REF. #2

NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

Total Number of Document Pages 10
Total Number of Alphanumeric Pages —
Total Number of Attachment Pages —
Total Number of Appendix Pages —

CALCULATION TITLE PAGE

Calculation Number : GL89-10-1243 M2 Revision No. : 1

TITLE : Containment Recirculation Sump Evaporation

Responsible Discipline : Millstone 2 Design Engineering / Mechanical Engineering

Prepared By : M. H. Bates (signed) (printed) Date : 7/26/95

Reviewed By : J. M. Park (signed) (printed) Date : 7/26/95

Approved By : S. Hou Uranio (signed) (printed) Date : 7/27/95

PMMS Codes		
Structure	System	Component
AB	CS/2309	2CS-K.1A&B

Computer Code	Rev. No. / Level
H.H.	

Quality Assurance Category

Nuclear Indicator

- [X] - Quality Assurance Category I
- [ ] - Fire Protection Quality Assurance
- [ ] - Rad Waste Quality Assurance
- [ ] - Anticipated Transient Without Scram
- [ ] - Non-Quality Assurance

Superseded By : —

Method of Review : —

Date CTP
Data Entered : —

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CTP DATA BASE INPUTS

NUSCO [X]
(A/E)/Other [ ]

Calculation No. : GL89-10-1243M2

Latest Rev. : 1

Date : 2/26/95

TITLE : Containment Recirculation Sump EVAPORATION

QA (y/n) : yes

Calculation Change Notice Number : _____

Superseded By : _____

Plant	PA Number	Component ID	Computer Code	Rev. No. / Level
MP2	N.A.	2CS-16.1A&B	N.A.	N.A.

PMMS Codes

Structure	System	Component	Reference Drawings	Sheet	Reference Calcs.
AB	CS/2309	2CS-16.1A&B	25203-24030		N.A.

Comments : _____

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CALCULATION CHECKLIST

Calculation Number : GL89-10-1243M2

Revision No. : 1

Date : 7/26/95

		Initials
1.	**Preparation**	
1.1	Section 6.1.2	MHS
1.2	Section 6.1.3	MHS
1.3	Section 6.1.4	MHS
1.4	Section 6.4.6	MHS
2.	**Verification**	
2.1	Section 6.2.2.1	JMP
2.2	Section 6.2.2.2	JMP
2.3	Section 6.2.2.3	JMP
2.4	Section 6.2.2.4	JMP
2.5	Section 6.2.2.5	JMP
2.6	Section 6.2.2.6	JMP
2.7	Section 6.2.2.7	N/A
2.8	Section 6.2.2.8	JMP
2.9	Section 6.2.2.9	JMP
2.10	Section 6.2.2.10	N/A
2.11	Section 6.2.2.11	JMP
2.12	Section 6.2.2.15	JMP

		Initial & Date
3.	**Approval**	
3.1	Section 6.3.1	K.W.W. 7/27/95
3.2	Section 6.3.2	K.W.W.
3.3	Section 6.3.3	K.W.W.
3.4	Section 6.3.4	K.W.W.
3.5	Section 6.3.5	-NA-
3.6	Section 6.3.6	K.W.W. 9/27/95

		Initial & Date
4.	**Non-QA Applications**	
4.1	Section 5.4 waived	
4.2	Section 6.1.4.7 waived	
4.3	Section 6.2 waived	

Basis for Waiver(s)

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SUBJECT Containment Recirculation Sump Evaluation

BY A. H. Hsia DATE 7/26/95

CHKD. BY Jim Park DATE 7/26/95

CALC. NO. CE1-16-1293-M2 REV. 1

SHEET NO. 5 OF 10

REVISION STATUS

Rev No.	Date	Description/Reason for Revision	Affected Pgs.
1	7/26/95	• Acceptable water height in the sump was revised • More accurate temperature measurement data was found for the reactor containment	6 of 10, 7 of 10 8 of 10, 10 of 10

1.0 ANALYSIS OBJECTIVE

The objective for this calculation it to determine the period of time required to evaporate the Containment Recirculation Sump piping from a full level to an elevation of - (24'-0") during normal plant operation. 1

BACKGROUND

To eliminate pressure locking concerns with Containment Sump Isolation Valves 2-CS-16.1A&B, the piping on the containment side must remain full of water. This piping is isolated from the system pressure and is exposed to the containment atmosphere at the Containmant Recirculation Sump. Because of the sump height relative to 2-CS-16.1A&B, a certain amount water can evaporate before the potential exists for pressure locking. This calculation will determine how long it will take for this water to evaporate.

2.0 DESIGN INPUTS

2.1 Plant Piping Drawing 25203-24030
2.2 Technical Specification Section 3.6.1.5
2.3 Plant Containment Trend Data for normal operation

3.0 ASSUMPTIONS

3.1 The reactor containment dry bulb temperature and dew point temperature is assumed to be 88 °F and 70 °F respectively at the sump level. Both the dry bulb and dew point temperatures are based on operating data, shown in Attachment 1 measured in the vicinity of the sump. The worst case dry bulb temperature was conservatively rounded from approximately 86 °F to 88 °F and the worst case dew point was conservatively rounded from approximately 75 °F to 70 °F. 1

3.2 The containment sump piping water temperature is assumed to be 88 °F. This number is conservative since the concrete floor will tend to cool the water in the pipe.

3.3 Prandtl number (Pr) and Schmidt number (Sc) are both equal to one. This assumption is most valid for heat/mass transfer when direct contact exists between the air and water. This assumption is also valid for smooth water surfaces. Both conditions exist for this evaluation.

3.4 The reactor containment atmosphere will not change with evaporation of the water in the pipe. This assumption is conservative since the evaporation rate would decrease with increases in room humidity.

3.5 The air flow across the water surface in the pipe will be minimal. A surface heat transfer coefficient for still air will be assumed for this calculation (1.65 BTU/hr-ft^2