR TOTAL BODY	6.86E-02	7.50E+00	9.15E-01
TOTAL DOSE (MREM) FOR THYROID	6.86E-02	7.50E+00	9.15E-01
TOTAL DOSE (MREM) FOR KIDNEY	6.86E-02	7.50E+00	9.15E-01
TOTAL DOSE (MREM) FOR LUNG	6.86E-02	7.50E+00	9.15E-01
TOTAL DOSE (MREM) FOR GI-LLI	6.86E-02	7.50E+00	9.15E-01
TOTALS FOR 1988			
DOSE FROM RADIOIODINES, PARTICULATES, AND TRITIUM AT CONTROLLING LOCATION:			
TOTAL DOSE (MREM) FOR BONE	7.69E-06	1.50E+01	5.13E-05
TOTAL DOSE (MREM) FOR LIVER	7.94E-02	1.50E+01	5.29E-01
TOTAL DOSE (MREM) FOR TOTAL BODY	7.94E-02	1.50E+01	5.29E-01
TOTAL DOSE (MREM) FOR THYROID	8.17E-02	1.50E+01	5.45E-01
TOTAL DOSE (MREM) FOR KIDNEY	7.94E-02	1.50E+01	5.29E-01
TOTAL DOSE (MREM) FOR LUNG	7.94E-02	1.50E+01	5.29E-01
TOTAL DOSE (MREM) FOR GI-LLI	7.94E-02	1.50E+01	5.29E-01

1. Based on Wolf Creek Technical Specification 3.11.2.3 which restricts dose during any calender quarter to less than or equal to 7.5 mrem to any organ and during any calender year to less than or equal to 15 mrem to any organ.

Year 1988

GASEOUS CUMULATIVE DOSE SUMMARY
TABLE 2

A. Fission & Activation Gases	Quarter 1	Quarter 2	Total
1. Total Release (Ci)	4.44E+02	1.06E+02	5.50E+02
2. Total Gamma Airdose (mrad)	1.13E-02	6.16E-03	1.75E-02
3. Gamma Airdose Limit (mrad)	5.00E+00	5.00E+00	1.00E+01
4. % of Limit	2.26E-01	1.23E-01	1.75E-01
B. Particulates			
1. Total Particulates (Ci)	3.18E-06	0.00E+00	3.18E-06
2. Maximum Organ Dose (mrem)	1.68E-06	0.00E-00	1.68E-06
3. Organ Dose Limit (mrem)	7.50E+00	7.50E+00	1.50E+01
4. % of Limit	2.24E-05	0.00E+00	1.12E-05
C. Tritium			
1. Total Release (Ci)	1.51E+01	9.62E+01	1.11E+02
2. Maximum Organ Dose (mrem)	1.08E-02	6.86E-02	7.94E-02
3. Organ Dose Limit (mrem)	7.50E+00	7.50E+00	1.50E+01
4. % of Limit	1.44E-01	9.15E-01	5.29E-01
D. Iodine			
1. Total I-131 (Ci)	4.04E-06	0.00E+00	4.04E-06
2. Maximum Organ Dose (mrem)	2.31E-03	0.00E+00	2.31E-03
3. Organ Dose Limit (mrem)	7.50E+00	7.50E+00	1.50E+01
4. % of Limit[1]	3.08E-02	0.00E+00	1.54E-02

1 These values differ from the "Report of Radioactive Effluents: Airborne" table since this value is based on dose and not one (1) curie.

This table is included to show the correlation between curies released and the associated calculated maximum organ dose. The maximum organ dose is calculated using Wolf Creek ODCM methodology which assumes that an individual actually resides at the release point. Technical Specification 3.11.2.3 organ dose limits are used.

SECTION II
Supplemental Information

Facility: Wolf Creek Generating Station License Number: NPF-42

1. Regulatory Limits

A. For liquid waste effluents

A.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microCurie/ml total activity.

A.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to UNRESTRICTED AREAS shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrems to the whole body and to less than or equal to 5 mrems to any organ, and
b. During any calendar year to less than or equal to 3 mrems to the whole body and to less than or equal to 10 mrems to any organ.

B. For gaseous waste effluents

B.1 The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY shall be limited to the following:

a. For noble gases: Less than or equal to 500 mrems/yr to the whole body and less than or equal to 3000 mrems/yr to the skin, and
b. For Iodine-131 and 133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrems/yr to any organ.

B.2 The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and
b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation.

B.3 The dose from Iodine-131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each unit, to areas at and beyond the SITE BOUNDARY shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrems to any organ, and
b. During any calendar year: Less than or equal to 15 mrems to any organ.

2. Maximum Permissible Concentrations

   Water - covered in section 1.A.

   Air - covered in section 1.B.

3. Average energy of fission and activation gaseous effluents is not applicable.

4. Measurements and Approximations of Total Radioactivity

   A. Liquid Effluents

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	METHOD OF ANALYSIS	TYPE OF ACTIVITY ANALYSIS
1. Batch Waste Release Tanks	P Each Batch	P.H.A.	Principal Gamma Emmiters
		P.H.A.	I-131
a. Waste Monitor Tank	P One Batch/M	P.H.A.	Dissolved and Entrained Gases (Gamma Emitters)
b. Secondary Liquid Waste Monitor Tank	P Each Batch	L.S.	H-3
		G.F.P.	Gross Alpha
	P Each Batch	O.S.L.	Sr-89, Sr-90
		O.S.L.	Fe-55

P = prior to each batch

M = monthly

P.H.A. = gamma spectrum pulse height analysis using a High Purity Germanium detector.

L.S. = liquid scintillation

G.F.P. = Gas Flow Proportional counting

O.S.L. = performed by an Offsite Laboratory

There were no continuous radioactive waste effluents for this reporting period.

B. Gaseous Waste Effluents

GASEOUS, RELEASE TYPE	SAMPLING FREQUENCY	METHOD OF ANALYSIS	TYPE OF ACTIVITY ANALYSIS
Waste Gas Decay Tank	P Each Tank Grab Sample	P.H.A.	Principal Gamma Emitters
Containment Purge or Vent	P Each Purge Grab Sample	P.H.A.	Principal Gamma Emitters
		Gas Bubbler and L.S.	H-3 (oxide)
Unit Vent	M Grab Sample	P.H.A.	Principal Gamma Emitters
		Gas Bubbler and L.S.	H-3 (oxide)
Radwaste Building Vent	M Grab Sample	P.H.A.	Principal Gamma Emitters
All Release Types as listed above	Continuous	P.H.A.	I-131
			I-133
	Continuous	P.H.A. Particulate Sample	Principal Gamma Emitters
	Continuous Composite	G.F.P. Particulate Sample	Gross Alpha
	Continuous	O.S.L. Composite Particulate Sample	Sr-89, Sr-90

C. A conservative error of ±30% has been estimated. This includes volumetric measurement device, flow measurement device and analytical errors.

5. Batch Releases

There were thirty (30) gaseous batch releases during the report period. The longest gaseous batch release took 168 hours, the shortest occurred over a fourty-eight (48) minute interval. The average release took 18.2 hours with a total gaseous batch release time of 547 hours.

There were 119 liquid batch releases during the report period. The longest liquid batch release took 221 minutes while the shortest took only 38 minutes. The average release time for the liquid batch releases was 81.2 minutes. Total release time for all 119 liquid batch releases was 161 hours.

6. Abnormal Releases

   a. There were no abnormal liquid or gaseous releases for this report period.

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1988)
SOLID WASTE SHIPMENTS

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

1. Type of waste	Unit	6-month Period	Est. Total Error %
a. Spent resins, filter sludges,	m3*	10.23E+00	
evaporator bottoms, etc.	Ci	1.27E+03	2.50E+01
b. Dry compressible waste,	m3*	1.76E+01	
contaminated equip. etc.	Ci	1.80E-01	2.50E+01
c. Irradiated components,	m3*	0.00E+00	
control rods, etc.	Ci	0.00E+00	0.00E+00
d. Other (describe)	m3*	0.00E+00	
	Ci	0.00E+00	0.00E+00

m3* = cubic meters

2. Estimate of major nuclide composition (by type of waste)

a.	Co-58	%	4.44E+01
	Fe-55	%	2.64E+01
	Co-60	%	1.68E+01
	Mn-54	%	4.87E+00
	Cr-51	%	2.65E+00
	Fe-59	%	1.04E+00
	Nb-95	%	9.87E-01
	Zr-95	%	7.36E-01
	Ni-63	%	4.66E-01
	Ce-144	%	3.67E-01
	Co-57	%	3.57E-01
	I-131	%	3.20E-01
	H-3	%	2.03E-01
	Cs-137	%	1.41E-01
	Sr-89	%	1.01E-01
	Hf-181	%	8.60E-02
	Sn-113	%	5.60E-02
	C-14	%	2.80E-02
	Sr-90	%	1.69E-04
b.	Fe-55	%	3.34E+01
	Co-58	%	3.23E+01
	Co-60	%	2.15E+01
	Mn-54	%	4.77E+00
	Co-57	%	3.15E+00
	Fe-59	%	2.51E+00
	Cr-51	%	2.25E+00
	C-14	%	7.50E-02

c. None

d. None

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
3	Truck	Barnwell, South Carolina
1	Truck	Beatty, Nevada

4. Class of Solid Waste
   a. Class A
   b. Class A
   c. Not applicable
   d. Not applicable

5. Type of Container
   a. LSA (Strong, tight)
   b. LSA (Strong, tight)
   c. Not applicable
   d. Not applicable

6. Solidification Agent
   a. Not applicable
   b. Not applicable
   c. Not applicable
   d. Not applicable

B. IRRADIATED FUEL SHIPMENTS (Disposition)

There were no irradiated fuel shipments during this reporting period.

SECTION III

Additional Information

1. Unplanned Releases

   There were no unplanned releases during this report period.

2. Process Control Program

   Revision four (4) to the Wolf Creek Process Control Program (PCP) was issued on August 27, 1986. This was a general revision and was included in the Semiannual Radiological Effluent Release Report Number 4, covering the period from July 1, 1986 through December 31, 1986. There have been two temporary changes to the PCP since Revision 4 was issued. The first change was dated December 5, 1986, and was inadvertently omitted from the Semiannual Radiological Effluent Release Report Number 4, and is therefore being reported herein. The second change to the PCP discussed in this report is dated March 10, 1988. A complete copy of the PCP Revision 4 is included with this report as Attachment 1.

   The first change to the PCP, dated December 5, 1986, changed section 4.1.2 in its entirety to read "Chem-Nuclear Systems, INC. performance of resin dewatering will be performed in accordance with an NRC approved Topical Report. NUS performance of solidification and filter encapsulation will be performed in accordance with an NRC approved Process Control Program." This change was implemented to provide a more accurate representation of vendor programs used. The overall conformance of the solidified waste product to existing criteria is not reduced by this PCP change. The change only names the specific vendor and which function the vendor performs.

   The second change to the PCP, dated March 10, 1988, added section 4.2 as follows:

   4.2 WCGS Processing

   4.2.1 WCGS waste shall be processed for shipment in accordance with NRC, DOT, and state burial requirements.

   4.2.2 When solidification, resin dewatering or filter encapsulation is done by WCGS, it shall be done in accordance with the latest revision of an NRC approved vendor process control program or topical report where applicable.

   This change was implemented to include provisions for WCGS personnel to use vendor approved processes. The change did not reduce the overall conformance of the solidified product as the same equipment was used that a vendor would use. The same acceptance criteria was adhered to for a finished product.

3. Offsite Dose Calculation Manual (ODCM)

There were no changes to the ODCM during this report period.

4. Major Changes to Liquid, Gaseous or Solid Radwaste Systems

A permanent change to the Liquid Radwaste System which altered the capacity of handling Radioactive wastes was reviewed and found acceptable by the Plant Safety Review Committee on November 4, 1986. Because this change was not reported previously, it is being reported herein.

Plant Modification Request (PMR) Ø1594 installs an additional cross-tie between the Boron Recycle System (HE) and the Liquid Radwaste System (HB). Relevant drawings from PMR Ø1594 are included with this report as Attachment 2.

a. This modification does not involve any safety-related systems and has no impact on any safety aspects of the plant. Therefore, it does not involve an unreviewed safety question.

b. This modification allows the floor drain tanks and the waste holdup tank to be processed through the Secondary Waste System (HF) evaporator while the Liquid Radwaste System is processing waste from the Boron Recycle System. The increased flexibility from this modification optimizes the liquid Radioactive waste processing.

   The radwaste crystallizer (rated at 3Ø gpm) is essentially a specially designed forced circulation evaporator consisting of a vapor body, recirculation pipe, large recirculation pump, and two pass vertical heater. For WCGS, three inorganic salts can be crystallized. These are sodium sulfate (Na_2SO_4), ammonium sulfate ($(NH_4)_2SO_4$) and boric acid (H_3BO_3). The design concept includes concentrating of either a multi-component mixture of Na_2SO_4, $(NH_4)_2SO_4$, H_3BO_3 or any one of these salts combined with floor drain waste to 5Ø% by weight total solids.

Another plant has made this change, and is currently concentrating with the HF evaporator up to 25 gpm without boric acid (40-45% total solids), which is more than double the output from the HB evaporator at WCGS. This change would therefore allow WCGS to maximize (by doubling) the amount of concentrated waste loaded into a 55 gallon drum and at the same time allows WCNOC to optimize the successful boric acid solidification.

This change allows the floor drain tanks and the waste holdup tank liquid radwaste feed to be processed through a more suitable Inconel 625 tubing material (which is a superior material in terms of resistance to pitting and stress corrosion cracking in environments where a high chloride concentration and low pH exists for extended periods of time) as compared to Incoloy 825 that is used in the evaporator packages.

By allowing the HF evaporator to process what is normally HB feed, the HB evaporator package could then be used interchangeably with the HE evaporator to concentrate reusable boric aci . This would provide radwaste operators a greater degree of flexibility within the Boron Recycle System by having an operable alternate package for the HE (15gpm) evaporator.

c. The additional cross-tie is a two inch pipe and valve that connects the supply side of Boron Recycle System valve V-158 and the Liquid Radwaste System, downstream of valve V-053. (See Attachment 2).

Because the original design allowed the secondary waste evaporator to be used to process the water from the floor drain tanks:

d. The modification does not change the predicted releases of Radioactive materials.

e. The modif.cation does not change the expected maximum exposures.

f. The modification does not change the predicted release of Radioactive materials.

g. The modification does not change the exposure to plant operating personnel.

5. Land Use Census

There were no new locations for dose calculations identified during this report period.

6. Radioactive Shipments

There were four shipments of Radioactive radwaste during this report period. Three shipments were to Barnwell, South Carolina, and one shipment was to Beatty, Nevada.

7. Inoperability of Airborne Effluent Monitoring Instrumentation

On July 1, 1988, the Unit Vent System Noble Gas Radiation Monitor, GT RE-21B, had been out of service for thirty days. Therefore, the following information is included in the Semiannual Radioactive Effluent Release Report in accordance with Technical Specification (T/S) 3.3.3.11.

On June 1, 1988, at approximately 0840 CDT, GT RE-21B was removed from service for scheduled maintenance activities. The licensed operations personnel entered T/S 3.3.3.11, Action Statement b, and initiated 12-hour grab samples as required for GT RE-21B. On June 2, 1988, the scheduled maintenance activities were completed, but because GT RE-21B failed its retest, the monitor was not returned to service.

As a result of the retest failure, troubleshooting activities were conducted on June 3, 1988. Diagnostics on GT RE-21B indicated a programmable read-only memory (PROM) chip failure. A spare set of PROM chips were installed but indicated a different PROM chip failure. Additional troubleshooting was then conducted to verify that the failure was in the PROM chips. Because additional spare sets of PROM chips were not available on site, a purchase order was initiated on June 9, 1988, to obtain the PROM chips from the vendor. The vendor was contacted to expedite the shipment of the replacement chips needed to restore GT RE-21B to operable status. Following receipt of the PROM chips, maintenance and testing were completed and GT RE-21B was returned to service on July 8, 1988.

ATTACHMENT 1

PROCESS CONTROL PROGRAM

FIGURE 9 - TEMPORARY PROCEDURE CHANGE FORM

Tracking No. MA

☑ MAJOR ☐ MAJOR SPECIAL SCOPE

PROCEDURE NUMBER AND CURRENT REVISION: WCHP-02 Rev 4
PROCEDURE TITLE: Process Control Program

REASON FOR CHANGE: Include provision for WCGS Processing

CHANGE: Add step 4c as per attached

Valid Until Next permanent revision

SAFETY EVALUATION SCREENING

Does this procedure change or revision involve

1) Yes____ No ✓ A change to the facility or procedures from their description in the USAR?

(2) Yes____ No ✓ A change to a test or experiment not described in the USAR?

(3) Yes____ No ✓ A change that affects Nuclear Safety in a way not previously evaluated in the USAR?

(4) Yes____ No ✓ A change to the Technical Specifications or a reduction of the margin of safety as defined in the Technical Specification?

(5) Yes____ No ✓ An Environmental Question?

(6) Yes____ No ✓ A Technical Specification Surveillance Requirement?

(7) Yes____ No ✓ A previously made committment?

If the answer to any one of questions (1) - (5) is yes, this Change Form shall be routed to the Supervisor Results Engineering for a safety/environmental evaluation per ADM 01-022. If the answer to question (6) is yes, this Change Form shall be routed to the Surveillance Coordinator for evaluation. If the answer to question (7) is yes, this Change shall be routed to the Superintendent of Regulatory, Quality and Administrative Services for evalution. If the answers to above questions are no, the normal approval process may proceed.

Prepared By [signature] Date 3/10/88

Approval [signature] Date 3/10/88
Cognizant Group Supervisor

Call Superintendent [signature] Date 3-10-88

PSRC Approval Recommendation [signature] Date 3-10-88

Plant Manager [signature]

OC30 3 14 88

4.2 WCGS Processing

4.2.1 WCGS waste shall be processed for shipment in accordance with NRC, DOT, and state burial requirements.

4.2.2 When solidification, resin dewatering or filter encapsulation is done by WCGS it shall be done in accordance with the latest revision of an NRC approved vendor process control program or topical report where applicable.

FIGURE 5

WOLF CREEK NUCLEAR OPERATING CORPORATION

PSRC SERIAL REVIEW SHEET

Document Number/Revision (if applicable) WCHP-02 R4

Document Title Process Control Program

Procedure Classification (if applicable):

Major/Maj. Spec. Scope	Minor/Minor Spec. Scope	NNSR
☒	☐	☐

Superintendent of Operations ________________ Date ________

Superintendent of Technical Support ________________ Date ________

Chemist ________________ Date ________

Health Physicist ________________ Date ________

I&C Supervisor ________________ Date ________

Reactor Engineering Supervisor [signature] Date 3/10/88

Superintendent of Maintenance [signature] Date 3-10-88

Superintendent of Plant Support [signature] Date 3-10-88

Results Engineering Supervisor [signature] for Verl MacTaggart Date 3-10-88

Superintendent of Regulatory, Quality and Administrative Services N/A Date ________

Quality Engineering ________________ Date ________
(As required per 6.7.1)

Approved: [signature] Date 3-10-88
PSRC Chairman

PCPCN 4-1

FIGURE 10

Tracking No. MA N/A

TEMPORARY PROCEDURE CHANGE FORM

[X] MAJOR

[ ] MAJOR SPECIAL SCOPE

PROCEDURE NUMBER AND CURRENT REVISION: WCHP-02 Rev. 4
PROCEDURE TITLE: Process Control Program

10 CFR 50.59 NUCLEAR SAFETY EVALUATION (Refer to ADM 01-022 for specific guidelines)

The procedure revision or change to which this evaluation is applicable represents:

1) Yes____ No XX A change to the facility or procedures from their description in the FSAR?
(2) Yes____ No XX A change to a test or experiment not described in the FSAR?
(3) Yes____ No XX A change that affects Nuclear Safety in a way not previously evaluated in the FSAR?
(4) Yes____ No XX A change to the Technical Specifications or a reduction of the margin of safety as defined in the Technical Specifications.
(5) Yes____ No XX Does an Environmental Question exist?

If the answer to any of the above questions is "Yes", this Change Form shall be forwarded to the Results Engineering Supervisor or Supervisor Environmental Management for completion of a safety/environmental evaluation per ADM 01-022. If the answers to all of the above are no, no unreviewed safety/environmental question exists.

REASON FOR CHANGE: More accurate representation of vendor programs used.

CHANGE: Change section 4.1.2 in its entirity to read "Chem-Nuclear Systems, Inc. performance of resin dewatering will be performed in accordance with an NRC approved Topical Report. NUS performance of solidification and filter encapsulation will be performed in accordance with an NRC approved Process Control Program.

Valid Until Revision 5 is issued.

Prepared By Wayne C. Gand Date 12-4-86

Approval [signature] Date 12-4-86
Cognizant Group Supervisor

Call Superintendent [signature] Date 12/4/86

PSRC Approval Recommendation [signature] Date 12-5-86

Plant Manager [signature]

FIGURE 6

WOLF CREEK GENERATING STATION

PSRC SERIAL REVIEW SHEET

Document Number/Revision (if applicable) WCHP-02 / 4
Document Title Process Control Program

Procedure Classification (if applicable):

Major/Maj. Spec. Scope	Minor/Minor Spec. Scope	NNSR
☒	☐	☐

Superintendent of Operations [signature] Date 12/5/86

Superintendent of Technical Support ____________ Date ________

Chemist [signature] Date 12-5-86

Health Physicist [signature] Date 12-5-86

I&C Supervisor ____________ Date ________

Reactor Engineering Supervisor [signature] Date 12/5/86

Superintendent of Maintenance ____________ Date ________

Superintendent of Plant Support ____________ Date ________

Results Engineering Supervisor ____________ Date ________

Superintendent of Regulatory, Quality and Administrative Services ____________ Date ________

Quality Assurance ____________ Date ________
(As required per 6.7.1)

Approved: [signature] Date 12-5-86
PSRC Chairman

(ADM 07-407 rev. a)

PROCESS CONTROL PROGRAM

REV.	REVISION RECORD	BY	DATE
3	RELEASED FOR USE	B.J.	7-19-85
4	GENERAL REVISION	[illegible]	8-27-86

KANSAS GAS & ELECTRIC COMPANY
WOLF CREEK GENERATING STATION

KGE THE ELECTRIC COMPANY

DOCUMENT NUMBER	REV.
WCHP-02	4

WOLF CREEK GENERATING STATION

PROCESS CONTROL PROGRAM

Revision 4

Classification: Major

PREPARED BY	20 AUG 86 DATE
INDEPENDENT REVIEW	8/21/86 DATE
COGNIZANT GROUP SUPERVISOR	8/21/86 DATE
RESPONSIBLE SUPERINTENDENT APPROVAL	8-22-86 DATE
PSRC APPROVAL RECOMMENDATION	8-26-86 DATE
PLANT MANAGER APPROVAL	8-27-86 DATE
QUALITY ASSURANCE	DATE

TABLE OF CONTENTS

1.0 SCOPE

1.1 PURPOSE

The purpose of this process control program is to provide reasonable assurance that the final processed products produced at Wolf Creek Generating Station (WCGS) meet or exceed all federal, state and burial site requirements pertaining to the solidification, transportation and disposal of low-level radioactive waste (LLW).

1.2 APPLICABILITY

This process control program is applicable to all solidification evolutions involving the installed cement solidification system at WCGS.

This process control program acknowledges the potential use of mobile vendor processing including solidification, resin dewatering and filter encapsulation.

This process control program also applies to filter disposal in high integrity containers (HIC's).

2.0 REFERENCES AND DEFINITIONS

2.1 REFERENCES

2.1.1 NUREG-0800: Standard Review Plan Section 11.2 Liquid Waste Management Systems

2.1.2 NUREG-0800: Standard Review Plan Section 11.4 Solid Waste Management Systems

2.1.3 Branch Technical Position 11-3, "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light Water Cooled Nuclear Power Reactor Plants"

2.1.4 10CFR20, "Standards for Protection against Radiation"

2.1.5 10CFR61, "Licensing Requirements for Land Disposal of Radioactive Waste"

2.1.6 10CFR71, "Packaging of Radioactive Material for Transport and Transportation of Radioactive Materials under Certain Conditions"

2.1.7 NUREG-0472, Revision 3, "Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors"

2.1.8 USNRC Branch Technical Position on Waste Form, May 11, 1983

2.1.9 Stock Equipment Company, Equipment Manual(s) for the Wolf Creek Generating Station's Installed Cement Solidification System; M-135 series.

2.1.10 Reg. Guide 1.143 Rev. 0, Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants.

2.2 DEFINITIONS

2.2.1 Free Standing Liquid (FSL) - is water which is not chemically or mechanically combined with the solidification binder. Solidified products which meet FSL criteria of the applicable disposal facility shall be termed a dry product.

2.2.2 Free Standing Water (FSW) - is defined as that water which is present above a settled bed of resin in the decant tank. The percent free standing water is the volume percentage of the total volume of waste represented by this free standing water, prior to solidification.

2.2.3 Structural Stability - The ability of the solidified product or processed waste package to withstand the expected disposal conditions, such as weight of soil overburden, the presence in the burial environment of moisture and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposable container that provides stability after disposal.

2.2.4 High Integrity Container (HIC) - A package designed to provide for structural stability and prevent the egress of its contents under burial conditions for a period of 300 years.

2.2.5 Batch - The final recirculated volume prior to injection into the solidification system.

3.0 SYSTEM DESCRIPTION

3.1 SOLIDIFICATION SYSTEM DESCRIPTION

The installed cement solidification system is designed to solidify the three primary waste streams generated at WCGS: boric acid concentrates, sodium sulfate concentrates and spent bead resins.

The system consists of three major subsystems:

3.1.1 Cement storage and filling systems which include the bulk storage silo, day tank and required support equipment.

3.1.2 Drum conveying system which includes the necessary equipment to locate the drums at the cement filling station and to safely move the cement loaded drums to the radwaste drumming station.

3.1.3 Decanting station which includes the necessary controls and monitoring devices required to deliver properly decanted resin slurries to the radwaste drumming station.

3.2 PROCESS PARAMETERS

3.2.1 PROCESS DESCRIPTION

Prior to the first solidification of a particular type of radioactive waste in a full-size container, process control verification test(s) will be performed. The purpose of the verification test(s) will be to determine the proper quantities of cement, and additives required to be placed in each 55-gallon drum. The verification test(s) will also indicate the required amount of pH additive required to be added to the waste tank to insure the proper pH is obtained.

Once a satisfactory verification test has been performed, the radwaste operator will begin the solidification evolution. The required quantities of additives will be placed in the 55-gallon drum prior to placing the container on the drum conveying system.

Once the additives have been placed in the container, the container will be placed on the drum conveying system and moved to the cement fill station, where the required quantity of Portland Type III cement will be placed in the drum. A mixing weight will be placed in the drum following concrete addition. The drum conveying system will then move the cement-filled drum to the loaded drum storage area.

The installed overhead crane system will transfer the cement-filled drum to the radwaste fill station where the wet radioactive waste will be metered into the drum. The drum will then be placed in the drum tumbler and tumbled for the required time.

3.2.1.1 Binder

The solidification binder used in the installed solidification system is Portland Type III hydraulic cement.

3.2.1.2 Calcium Hydroxide (Lime): $Ca(OH)_2$

A predetermined quantity of calcium hydroxide is added to the influent waste stream for; 1) initial pH adjustment, 2) to react with the boric acid to form insoluble calcium metaborate salts to prevent boron from retarding the hydration of the cement, and 3) to act as a divalent cation depleting agent for ion exchange resins.

3.2.1.3 Calcium Chloride: $CaCl_2$

Calcium chloride is added to the solidification binder to accelerate the hydration of the cement.

3.2.1.4 Lithium Hydroxid: $LiOH \cdot 2H_2O$

Lithium hydroxide is added to the influent waste stream as required to insure the final pH will be at least 10.5.

3.2.2 WASTE BOUNDARY CONDITIONS

In order for radioactive waste solidified with Portland cement to meet the stability requirements, certain boundary conditions must be achieved.

3.2.2.1 pH

The waste stream pH affects the ability of the cement to hydrate. The solidification process at WCGS incorporates the addition of calcium hydroxide and lithium hydroxide for initial and final pH control additives, respectively.

3.2.2.2 Boric Acid

Boric acid affects the ability of the cement to properly solidify the waste stream by providing an acidic environment. The boron present in the waste stream also affects the hydration process of the binder. The solidification process at WCGS incorporates the use of calcium hydroxide ($Ca(OH)_2$) to react with boron to form insoluble calcium metaborate salts.

3.2.2.3 Sodium Sulfate

The presence of sodium sulfate in the waste stream can cause a flash set of the solidification binder producing excessive heat from the hydration of the cement binder.

3.2.2.4 Bead Resin

When solidifying depleted bead resin, care must be taken to insure the active cation sites have been neutralized to prevent removal of divalent or trivalent ions from the cement/waste slurry.

3.2.2.5 Oil

Waste stream containing greater than 2% oil will be solidified with an acceptable oil solidification binder and process control program for the solidification of oil waste.

3.3 DETAILED SYSTEM DESCRIPTION

3.3.1 CEMENT STORAGE SYSTEM DESCRIPTION

The STOCK solid radwaste system for WCGS begins with a cement filling system for onsite storage of large quantities of cement as well as the control equipment and instrumentation to accurately transfer measured quantities of cement to standard 55-gallon drums. Although the entire cement filling process is carried out in safe areas of the plant, the equipment has been precision engineered for dust-free operation so that no cement dust will enter the plant atmosphere or cause deposits on the outside surface of the drums which might subsequently become contaminated.

The entire cement filling system is operated from its own control console located adjacent to the cement filling station and the conveyor system. Controls, monitoring devices and alarm indicators have been centralized in this location for ease of operation and to keep the operator informed of system status and operation.

Incoming cement is transferred into the storage silo utilizing the fluidizing equipment and blowers mounted on the cement delivery truck. Cement is again fluidized and transferred in small increments on operator command to the inside cement filling station day tank as needed. Mounted above the day tank is a dust collection system interconnected to the day tank, the drum feeder assembly fill nozzle and to the storage silo to maintain vacuum conditions and dust containment at all times.

Standard 55-gallon drums from a clean storage area enter the cement filling station on a STOCK roller conveyor and are individually positioned beneath the cement fill nozzle. A predetermined amount of cement is placed into each drum by the action of a screw feeder located at the day tank discharge hopper. The weight of cement per drum is determined in accordance with the process sample verification which is performed on each batch of radioactive waste to be processed.

Once a drum has been filled with cement and sealed, it is conveyed to the drum staging area for pickup by the bridge crane. The crane may transfer the drum either to a drum storage area or to the drum processing enclosure where the decanting and drumming equipment remotely apply measured quantities or specified proportions of radioactive slurries and concentrates.

An air compressor system is included in the cement filling system and is housed in an environmentally-controlled room located at the base of the storage silo to provide process air free of oil and water contaminants. STOCK-supplied transfer piping supplies air to the pneumatic conveyor, the fluidizing jets in both the silo discharge zone and in the day tank discharge hopper, the automatic filter cleaning equipment in the dust collection system, the bell-type shut-off valve in the cement fill nozzle orifice and to the air-oil cylinder operating the drum scale platform.

The cement filling system performs a number of related functions: inspection of drums and caps for damage and proper thread line, long-term storage of large quantities of cement under controlled conditions, application of the specified quantity of cement and the mixing weight to the drum, recording of drum tare weight and filled weight and drum sealing. It is recommended that a drum control number be assigned to each drum and recorded, and that a label or stencil be applied to the drum head in this safe location.

Numbering will facilitate positive identification for subsequent process control; therefore, the labels or stencils used should be of sufficient size and contrast to permit viewing by means of the traveling bridge crane grab TV and surveillance cameras located a considerable distance above the drum storage area. The cement filling system has been provided with the following systems and components.

3.3.1.1 <u>Cement Storage Silo</u>

The cement storage silo is of cylindrical construction with a dished head and conical discharge section, fabricated from 1/4" ASTM A-283-C steel. Double-welded construction throughout assures dust-tight integrity and vacuum maintenance. Storage capacity is 1,530 cubic feet of cement.

The silo is filled from self-unloading delivery trucks through a 4" diameter fill line. The fill line includes a clean-out port at its highest elevation and is connected to a discharge box centered on the top of the silo. The discharge box allows the cement to fall evenly inside the tank during filling.

Also located at the top of the silo is an inspection manhole and a 5" diameter vent line which is connected to the dust collection system located on the cement filling station day tank. Access to the top of the silo is provided by a hand ladder with safety cage and a maintenance platform with perimeter railing--all designed and constructed to OSHA standards.

Cement is discharged from the bottom of the silo to a pneumatic conveying system. The pneumatic conveying system is mounted to the inlet chute. The pneumatic conveying system connects to the cement silo via a dust-tight inlet chute and a manually-operated shut-off valve. The sides of the discharge cone of the silo directly above the shut-off valve are sloped at a 50° angle from horizontal. Ten automatically controlled air fluidizing nozzles are installed in the perimeter of the discharge cone to prevent packing of the cement powder.

3.3.1.2 Silo Pressure Relief Valve

A mechanical pressure relief valve is mounted at the top of the silo to prevent possible pressurization of the silo. It is set to open at 10" of water and, through a limit switch, energizes a red alarm.

3.3.1.3 Silo High-Level Controls

The cement storage silo is equipped with a sonic high-level sensor located at the normally filled level of the silo. When activated by abnormally high cement levels, the control energizes two red lights located at the cement filling station electrical console and located on the exterior wall of the silo.

The high-level control also activates an audible alarm located at the top of the silo.

During normal filling of the silo, placing the ON/OFF switch to the ON position will energize two green lights located on the exterior side wall of the silo and in the rear of the cement filling station console. Placing the ON/OFF switch into ON position also energizes the dust collector.

3.3.1.4 Silo Cement Level Indicator

A mechanical level indicator is provided for monitoring the amount of cement remaining in the silo.

A 4-figure digital readout located in the air compressor room displays in tenths of feet the level of cement remaining in the silo.

3.3.1.5 Silo Fluidizing System

Transfer of cement from the storage silo to the air conveyor equipment is facilitated by an air fluidizing system. The air fluidizing system consists of an air filter with automatic drain, an accumulator tank for air storage, a pulsator motor with cycle timer and ten fluidizing nozzles. The nozzles are deployed at various levels around the perimeter of the silo discharge cone.

All nozzles are connected by a common manifold to a pulsator solenoid valve located next to the silo discharge cone downstream of the accumulator tank. The cement conveying system controls are interlocked to the fluidizing system, permitting a pulsator motor and cycle timer to open for several brief intervals before the start of each conveying cycle. Short bursts of high pressure air through the fluidizing nozzles aerate the cement in the discharge cone area of the silo facilitating its passage to the cement chute for controlled application to the fluidizing vessel.

3.3.1.6 Air Compressor System

An air compressor system is installed in a separate room attached to the base of the cement storage silo to supply process air to the cement filling system. The pneumatic equipment is an independent and self-contained system including all necessary components to provide the required delivery of air for the cement filling system free of any oil or water contamination. The air system is equipped with two air compressors, coalescing filters, air dryers and pressure regulators.

3.3.2 CEMENT FILLING SYSTEM

The cement filling system includes all the equipment necessary to transfer cement from the storage silo into the drum. The four principal items of equipment are: an air conveyor unit to transfer cement to the day tank, the day tank, a screw feeder assembly which precisely meters the applicaton of cement into each drum and a dust collector assembly designed to remove the cement dust generated at each point in the process.

3.3.2.1 Air Conveyor System

An air conveyor system is utilized to transfer cement from the cement storage silo to the cement day tank. The system has an operating capacity of transferring 150 lbs/1.5 minutes. Compressed air at 80-100 psi (30 SCFM) is required to operate the system.

Cement in the silo discharge cone is fluidized by the continuous application of high-pressure air. This allows the cement to drop into the fluidizing vessel of the air conveyor system without packing. Once the fluidizing vessel is filled with cement, unregulated air at 80-100 psi is introduced into the vessel. The unregulated air aerates the cement and causes the pressure in the vessel to increase. When pressure in the fluidizing vessel reaches 15 psi, the unregulated air is stopped. Regulated air then forces the aerated cement from the fluidizing vessel into the transfer line. The transfer line is connected to the day tank. The regulated air forces the cement in the transfer line into the day tank.

The conveying cycle is complete when the transfer line is empty.

3.3.2.1.1 Air Conveyor Booster Jet

The air conveyor discharge piping into the day tank contains a pneumatic booster jet to impart additional accelerating force and mixing action to the cement flow. Air application to the booster jet is regulated at the pneumatic control panel by an air service valve.

3.3.2.1.2 Conveying Fault Timer

The conveying fault timer is included to automatically stop the conveying process if a batch of cement is not completely evacuated from the fluidizing vessel to the day tank within a specified interval.

3.3.2.2 Cement Filling Station Day Tank

The day tank of the cement filling station is located inside the radwaste building and is designed to hold sufficient cement for one day's operation. The tank has a net storage capacity of 50 cubic feet. The air conveyor system is capable of filling the day tank in 1.25 hours.

The day tank is rectangular in shape with all four sides tapered sharply into an integral discharge hopper. The entire assembly is fabricated from 1/4" ASTM A-283-C steel utilizing double-welded construction for strength and dust-tight integrity. The tank itself and equipment mounted thereon is accessible by a welded steel service ladder and a bar-grating maintenance platform surrounded by OSHA specified double handrailing.

Fluidized cement from the air conveyor enters the day tank through a discharge box which distributes the cement evenly inside the tank.

The day tank is equipped with a mechanical pressure-relief valve. The pressure-relief valve is set to open at 10 inches of water to prevent the possible over pressurization of the day tank.

A sonic high-level sensor located at the normally filled level of the day tank provides indication of day tank level. The day tank has sufficient capacity to complete the transfer of a batch of cement should the high-level set point be reached during transfer. The day tank is equipped with an interlock to prevent the transfer of cement to the day tank once the day tank high-level alarm has been reached.

The transferring of cement from the day tank to the drum screw feeder assembly is facilitated by four fluidizing nozzles located in the wall of the discharge hopper. The nozzles are connected by a common manifold to a solenoid valve and the compressed air supply.

3.3.2.3 Screw Feeder Assembly

The screw feeder assembly is used to transfer cement from the day tank discharge hopper to the fill nozzle. The fill nozzle is placed inside the 55-gallon drum. The screw feeder consists of a tapered, rolled, steel screw driven at 25.7 rpm. This provides a cement delivery rate of 110 cubic feet per hour.

The screw feeder discharges to a vertical exit hopper. The drum fill nozzle is attached to the base of the exit hopper. The walls of the exit hopper are installed at a steep angle to prevent the accumulation of cement in the exit hopper.

3.3.2.4 Dust Collection System

A Torit filter cartridge-type dust collector is installed with the cement filling system to provide vacuum conditions within the system and to eliminate area contamination from airborne cement dust. The dust collection equipment is mounted to the top of the day tank for direct dust collection from the day tank but, is also interconnected throughout the cement filling system. The dust collection system takes a suction on the cement filling system at the following points:

a. Cement silo,

b. Silo fluidizing vessel, and

c. Exit hopper.

Air is drawn in by the system vent fan through nine filter cartridges housed within the dust collector. Dust is captured on the exterior surface of the elements while filtered air passes out through the filters to the exhaust discharge port and into the radwaste building ventilating system. The capacity of the ventilation system at the dust collector is 1,200 SCFM @ 6" H_2O.

The filter elements are alternately cleaned in groups of three. Each group of filters is equipped with a solenoid valve and will admit high-pressure air to the center of the filter elements. At ten-second intervals a pulse of low-volume, high-pressure air is directed into the center of the selected elements. The dislodged dust falls into the day tank where it is utilized for drum filling.

The dust collector is electrically interlocked to operate automatically whenever any of the following operations are initiated:

a. Drum Filling - by moving console selector switch SS57 to either the AUTOMATIC or MANUAL drum fill position.

b. Storage Silo Filling - by moving selector switch SS28 at the silo to the ON position.

c. Cement Conveying to the Day Tank - by depressing the AIR START pushbutton at the electrical console.

3.3.3 DRUM CONVEYING SYSTEM

The drum conveying system consists of the roller conveyor used to transport drums through the cement filling station area and the integral lift assembly and scale platform which raise the drums to the cement fill nozzle for filling.

3.3.3.1 Roller Conveyor

The roller conveyor is divided into four distinct sections. The first section is a flat drum staging area seven feet in length for drum inspection, numbering and cap removal. The second section is the scale platform and drum lift area which hydraulically elevates one drum at a time for filling and weighing. The third section is a long, flat receiving area for inserting the mixing weight and replacing the cap. The fourth section is a floating storage area approximately 22 feet in length for conveying filled drums to the traveling bridge crane pickup point. The length of the storage area is designed to hold enough prefilled drums for one day's normal needs.

All individual rollers in the conveyor are provided with dust-proof sealed bearings. Five brake rollers are spaced throughout the storage area of the conveyor.

3.3.3.2 Scale Platform

A scale platform is installed for weighing individual drums. It is located beneath the elevating section of the roller conveyor. It consists of three 500-pound capacity load cells. The outputs of the three cells are added by the load cell summing junction in the electrical console and the total is displayed on one of two LED-type, three-figure digital readouts on the electrical console. The readout labeled DRUM TARE displays the weight of the empty drum when the scale platform is in its lowered position. This tare weight is retained in a memory circuit of the electronic weighing system. The readout labeled DRUM NET displays the continuously changing net weight of cement as it is being injected into a drum.

When the desired net weight of cement is reached and the feed screw is deactivated, the operator will depress the CLEAR TARE pushbutton on the electrical console. This allows the tare weight to be added to the net weight of cement. This is the net weight of the drum.

3.3.3.3 Mixing Weights

The mixing weight is a reinforcing bar bent at its midpoint to an angle of approximately 120 degrees. At least one mixing weight will be inserted into each drum at the cement filling station after the cement has been metered into the drum. While the drum is tumbled, the weight(s) imparts mixing action to its contents in the drumming operation.

3.3.4 CEMENT FILLING STATION CONTROLS

The electrical control console contains all controls for operating the cement filling station. The controls and instrumentation are located at various points in the console and are listed below by area.

3.3.4.1 Console Control Panel

The operations and control panel is mounted on the desk top of the control console. The operations and control panel contains the following system indications.

3.3.4.1.1 Control On/Off

The two-position selector switch energizes the complete cement filling station and all control circuitry.

3.3.4.1.2 Main Tank High Level

A red indicator light informs the operator of high cement level in the main storage silo. Input is provided by the silo high-level sensor.

3.3.4.1.3 Day Tank High Level

A red indicator light informs the operator of high cement level in the day tank. Input is provided by the day tank high-level sensor. In a high-level condition, cement conveying to the day tank will cease as soon as the current cycle is completed.

3.3.4.1.4 Emergency Stop

A red pushbutton immediately de-energizes the cement filling station control circuitry including any operations in progress.

3.3.4.1.5 Air Compressor

A red pushbutton energizes the control and power circuits to the air compressor system, including the desiccant dryers and electric drain trap. The pushbutton will light the red AIR COMPRESSOR indicator light on the control panel.

3.3.4.1.6 Vent Fan

A red pushbutton energizes the control and power circuits to the dust collector system ventilation fan. Operation of the dust collector system is automatic whenever drum filling operations are initiated or when cement is being loaded into the storage silo or transferred to the day tank. However, this pushbutton is provided to enable the operator to activate the dust collection system independently as needed. The pushbutton will light the red VENT FAN indicator light on the control panel.

3.3.4.1.7 Feed Screw Running

A red indicator light informs the operator that the day tank feed screw conveyor is operating. Input is provided by the DRUM FILL PERMIT pushbutton located on the right side wall of the console.

3.3.4.1.8 Air Conveyor On/Off

The two-position selector switch energizes the complete air conveyor process and circuitry.

3.3.4.1.9 Air Start

A black pushbutton starts the air conveyor transferring cement. The process will continue until the day tank high-level is reached or SS73 is turned off.

3.3.4.1.10 Scale Zero

A black pushbutton enables the operator to recalibrate the platform scale after each drum filling operation.

3.3.4.1.11 Clear Tare

A black pushbutton releases the drum's tare weight from storage in the electronic memory circuit and adds it to the net weight of the cement in the drum. The total weight is then displayed as DRUM TARE weight.

3.3.4.1.12 Fluidize Day Tank

A black pushbutton opens a solenoid valve permitting air injection into the day tank discharge hopper. This promotes cement flow to the feed screw and will continue as long as PB100 is depressed.

3.3.4.1.13 Conveying

A red indicator light informs the operator that a batch of cement has been fluidized in the air conveyor and is en route to the day tank. Input is provided by the fluidizer vessel pressure switch.

3.3.4.1.14 Auto/Manual Fill Drum

A spring-return toggle switch enables the operator to selectively fill drums with cement by setting the desired weight on the thumbwheel switch or by visually monitoring the weight as it appears on the DRUM NET readout.

3.3.4.1.15 Drum Raise/Lower

A spring-return toggle switch is provided to raise and lower the drum on the scale platform. The switch lever must be held in the appropriate position for the control to be energized. Automatic circuitry prevents overtravel in either direction.

3.3.4.1.16 Drum Tare

An LED-type digital readout displays the empty weight of a drum moved into position on the scale platform.

3.3.4.1.17 Drum Net

An LED-type digital readout displays the net weight of cement in the drum as it is being filled. When filling is complete and the CLEAR TARE pushbutton is depressed, this weight is blanked and the combined weig of the cement and the drum weights . displayed at the DRUM TARE display.

3.3.4.1.18 Set Net Weight

A thumbwheel switch is provided to permit the operator to program into the electronic weighing system the required amount of cement to be added to the drum. In the manual drum filling mode, this switch is not utilized.

3.3.4.1.19 Drum Fill Permit

A pushbutton located alone near the top of the right side of the electrical console enables the operator to initiate the drum filling operation, as long as the scale platform has been completely raised.

3.4 SYSTEM CONTROL

3.4.1 SYSTEM CONTROL PANEL

The system control console is a free-standing, desk-type enclosure for single unit control of the overhead traveling bridge crane, the decanting station, the cement drumming station and the operations section for radwaste feed system control of tanks, pumps and valves.

All control and indication devices required for remote operation of the STOCK traveling bridge crane, decanting/drumming stations, and the spent resin/evaporator bottoms tanks and associated system valves and pumps are located on the vertical front face and operator's writing table of the console. The control console consists of three modularized sections, each approximately 24" wide, which comprise the operational controls of the radwaste system.

The drum processing control section contains a graphics display panel of the system and all manual switches and visual indicators for operating the decanting/drumming stations. An annunciator panel, process selection panel, status display and control panel and operations panel comprise the control sector for this section of the control console.

Located in the bridge crane control section are the TV monitors with their control units conveniently grouped for operator surveillance while operating the crane. Spring loaded, toggle-type control handles are provided to operate the crane, in addition to a crane control panel with indicators and controls for grab elevation, crane operation/status, lighting, grab operation/status and crane/TV circuit selection.

The control section contains an annunciator panel, meter panel, tank/pump status display and control panel and valve operations panel for spent resins and evaporator bottoms waste control.

Removable front panels and hinged doors on the lower front and entire rear of the console provide for easy access to equipment for maintenance and replacement. A graphics display panel provides a visual process flow schematic for the decanting and drumming stations.

3.4.1.1 Process Selection Panel

The process selection panel is positioned below the graphics display. The process selection panel contains the following control and instrumentation:

a. Evaporator Bottoms Waste Operations Select,

b. Decant Tank Gallons - 0-530 gallons full range,

c. Machinery Air psig - 0-150 psig full range (PI2),

d. Flush Water psig - 0-100 psig full range (PI1),

e. Evaporator Bottoms Primary Feed Temp ^{O}F - 0-240^{O}F. full range, and

f. Evaporator Bottoms Secondary Feed Temp ^{O}F - full range.

3.4.1.2 Status Display and Control Panel

The status display and control panel is below the process selection panel and contains digital readout displays which serve as both status displays and controls. The following readouts are functionally grouped on the status display and control panel:

a. Evaporator Bottoms/Chemical Waste Metering Pump Gallons - Indicates the total number of gallons of waste material metered into a drum. The readout is displayed in half-gallon increments to correspond to the delivery rate of the metering pump.

b. 1st Count/2nd Count - A pair of thumbwheel switches are provided with which to select the amount of waste, in gallons, to be metered into the drum. The switches can be used in three different combinations: 1ST COUNT only, 2ND COUNT only, or 1ST COUNT and 2ND COUNT combination for double filling. Each switch is set to the nearest half gallon increment. Also, both the decant metering pump and evaporator bottoms/chemical waste metering pump can be set to fill a drum simultaneously or in any 1st and 2nd count combinations, such as setting the 1st fill from the decant tank and the 2nd fill from the evaporator bottoms metering pump.

c. Drumming Station On/Off - A separate two-position selector switch is used as an ON/OFF switch to energize the relay logic for the drumming station controls.

d. Drum or Tank Radiation Level/Roentgens Per Hour - The 1,000R radiation monitor consists of a scintillator detector and its associated electronics and display package. The system is designed as a dual-channel system with an operating range of 1,000R to 10 mr. A three-position selector switch, with DRUM RADIATION/OFF/TANK RADIATION clockwise indicators is provided to display the radiation signal from either the decant tank or the drumming station scale, via the radiation level display.

e. Drum Gross Weight/Lbs. - A readout provides the weight of a processed drum via an electronic weighing system.

f. Zero Scale - A black zero scale push button is provided to reset the drum gross weight display to zero before or after weighing a drum.

3.4.1.3 Operations Panel

The operations panel is positioned immediately below the status display and control panel and mounted on the desk top of the control console.

The operations panel contains pushbuttons or pushbutton/indicator light combinations for additional operator-controlled functions.

The operations panel contains the following controls and instrumentation:

3.4.1.3.1 Flush Drum Fill Line

Energizes valve operators to open the proper valves to allow flush water through the decant metering pump, decant to drum fill line and the slurry filling nozzle to clean the line.

3.4.1.3.2 Flush Evaporator Bottoms/Chemical Waste Feed Line

Energizes valve operators to open the proper valves to allow flush water through the evaporator bottoms metering pump and into the select evaporator bottoms waste feed line. The chemical waste feed line is flushed independent of the evaporator bottoms metering pump.

3.4.1.3.3 Enclosure Washdown

Energizes valve operators and a rotating spray drive motor to allow flush water through a revolving manifold to clean the inside of the drum processing enclosure.

3.4.1.3.4 Drum Washdown

Energizes valve operators to open proper valves to allow flush water through a manifold within the drum processing enclosure to wash down the exterior surfaces of a drum. The washdown can be energized when the drum is either tumbling or at rest.

3.4.1.3.5 Auto On

Energizes the automatic mode of the drum processing cycle. Assuming all conditions are satisfied, the drum will proceed through a complete cycle automatically.

3.4.1.3.6 Hatch Open

Energizes a solenoid valve which causes a pneumatic actuator to raise the drum processing enclosure hatch cover to the fully open position.

3.4.1.3.7 Manual Advance

Permits step-by-step advancement through the drum processing cycle rather than automatic advancement.

3.4.1.3.8 Hatch Closed

Energizes a solenoid valve which causes the same actuator to lower the drum processing enclosure hatch cover to the fully closed position. The light indicates that the hatch is fully closed.

3.4.1.3.9 Skip Operation

Depressing the red SKIP OPERATION push button will cause the drumming sequence programmer to cycle through the steps in the automatic cycle without the equipment actually performing the operation. The lights on the right side of the graphic display panel will flash on as the programmer cycles through each step in the automatic sequence, letting the operator know which steps are being by-passed. The programmer will continue to cycle until the buttons are released. Drum processing may be continued from any point in the sequence as long as the permissives are satisfied.

3.4.1.3.10 Emergency Stop

De-energizes the drumming cycle circuit immediately. This button is independent of the decanting operation.

3.4.1.4 Graphics Display

A graphics display panel, located below the annunciator panel on the left vertical section of the control console, represents the decanting and drumming stations, with associated interconnecting piping, valves, pumps and equipment. The symbols on the left represent the decanting station, with the decant tank, mixer, decant arm and decant pump. Red lights indicate mixer running, arm movement up or down, decant pump running, and high- or low-level tank status. The circle under the tank represents the decant metering pump with a piston in the center and four valves which can be opened in various combinations of opened or closed depending upon the mode of operation and direction of flow through the pump. The pump port valves light (red) when open, turn off when closed. The pump piston will light (amber) when intake is complete and turn off upon discharge. The pump valve and piston lights visually indicate that the pump is in operation and show which valves and lines are in use. The shut-off valves, for flush/spray lines and for tank feed loops, have red (open) and green (closed) indicating lights, which are operated from valve actuator limit switches, to give positive indication of valve position. The metering pump and process valving along with the piping flow indications (amber), verify to the operator which process lines are in use for a particular station operation.

The symbols at the center of the mimic represent the drumming station, showing the drumming enclosure and evaporator bottoms metering pump, along with associated piping and valves. In addition to the valve, pump and flow indicators, there are two rotational arrows in the center of the drum symbol which light (red), after each revolution of the DRUM TUMBLE cycle, giving positive indication that the drum is being tumbled.

On the right side of the mimic is a vertical row of indicator lights that identifies each sequence of the drumming operation cycle. The drumming cycle is initiated and completed at the Load Position sequence. During the drumming operation, the operator knows the status and position of the drum by referencing the glowing (amber) indicator light, which identifies the drumming cycle sequence occurring. The indicator lights provide greater flexibility in operation by allowing the operator to change from the automatic mode to MANUAL ADVANCE at any stage in the sequence or to skip sequences, for example, advancing the step programmer to the CLAMP 2nd step from the CAP/TUMBLE POSITION for a contaminated drum washdown, and returning the operation to the automatic mode to complete the drumming cycle. The drumming cycle sequence indicator lights also serve as a troubleshooting aid by indicating which sequence the drumming cycle was in when a fault trip occurs, thus allowing the operator to manually reset the sequence programmer at the desired step for restarting the drumming operation.

3.4.1.5 Annunciator Panel

Annunciator windows above the graphics display panel provide the following fault or status indication to the radwaste operator:

a. demineralizer water pressure,

b. machinery air pressure,

c. decant tank high-level,

d. select feed loop valve,

e. motor overload tripped,

f. drum process cycle complete,

g. no cap in drum,

h. no fill selection (gallons of fill),

i. drum overfill,

j. drum process fault, and

k. evaporator bottoms feed line temperature high.

3.4.3 DECANTING STATION CONTROLS

The decanting station is functionally controlled by the operator from the control console decanting and drumming section by means of selector switches and pushbuttons, with indicators and indicator lights supplementing the controls. Controls and monitoring devices have been provided to allow for ease of operation and to inform the operator of station status and operation.

The decanting station has been provided with the STOCK solid radwaste system to accurately decant slurries prior to drum filling. This station is a compact assembly of components attached to both sides of a 12" thick steel shield wall. Mounted on the maintenance side of the shield wall are all motors, pneumatic valves, actuators and as many of the gear reducers as is practical. On the process side of the wall are the decanting tank and the pumping ends of the metering and decanting pumps.

Incoming waste slurries are transferred from the liquid radwaste system storage tanks to the decanting tank through the piping manifold. During this filling operation, the decant tank mixer is automatically operated to ensure that the slurry is a uniform mixture. Upon completion of the filling operation, an automatic flush operation is initiated to flush the fill line to the decant tank and the feed line back to the liquid system storage tank. After this flush operation has been completed, the slurry is allowed to settle for a predetermined period of time. This settling time allows for the separation of solids and water to a uniform level bed-of-solids.

Once this settling period has elapsed, the water level and water-solid interface level are accurately measured with sensors mounted on the decanting arm and STOCK designed solid state equipment. These readings are displayed on the control console and inform the operator as to whether excess water is to be removed or if water is to be added to the decant tank. This is done in accordance with the process control program in order to achieve the correct solid/water ratio consistent with the pretested solidification formula for the waste stream. Excess water is removed with decanting equipment and returned to the liquid radwaste system storage tanks by means of a specially designed decanting pump. This minimizes the amount of water requiring disposal.

After the decant tank has been prepared with the correct solid/water ratio, the mixer is then automatically started and operated for a predetermined period of time to ensure that the slurry is again uniform. While the slurry is being mixed, the operator is then able to record the radiation level of the slurry to be processed with the radiation detector provided with the decanting station. The STOCK metering pump is used to transfer the prepared decant tank slurry to the drumming station for drum processing. The pump and its associated controls allow the operator to program accurate pump quantities to be processed in each drum. Once programmed, the pumping operation becomes part of the automatic processing cycle at the drumming station. The metering pump is also used for transferring decant tank contents back to the waste stream storage tank.

3.4.4 DRUMMING STATION CONTROLS

All controls for operation of the drumming station are located immediately adjacent to the decanting station controls. A single selector switch on the front face of the control console energizes the drumming station control circuits. Complete monitoring of operation of the drumming station can be accomplished by watching the graphics display panel while the drumming station is in use. The operator has the option of drumming either decanted wastes or concentrator wastes as well as any combination of the two.

The drumming station is a compact assembly of components to drum radioactive slurries and solutions in 55-gallon drums with cement solidification binder. For safety in operation and for maintenance, the equipment is attached to both sides of a 12-inch thick steel shield wall. On the safe side of the wall are mounted all motors, pneumatic valves, actuators and as many of the gear reducers as is practical. On the hot side of the wall are the pumping ends of the metering pump and the drum processing enclosure. The 12-inch thick steel shield wall provides the equivalent of 39 inches of concrete shielding, allowing personnel to be present on the safe side of the wall during operation for maintenance or for other purposes.

The drumming station is remotely operated from the console which is provided with the control station. Controls and monitoring devices have been provided to allow automatic or manual operation and to inform the operator of station status and operation.

The drumming station allows drums to be filled with either evaporator concentrates or resin slurries. Prior to drumming operations process control verification tests are performed in accordance with the requirements of the process control program. Once a satisfactory verification sample has been performed, the required quantity of waste is programmed into the waste meter pump controls. The metering pump will automatically transfer the required quantity of waste to the disposal container.

Disposable containers which have been prefilled with concrete at the cement filling station are transferred to the drum positioning platform inside the drum processing enclosure. Once the drum is inside the drum processing enclosure, the station operator shuts the drum processing enclosure hatch isolating the drum processing enclosure from the station's environment.

With the metering pumps and the appropriate feed controls setup for the correct quantity of waste(s), drum processing can then be initiated. The movement of the drum through the drumming station cycle is automatic, once the drum has been loaded into the drum processing enclosure and the hatch has been closed. The drum is uncapped, filled, recapped, clamped, tumbled and unclamped. This operational sequence may be repeated in the automatic cycle to permit the drum to be filled twice.

Upon completion of the automatic process cycle, the drum is returned to the load/unload position within the drum processing enclosure. The operator then initiates remote opening of the hatch and lowers the crane's drum grab into the enclosure. The drum grab is equipped with a downward viewing camera, which allows the operator to inspect the drum.

After the operator has verified that the top head of the drum is free from contamination, he then raises it out of the drum processing enclosure and positions it upon the scale platform. Once the drum has been released, the drum's weight and radiation level are then measured and recorded. Displays for these functions are provided at the control console and provide valuable information as to the decay pit and location at which the drum should be stored.

?.5 SOLIDIFICATION SAMPLE VERIFICATION

3.5.1 RECIRCULATION OF WASTE STREAMS

3.5.1.1 Prior to sampling radioactive waste hold up tanks for process control sample verification, each tank shall be recirculated until a representative sample can be obtained.

3.5.1.2 No waste should be added to or removed from a batch tank after sampling has been performed. Should waste be added or removed from the tank prior to completing the solidification of the tank, solidification activities will be secured and the tank placed in the recirculation mode until representative samples are obtained.

3.5.1.3 The radioactive waste tank shall remain in the recirculation mode during actual solidification operations.

3.5.2 VERIFICATION SAMPLE REQUIREMENTS

3.5.2.1 Solidification sample verification will be performed on each batch of each type radioactive waste until standard cement-to-waste ratios have been developed and proven to produce acceptable products on a minimum of ten consecutive batches.

3.5.2.2 Once the standard ratios have been proven to produce acceptable solidified products for ten consecutive batches of each type radioactive waste, solidification sample verification requirements will be decreased to at least once every tenth batch of each type of radioactive waste.

3.5.2.3 Should any solidification verification sample prove to produce unsatisfactory solidified products, solidification verification sampling requirements will be increased to every batch of each type radioactive waste until the criteria of Step 3.5.2.1 are met.

3.5.3 WASTE IDENTIFICATION

3.5.3.1 Each verification sample shall be analyzed for the following minimum characteristics:

3.5.3.1.1 Oil per procedure CHM-02-450.

3.5.3.1.2 pH per procedure CHM-02-230.

3.5.3.1.3 Temperature pe[illegible]ure CHM-02-230.

3.5.3.1.4 Boron content per procedure CHM-02-052 or sodium sulfate per procedures CHM-02-075 and/or CHM-02-110.

3.5.3.1.5 Isotopic analysis per procedure CHM-03-021.

3.5.3.2 The results of each sample verification will be recorded on the appropriate sample worksheets.

3.5.3.3 Wastes shall be classified and curie content determined per procedures HPH 09-501 and HPH 09-502, respec[illegible]vely, or by NRC approved computer software. Each package shall be identified in accordance with applicable NRC and DOT regulations for packaging and transportation of low-level radioactive waste.

3.5.4 SOLIDIFICATION SAMPLE ACCEPTANCE CRITERIA

3.5.4.1 Visual inspection of the end product after solidification must indicate a free standing, monolithic structure which meets the free standing water criteria of the appliciable low level radioactive waste disposal facility.

3.5.4.2 The end product must resist penetration when probed with a spatula or comparable firm object.

3.5.5 SOLIDIFICATION SAMPLE VERIFICATION DOCUMENTATION

3.5.5.1 Calculate and record all required information on either the concentrates solidification work sheet or the resin solidification worksheet.

3.5.5.2 The Radwaste Coordinator or his designee shall inspect and verify the results of each sample verification.

3.6 PRIMARY CONCENTRATES VERIFICATION

3.6.1 Based on the sample analysis, determine the quantities of calcium hydroxide, calcium chloride, and lithium hydroxide required for satisfactory solidification. Record these quantities on the concentrates solidification worksheet.

3.6.2 Ensure the temperature of the concentrate sample is at least 160 F. Record the temperature on the solidification sample verification worksheet.

3.6.3 Transfer the waste stream to the disposable container. Measure and record pH.

3.6.4 Add the required quantity of calcium hydroxide to the waste sample. Mix for five minutes.

3.6.5 Measure and record pH. If pH is less than $10.5 \pm .5$ add $LiOH \cdot 2H_2O$ increments of 2 grams until pH is greater than 10.5.

NOTE: Because of the difference in the quantity of heat of hydration released in the test sample and the full scale solidification, the test sample will not demonstrate the quantity of hardness of the full scale sample.

3.6.6 Mix sample for approximately 1 minute.

3.6.7 Record sample weight and volume on the solidification sample verification form.

3.6.8 Place a lid on the disposable beaker and allow to stand for a maximum of 24 hours at 130 F in a convection oven.

3.6.9 Inspect each sample for free standing water and product integrity. Record sample results on the solidification sample verification form.

3.6.10 If the solidification sample is satisfactory, determine the quantities of waste, thumb wheel settings, cement, calcium chloride, and lithium hydroxide to be placed in each 55 gallon drum and the quantity of calcium hydroxide to be placed in the batch tank by performing the calculations described in Section D of the concentrates solidification sample verification form.

3.6.11 If the solidification sample is not satisfactory, adjust the waste: binder ratio (Formula B.2) downward in increments of .5 until a satisfactory sample verification is obtained.

3.6.12 Perform Step 3.6.10.

3.6.13 Perform full scale solidification in accordance with the system operating procedure using the boundary parameters recorded in Section D of the concentrates solidification sample verification form.

3.7 SOLIDIFICATION OF SPENT ION EXCHANGE RESIN

NOTE: If radiation levels do not permit the verification testing of the actual depleted resin, depleted non-radioactive resin may be used.

3.7.1 Determine pH, boron content, and resin to water ratio of the resin stream to be solidified and record results on the resin solidification worksheet.

3.7.2 Based on sample analysis results, determine the quantities of cement, calcium chloride, and lithium hydroxide required to obtain a satisfactory solidification. Record these quantities on the resin solidification worksheet.

3.7.3 Transfer the required quantity of waste to a disposable container.

3.7.4 Measure and record waste stream temperature.

3.7.5 Add the required quantity of calcium hydroxide to the waste stream. Mix for 5 minutes prior to adding the waste to the disposable container.

3.7.6 Measure and record pH. If pH is less than $10.5 \pm .5$, add lithium hydroxide to the resin waste stream to increase pH to at least 10.5. Record the additional $LiOH:2H_2O$ required to increase pH to at least 10.5.

3.7.7 Transfer the required quantities of cement and calcium chloride to the disposable container.

3.7.8 Mix sample for 1 minute.

3.7.9 Record waste sample final pH on the resin solidification worksheet.

3.7.10 Record weight and volume of the waste sample on the resin solidification worksheet.

3.7.11 Place a lid on the disposable beaker and allow to stand for a maximum of 24 hours at 130 F in an convection oven.

3.7.12 Inspect each sample for free standing water and product integrity. Record sample results on the resin solidification worksheet.

3.7.13 If the solidification sample is satisfactory, determine the quantities of cement, calcium hydroxide, calcium chloride, lithium hydroxide and waste to be placed in each 55 gallon drum or batch tank by performing the calculations described in section D of the resin solidification worksheet.

3.7.14 If the solidification sample is not satisfactory, adjust the waste: binder ratio (Formula B.2) downward in increments of .5 until a satisfactory sample verification is obtained.

3.7.15 Perform Step 3.7.13.

3.7.16 Calculate the quantities of waste, thumb wheel settings, cement, calcium hydroxide, lithium hydroxide and calcium chloride required for each container.

3.7.17 Perform full scale solidification in accordance with the system operating procedure using the boundry parameters recorded in Section D of the solidification sample verification form.

3.8 SECONDARY CONCENTRATES AND SECONDARY SPENT RESIN VERIFICATION

3.8.1 Secondary concentrates and secondary system spent resins will be processed through the bulk waste disposal station. This waste will not be solidified in the in-plant solidification system.

3.8.2 Secondary spent resin will be discharged through the secondary bulk waste disposal station to 55 gallon drums. Secondary resins will be dewatered in the 55 gallon drums. The dewatered resins will be transported to a sanitary landfill for disposal. Sluice water will be returned to the clean floor drains.

3.8.3 Should secondary spent resins exceed the activity levels for unrestricted release, they will be processed in accordance with Section 3.7.

3.9 SYSTEM INTERFACING

3.9.1 The installed solidification system interfaces with the liquid radioactive waste system, solid radwaste decanting station, chemical drains, reactor make up water system, and the radwaste building ventilation system.

3.9.2 Liquid wastes are transferred from the primary evaporator bottoms tank, chemical drain tank, or the secondary evaporator bottoms tanks by installed pumps. All piping used to transfer the concentrates to the solid radwaste drumming station and for recirculation of the bottoms tanks is heat traced to prevent crystallization of the concentrates prior to reaching the solid radwaste drumming station. The solid radwaste drumming station also receives liquid waste from the chemicl drain tank.

3.9.3 The primary and secondary bottoms tanks and the chemical drain tanks are equipped with recirculation capability to insure satisfactory samples may be obtained and analyzed.

3.9.4 The installed resin sluicing system transfers spent resin and depleted charcoal to the spent resin storage tanks (primary and secondary). Resin slurries are then transferred to the solid radwaste decanting station. The solidification system operator can maintain the required amount of liquid in the resin slurry and decant and transfer all excess liquid to the spent resin hold up tanks.

3.9.5 All exhaust from the decanting station and the solid radwaste drumming station is processed by the radwaste building ventillation system.

3.9.6 The reactor make up water system is used to wash down and decontaminate processed drums as necessary to remove external contamination from the drums due to spillage.

3.9.7 The installed bulk waste disposal station provides necessary interface support for mobile vendor processing systems; the discharge header includes primary/secondary resins and concentrates supply; the return header provides a return route for decanted water resulting from resin slurries. Both lines are tied into the reactor makeup water (RMW) system for backflushing capability.

3.10 CORRECTIVE ACTIONS

3.10.1 At predetermined intervals a portion of the solidified containers will be inverted and allowed to stand for a period of time. Each of these containers will then be inspected for free standing water. The results of each inspection shall be recorded. Should any container be found to exhibit free standing water greater than the FSW criteria established by the low level radioactive waste disposal facility, the following actions shall be taken:

3.10.1.1 Secure solidification activities until new solidification ratios can be determined and proven.

3.10.1.2 Inspect all available containers from the same batch of radioactive waste solidified using the formulas which provided the unsatisfactory results.

3.10.2 Drums that exhibit free standing water shall either be dewatered or reprocessed by determining the quantity of water and adding proper quantities of cement and additive chemicals as required by a sample verification test.

4.0 ADDITIONAL PROCESSING

4.1 VENDOR PROCESSING

4.1.1 In the event that WCGS requires vendor processing capacity, KG&E shall use vendor processing to ensure that LLW produced at WCGS is efficiently processed for shipment in accordance with NRC, DOT and state burial requirements.

4.1.2 When vendor solidification, resin dewatering, or filter encapsulation services are used at WCGS the latest revision of the NRC approved vendor process control program shall govern the applicable LLW processing whenever this service is in use.

4.1.3 Low-level radioactive waste processed by vendor systems shall be certified as complying with the free standing liquid requirements for licensed shallow land disposal sites.

5.0 FILTER DISPOSAL IN HIGH INTEGRITY CONTAINERS (HIC'S)

5.1 ADMINISTRATIVE CONTROLS

5.1.1 Filter cartridges produced at WCGS that are in excess of 1 uCi/cc specific activity containing radionuclides with half-lives greater than five years shall either be encapsulated in accordance with step 4.1.2 or disposed of in approved high integrity containers (HIC's).

5.1.2 When HIC's are used at WCGS for filter cartridge disposal, each polyethylene HIC ordered shall be pre-foamed on its interior to preclude any container damage during packaging handling and transportation to a burial facility. Metal alloy HIC's will not require interior pre-foaming.

5.1.3 Filter packaging and disposal shall be done in conformance with the latest state-approved certificate of compliance. WCGS shall obtain the C of C onsite prior to any waste processing.

5.1.4 KG&E shall insure that the maximum allowable free standing liquid in a high integrity container is less than one half percent (0.5%) of the waste volume.

5.1.5 Qualified test data supporting compliance with the free standing liquid requirements in 10CFR61 for the WCGS filter disposal method are contained in Appendix C. Vendor certification statements for mechanical filter cartridge compatibility with identified HIC's are contained in Appendix D.

5.2 FILTER DESCRIPTION AND TRANSFER

5.2.1 Spent filter cartridges that normally require disposal at WCGS are Pall-Trinity cartridge filters. The Pall-Trinity cartridge filter contains fiber filter media rigidly enclosed in a stainless steel mesh cylinder housing. The plant Pall-Trinity seal water injection filters are 2-3/4" (inches) in diameter and 19-1/4" (inches) long; the remaining plant Pall-Trinity filters are 6" in diameter and 16-1/2" long.

5.2.2 The spent filters are first valved out of service, then vented and drained by the use of remote valve operators. The filter housing is unbolted and opened using long handled tools. The filters are then removed manually using a long handled hook or remotely using a shielded filter transfer cask (FTC) depending on radiation levels.

5.2.3 The filters are then transported to storage and placed into a high integrity container (HIC) if the estimated activity is equal to or greater than 1 uCi/cc of isotopes with half-lives greater than five years averaged over the volume of the filter.

5.2.4 Other filter cartridge types utilized at WCGS include de-sludging Cuno type cartridge filters (2" in diameter by 14-3/4" long); respirator trailer and ultrasonic turbulator Cuno type cartridge filter (2" dia. by 10" long); and a respirator trailer Gelman Acroflow II cartridge filter (2" dia. by 10" long). These filters are changed out manually and placed in plastic bags or other suitable container and transported for placement in a HIC, if the filters are determined to contain in excess of 1 uCi/cc of isotopes with greater than five year half-lives.

5.2.5 Spent cartridge filters produced at WCGS shall be classified according to 10CFR61 and have curie content determined per procedures HPH 09-501 and HPH 09-502, respectively, or by NRC approved computer software.

5.3 HIGH INTEGRITY CONTAINER DESCRIPTION

5.3.1 Spent filter cartridges produced at WCGS are placed into two different types of HIC's. The first type is constructed of polyethylene: the second type is constructed of a metal alloy (Ferralium 255). Both containers have undergone full scale testing and are designed to comply with the structural stability requirements of 10CFR61.56.

5.3.2 HIC's used for filter cartridge disposal at WCGS have been certified as being resistant to the identified filter cartridges and their contents, including the water absorbing agents. Refer to Appendix D for certification of compatibility statements between WCGS filter types and identified HIC's.

5.4 FILTER TREAMENT METHOD

5.4.1 Prior to the addition of the filters to the HIC, the bottom of the container is filled with approximately 6" of vermiculite or Aquaset agent. Following each filter addition, a minimum of one gallon of vermiculite or one-half gallon of Aquaset is also added to the HIC. The amount of agent added has been determined to provide a conservative amount of absorbent to assure at least twice the amount necessary to remove residual filter liquids within the HIC.

5.5 FILTER TREATMENT DETERMINATION

5.5.1 The previously described treatment method was determined to be adequate to meet regulations and burial ground requirements by measurements made at WCGS. Each type of filter was weighed dry then immersed overnight in water. The filters were then removed and weighed to determine the maximum water retention (the results are contained in Appendix C).

5.5.2 The Vermiculite and Aquaset agents were tested to determine the quantity required to absorb a known amount of liquid. The ratio was determined to be 2.5 parts Vermiculite to one part water. For Aquaset, this ratio was determined to be one part Aquaset to one part water.

5.5.3 Since the maximum amount of water that could conservatively be estimated to be present in a filter at WCGS is 627 ml, the required amount of Vermiculite would be 1568 ml, or 627 ml for Aquaset. Since the burial facilities dictate that twice the amount of absorbent required to fully absorb liquids be added, 3136 ml of Vermiculite or 1254 ml of Aquaset should be added. Therefore, a one gallon (3785 ml) addition of Vermiculite, or a one-half gallon (1893 ml) addition of Aquaset, for each filter packaged is a conservative amount to assure package free standing liquid restrictions are met. The preplaced 6" of absorbent is for conservatism.

APPENDIX A: CONCENTRATE SOLIDIFICATION WORKSHEET

A. Waste Identification

Boron Content ________ ppm Test # ________

pH ________ Waste Type # ________

Temperature ________ ^{0}F Tank Id # ________

Oil (% by volume) ________ %

DATE ________________ CHEMISTRY ________________

B. Sample Preparation

1. Waste Sample Volume (V_{WS}) 200 ml

2. Waste Sample Volume to Cement Volume Ratio

$$\frac{\text{Waste Volume } (V_{WS})}{\text{Cement Volume } (V_{CS})} = \underline{\ 0.75\ } \text{ or } \underline{\qquad}$$

3. Weight of Cement (W_{CS}) $= \dfrac{1}{0.75 \text{ or } \underset{\text{Step B.2}}{\underline{\qquad}}} \times V_{WS} \times 0.93\ \dfrac{gm}{ml} =$ ______ gm

4. Weight of Calcium Hydroxide (Lime)-$Ca(OH)_2$

________ ppm Boron x 3.64×10^{-4} = ________________ gm $Ca(OH)_2$

5. Weight of Lithium Hydroxide-$LiOH:2H_2O$

200 ml of Waste (V_{WS}) x 0.083 = 16.6 gm $LiOH:2H_2O$

6. Weight of Calcium Chloride-$CaCl_2$

(W_{CS}) gms Cement X 0.04 = ________ gm $CaCl_2$

7. pH following Addition ________ pH

8. Additional $LiOH \cdot H_2O$ required to increase pH to 10.5 ±.5

_____________gm $LiOH\ H_2O$

9. Total Weight of Lithium (WL) required _____________gm $LiOH\ H_2O$

10. Ratio Lithium = Weight of Lithium (WL) ___ ___ / 16.6 = _______

11. Final Product Volume (V_{FP}) __________ ml

12. Final Product Weight (W_{FP}) __________ gm

C. Solidification Sample Results

1. Free Liquid (Free Standing H_2O) ____________ % _______________ ml

2. General Appearance ____

____

3. Test Acceptable ☐ Yes ☐ No ___ ______________/______________

Shift Chemist Date

4. Radwaste Operator Review ______________________________/__________

Date

5. Comments ____

____

D. Full Scale Solidification

1. Volume of Container (Vc) _______________ ft^3 _______________ gal.

2. Useful Volume (Vu) _______________ ft^3 _______________ gal.

3. Waste Volume to Cement Volume Ratio (Waste to Binder Ratio)

0.75 or From Step B.2 _____________________

4. Waste Volume (V_W) in gallons.

V_{WS} (from B.1 in ml.) = 200 ml.

V_{FP} (from B.10 in ml.) = ________ml.

V_U (from D.2 in gal.) = ________gal.

$[V_{WS}/V_{FP}] \times V_U$ = _____________Waste Volume in Gallons (V_W)

5. Weight of cement

V_W (from D.4 in gal.) ________ gal.

$W_C = V_W \times \frac{7.75\ lb/gal.}{0.75 \text{ or } D.3} =$ __________ lbs. cement

6. Lime--$Ca(OH)_2$

$$\frac{\_\_\_\_\_\_\_\_ \text{ppm Boron} \times 1.853 \times V_W \text{(gal)} \times 3.785 \frac{\text{liters}}{\text{gal}}}{4.536 \times 10^5 \text{ mg/lb}} = \_\_\_\_\_\_ \text{lb Lime}$$

7. Lithium Hydroxide $LiOH\ H_2O$ (weight in pounds)

V_W gal X 0.6926 X Lithium Ratio (B.10) = _____________ lbs.

8. $CaCl_2$ (weight in pounds)

W_C (lb) X 0.04 = ____________pounds of $CaCl_2$

9. THUMBWHEEL SETTINGS

NOTE: Gallons = Pounds/(7.75 lbs per gal.)

a. (Container Volume x 0.95) - V_{CEMENT} = First Thumb Wheel Setting

First Thumb Wheel Setting __________________ Gallons

b. ($V_{WASTE} - V_{FIRST\ THUMB\ WHEEL\ SETTING}$) = Second Thumb Wheel Setting

Second Thumb Wheel Setting __________________ Gallons

10. Operation Verified Thumb Wheel Setting ____________________ / ________
Operator Date

a. Waste Container Id #'s ____

____

11. a. Prepared by Radwaste Operator

____ ____________
Radwaste Operator Date

b. Reviewed by Operations Radwaste Coordinator

____ ____________
Operations Radwaste Coordinator Date

APPENDIX B: RESIN SOLIDIFICATION WORKSHEET

A. Waste Identification

% Resin Slurry $\frac{\text{Volume of Resin}}{\text{Total Volume}}$ X 100% = ______% Resin-Test # ________

Boron Content ______ppm Boron-Batch # ________

pH ______pH-Waste Type ________

Temperature ______^{o}F - Tank Id # ________

Oil(% by volume) ______%

DATE ____________________ CHEMISTRY ____________________

B. Sample Preparation

1. Waste Sample Volume (V_{WS}) [Volume of Resin] = 200 ml
2. Waste Volume to Cement Volume Ratio

   $\frac{\text{Waste Volume } (V_{WS})}{\text{Cement Volume } (V_{CS})}$ = 0.43 or __________

3. Weight of Cement (W_{CS}) = $\frac{1}{0.43 \text{ or } \underline{\quad}}$ x V_{WS} x 0.93 $\frac{gm}{ml}$ = ______gm

   Step B.2

4. Weight of Calcium Hydroxide (Lime)-$Ca(OH)_2$

   ________ppm Boron x 3.64×10^{-4} = ____________grams of $Ca(OH)_2$

5. Weight of Calcium Chloride-$CaCl_2$

   ________ W_{CS} Weight of Cement x 0.04 = ____________ gm $CaCl_2$

6. pH following Lime Addition ________________pH
7. Final Product Volume (V_{FP}) ________________ ml
8. Final Product Weight (W_{FP})________________ gms

Page 1 of 3

C. Solidification Sample Results

1. Free Liquid (Free Standing water) __________ % __________ ml

2. General Appearance ______________________________

____

3. Test Acceptable ☐ Yes ☐ No ____________ / ________
Shift Chemist Date

4. Radwaste Operator Review ____________ / ________
Date

5. Comments ______________________________

____

D. Full Scale Solidification

1. Volume of Container (V_C) __________ ft^3 __________ gal.

2. Useful Volume (V_U) __________ ft^3 __________ gal.

3. Waste Volume to Cement Volume Ratio: (Waste to Binder Ratio)

 0.43 or From Step B.2 __________

4. Waste Volume (V_W) in gallons.

$$\frac{\text{Waste Volume } (V_W) \text{ ml}}{\text{Final Volume } (V_{FP}) \text{ ml}} \times \text{Useful Volume } (V_U) = \_\_\_\_\_\_ \text{ Waste Volume gallons}$$

5. Weight of Cement (W_C)

$$\_\_\_\_\_\_ V_W \times \frac{7.75 \text{ lb/gal}}{0.43 \text{ or D.3}} = \_\_\_\_\_\_ \text{ lbs. cement}$$

6. Weight of Lime—$Ca(OH)_2$

_____ ppm Boron X 1.546×10^{-5} X V_W (gal) = _______ pounds of lime

7. Weight of Calcium Chloride-$CaCl_2$

Weight of Cement (W_C) in pounds X 0.04 = _______ pounds of $CaCl_2$

8. THUMB WHEEL SETTINGS

(a) (Container Volume x 0.95) - $Volume_{CEMENT}$ = First Thumb Wheel Setting (gallons)

First Thumb Wheel Setting __________________ gallons

(b) Volume Waste (V_W)-$Volume_{FIRST\ THUMB\ WHEELSETTING}$=Second Thumb Wheel Setting

Second Th umb Wheel Setting __________________ gallons

9. (a) Operation erified Thumb Wheel Setting ____________/________
Operator Date

(b) Waste Container Id #'s ______________________________________

____

10. (a) Prepared by Radwaste Operator

_____________________________________ ______________
Radwaste Operator Date

(b) Reviewed by Operations Radwaste Coordinator

_____________________________________ ______________
Operations Radwaste Coordinator Date

APPENDIX C: FILTER CARTRIDGE DISPOSAL DATA

TEST ELEMENTS:

1) Chemistry department Metler PC 2000 digital weighing scale used for all data weight measurements.

2) Data was gathered for both size (large and small) Pall trinity cartridge filters, Cuno type filter cartridges, and a Gelman filter cartridge that may be generated at WCGS.

PALL TRINITY FILTER TEST DATA:

a. Filter size (large) = 6" x 15-1/4"
Large filter dry weight = 3.15 Kg
Large filter wet weight = 3.75 Kg
Weight of retained water = 0.60 Kg
Volume of retained water = 600 ml

b. Filter size (small) = 2-3/4" x 17-1/4"
Small filter dry weight = 0.75 Kg
Small filter wet weight = 1.00 Kg
Weight of retained water = 0.25 Kg
Volume of retained water = 250 ml

DE-SLUDGING FILTER TEST DATA:

a. Filter size (Cuno type) = 2" x 14-3/4"
Filter dry weight = 0.316 Kg
Filter wet weight = 0.943 Kg
Weight of retained water = 0.627 Kg
Volume of retained water = 627 ml

RESPIRATOR TRAILER/ULTRASONIC TURBULATOR FILTER:

a. Filter size (Cuno type) = 2" x 10"
Filter dry weight = 0.294 Kg
Filter wet weight = 0.739 Kg
Weight of retained water = 0.445 Kg
Volume of retained water = 445 ml

RESPIRATOR TRAILER FILTER:

a. Filter size (Gelman Acroflow II) = 2" x 10"
Filter dry weight = 0.287 Kg
Filter wet weight = 0.453 Kg
Weight of retained water = 0.166 Kg
Volume of retained water = 166 ml

Page 1 of 1

APPENDIX D: CERTIFICATION OF COMPATABILITY

June 18, 1986

NuPac
A Pacific Nuclear Company

Mr. Lon E. Paulson
Kansas Gas and Electric Company
P.O. Box 208
Wichita, Kansas 67201

Reference: KSLO 86-071 TE: 42538/42526
Sub: HIC/Filter Cartridge Compatibility Statement

Dear Mr. Paulson:

NuPac Services has reviewed the materials of construction and descriptions provided for the cartridge filters produced at WCGS. We find these filters to be compatible with our company's Enviralloy High Integrity Containers and our internally foamed Polyethylene High Integrity Containers. Use of containers by WCGS must be in conformance with the respective Certificate of Compliance and referenced NuPac Procedures and User's Guides for these containers.

I have also enclosed current copies of the State Certificates of Compliance for all HIC's we have licensed for shallow land burial.

NuPac Services appreciates the opportunity to be of service to WCGS and we look forward to our continued relationship.

Sincerely,

Chuck Fellhauer

Chuck Fellhauer
Customer Services Director

Encl: State Certificates of Compliance for HIC

NuPac Services Brookside Office Park No. 1 Harbison Way, Suite 209 Columbia, SC 29210 (803) 781-0426 Telex 152687 PNSI UD

APPENDIX D: CERTIFICATION OF COMPATABILITY

CHEM-NUCLEAR SYSTEMS, INC. LO-86-SP-.4.

P.O. Box 726 • Barnwell, South Carolina 29812

June 27, 1986

Mr. Lon Paulson
Kansas Gas and Electric Company
P. O. Box 20
Wichita, Kansas 67201

Dear Mr. Paulson:

Please be advised that Chem-Nuclear Systems, Inc. has performed testing to demonstrate the capability of Chem-Nuclear Systems, Inc. high integrity containers to receive filter cartridges provided the internal surfaces of the high integrity container are protected with polyurethane foam. The maximum weight of a single filter that can be placed in the container is eighty pounds.

This testing demonstrates the effectiveness of the foam cushioned container to withstand the impact of placing the filters in the container. The user retains responsibility to insure that the filters placed in the container are placed with care to insure that the container is not damaged by the loading process.

Yours truly,

Samuel D. Pearson, P.E.
Manager, Liner Operations

SDP/cac

(803) 259-1781 • Telex 2169??

Page 2 of 5

APPENDIX D: CERTIFICATION OF COMPATABILITY

Westinghouse
Hittman Nuclear
Incorporated

A Westinghouse
Subsidiary

Midwest Operations Office
2700 Kaslinger Road
P.O. Box 208
Geneva, Illinois 60134
(312) 232-4133

Refer to:
HN-3968

July 25, 1986

Mr. Wayne Gaul
Radwaste Engineer
Kansas Gas & Electric Company
Heritage Park Nuclear Building
P.O. Box 208
Wichita, Kansas 67202

Subject: Use Of Westinghouse Hittman Nuclear Incorporated RADLOKS
For Filter Storage And Burial

Dear Mr. Gaul:

Westinghouse Hittman's RADLOK line of high integrity containers (HIC's) can accept filter media that meet the criteria set in the enclosed standard STD-D-03-009, Revision 10, of our Users Manual. I have enclosed an uncontrolled copy for your reference. The filters you have described meet this criteria. Should you have any question, you can refer to this procedure or give me a call at the above number.

I have also enclosed a copy of our Certificate Of Compliance for each of the RADLOKs.

Thank you for your interest in our RADLOK product line.

Sincerely,

Doug Jamison
Sr. Project Engineer

DJ:jd

Enclosures

Page 3 of 5

APPENDIX D: CERTIFICATION OF COMPATABILITY

NUS PROCESS SERVICES CORPORATION

July 17, 1986
PS-86-0263-L12

Mr. Lon E. Paulson
Kansas Gas and Electric Company
201 N. Market Street
Wichita, Kansas 67201-0208

Dear Ron:

In response to your June 11, 1986 letter, NUS Process Services does have high integrity containers (HIC's) which can be used for disposal of the filter cartridges produced at the Wolf Creek Generating Station. Those HIC's are produced by IFC Nuclear Associates, Inc. and they are licensed for use at the Barnwell radioactive waste disposal site. A copy of the state certificate of compliance and a flyer describing the HIC are enclosed for your review.

In addition to the IFC HIC, NUS Process Services offers a filter encapsulation liner. This liner encapsulates the filters with cement and is acceptable at the Barnwell and Richland burial sites. This liner also serves as a self shield and can be used for spent filter storage when the filter generating rate is low. NUS Process Services is also in the process of licensing a new HIC that will meet the burial requirements at all waste disposal sites. We expect to have that HIC available early in 1987.

We have several methods available for disposing of your cartridge filters and we stand ready to provide the best one for your particular situation.

Sincerely,

Regan E. Voit
Director,
Waste Management Services

cc: Mike Isom
Gerry Motl
Walt Hipsher

Enclosure: 1) DHEC C of C for HIC
2) NUHIC 120 flyer

REV/dab

A Halliburton Company — 1501 KEY ROAD COLUMBIA S.C. 29201 (803) 256-4355

APPENDIX D: CERTIFICATION OF COMPATABILITY

TFC Nuclear Associates, Inc.

425 Bridgeboro Road
Moorestown, N.J. 08057
(609) 778-4529

July 14, 1986

Mr. Wayne Gaul
Kansas Gas and Electric Company
201 Market Street
P.O.Box 208
Wichita, Kansas 67201

Subject: High Integrity Containers

Dear Mr. Gaul:

In response to Mr. Lon E. Paulson's letter of 6/11/86, this is to certify that all TFC High Integrity Containers are compatible with the mechanical filter cartridges produced by WCGS, as listed in the above referenced letter. Enclosed also please find one(1) copy of our Certificate of Compliance with the state of South Carolina Department of Health and Environmental Control, providing approval for burial at Barnwell, South Carolina.

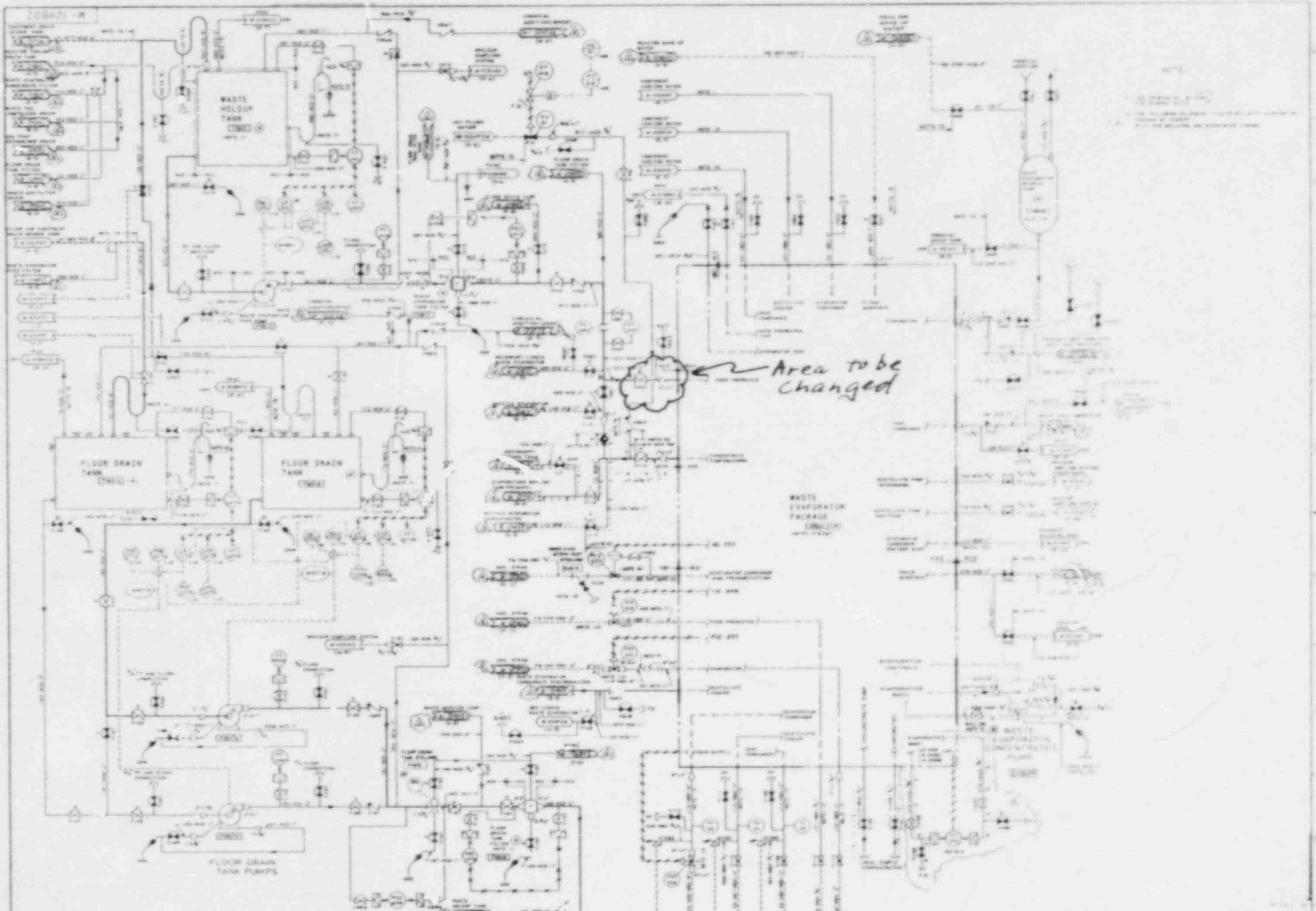
Should you require any additional information, please contact me.

Very truly yours,

John J. Chando, Jr.
President

JJC/cd
Enclosure:

ATTACHMENT 2
PMR Ø1594



WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

Figure 11.2-1

Liquid Radwaste System

Sheet 2

PMR 01594 PG N/A OF N/A

BECHTEL

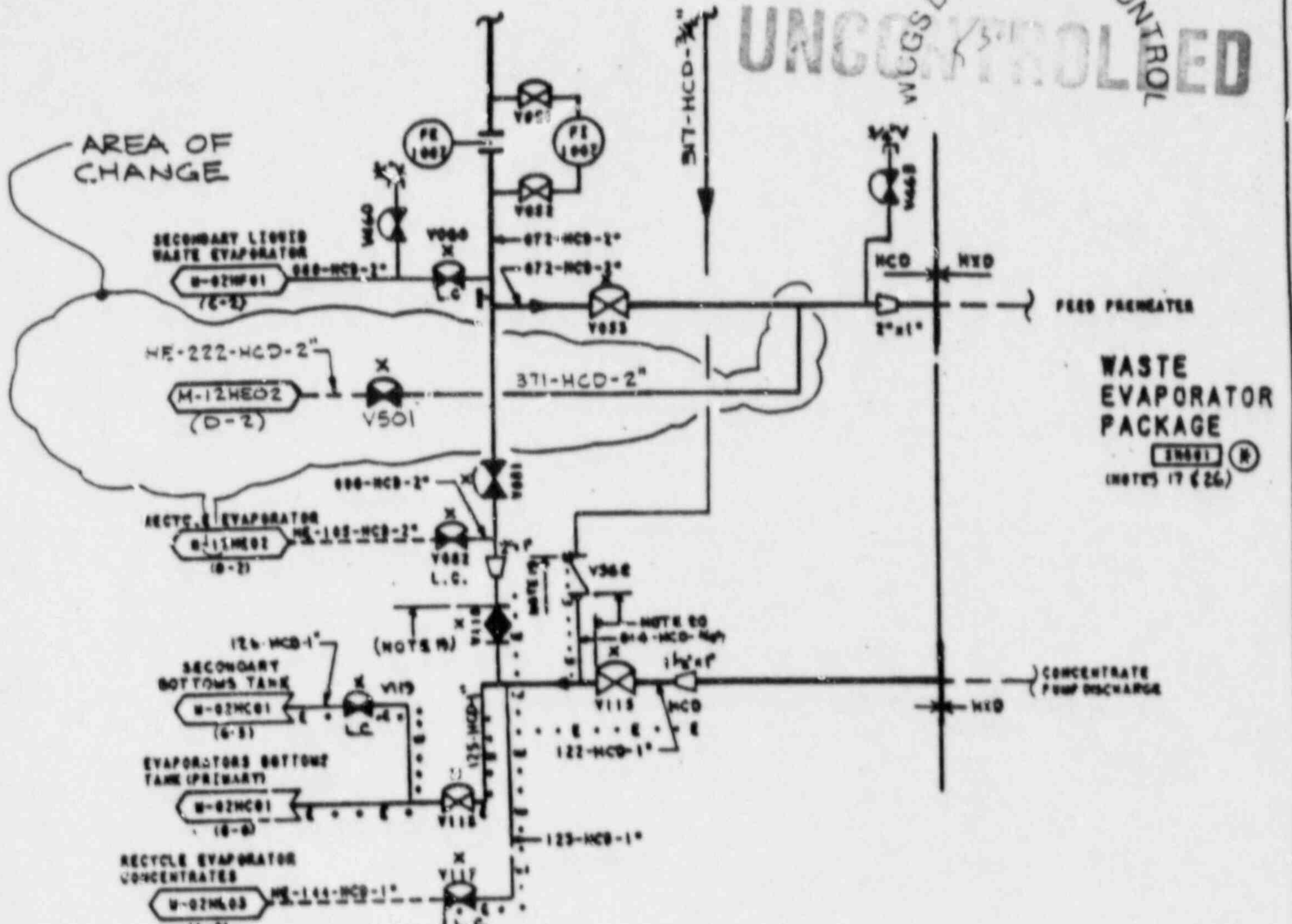
PLANT MODIFICATION PACKAGE CHANGE NOTICE

JOB NUMBER	DATE		
10466	Rel. Date AUG 12 1986		
PMP NO.	DOCUMENT	REV./SUB	CHANGE NO.
PDL-532-W	M-12HB02	1	1

PROJECT APPROVAL: C.M. Herbst

DESCRIPTION OF CHANGE:

ZONE: E-5

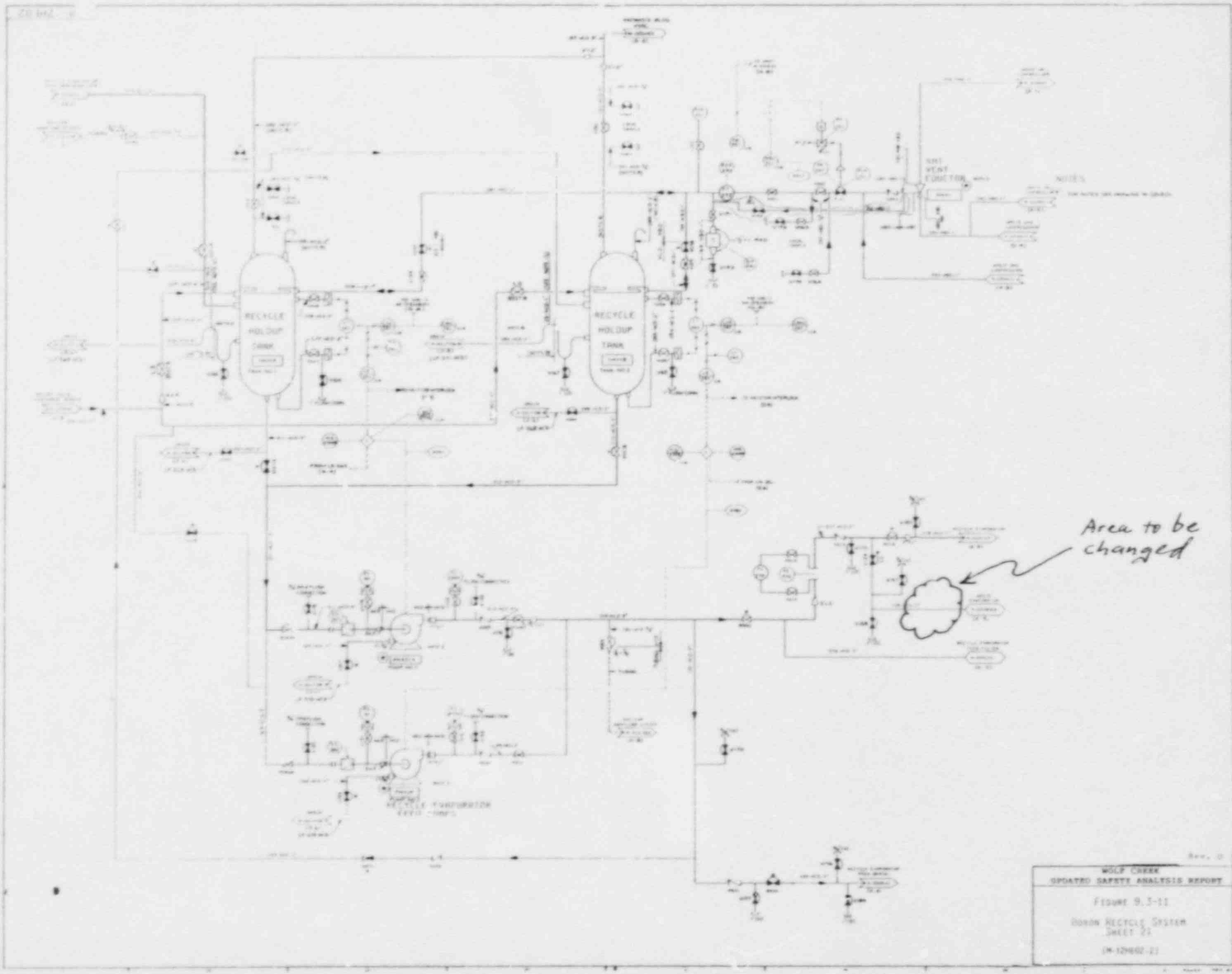


UNCONTROLLED

WCGS DOCUMENT CONTROL

REVIEWED WITHOUT COMMENT	CIVIL/HANGER	MECHANICAL/NUCLEAR/PIPE & VALVE/STRESS	ELECTRICAL/CONTROL SYSTEMS	LAYOUT/ARCHITECTURAL
	N/R	W.T. James, III	N/R	N/R

PREPARED BY	RESPONSIBLE ENGINEER	CHECKER	APPROVED BY	GROUP SUPERVISOR	PAGE	OF
	Dal T. Kim	D. Fox		W.A. Popp	1	1


RECYCLE HOLDUP TANK
RECYCLE HOLDUP TANK
SJET VENT EDUCTOR
NOTES
RECYCLE EVAPORATOR FEED PUMPS
Area to be changed
Rev. 0
WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT
Figure 9.3-11
Boron Recycle System
Sheet 2
(M-12HE02-2)

PMR 01594 PG N/A OF N/A

PLANT MODIFICATION PACKAGE CHANGE NOTICE

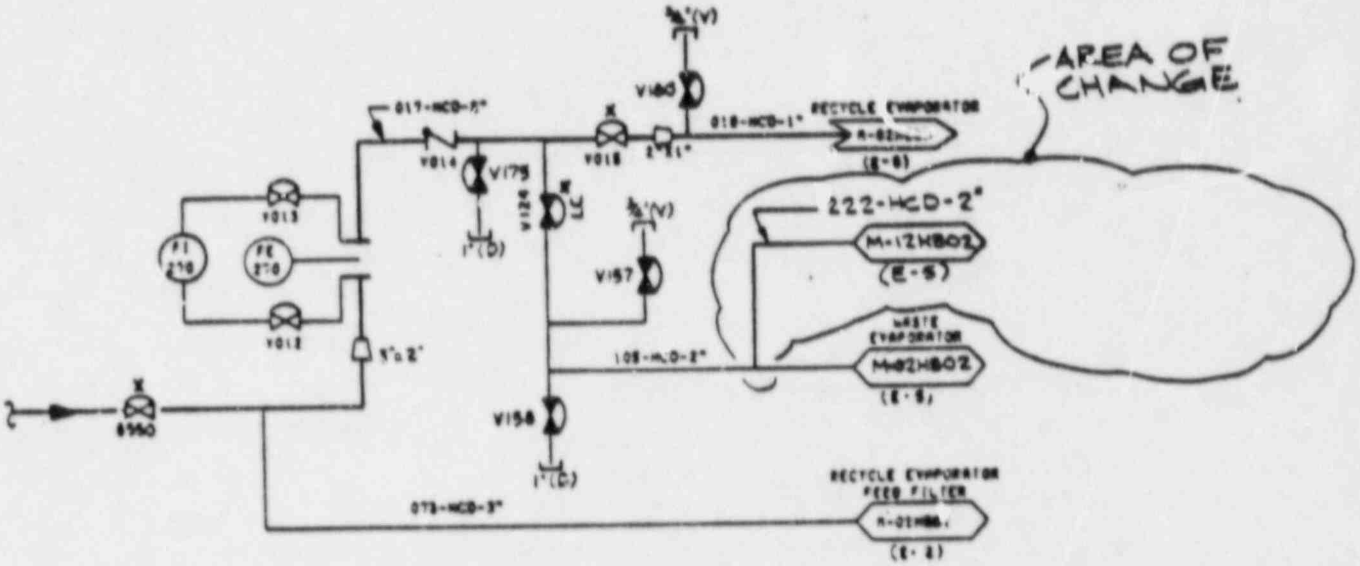
BECHTEL

JOB NUMBER		DATE	
10466		Rel Date DCEL 9-19-86 AUG 12 1988	
PMP NO.	DOCUMENT	REV./SUB	CHANGE NO.
PDL-532-W	M-12HE02	2	1

PROJECT APPROVAL: C.M. Herbst

DESCRIPTION OF CHANGE:

ZONE : D-2



REVIEWED WITHOUT COMMENT	CIVIL/HANGERS	MECHANICAL/NUCLEAR/PIPE & VALVE/STRESS	ELECTRICAL/CONTROL SYSTEMS	LAYOUT/ARCHITECTURAL
	N/R	W.T. James III	N/R	N/R

PREPARED BY	RESPONSIBLE ENGINEER	CHECKER	APPROVED BY	GROUP SUPERVISOR	PAGE	OF
	Cal T. Kim	G. Fox	▶	W.H. Boyce	1	1

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WOLF CREEK
NUCLEAR OPERATING CORPORATION

Bart D. Withers
President and
Chief Executive Officer

August 29, 1988

WM 88-C211

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, D. C. 20555

Subject: Docket No. 50-482: Semiannual Radiological Effluent Release Report

Gentlemen:

Attached is the Wolf Creek Generating Station Semiannual Radiological Effluent Release Report covering the period from January 1, 1988, through June 30, 1988. This report is submitted pursuant to section 6.9.1.7 of the Wolf Creek Generating Station, Unit No. 1, Technical Specifications.

Very truly yours,

BDWithers

Bart D. Withers
President and
Chief Executive Officer

BDW/jad

Attachment

cc: B. L. Bartlett (NRC), w/a
D. D. Chamberlain (NRC), w/a
R. D. Martin (NRC), w/a
P. W. O'Connor (NRC), w/a (2)

IE48
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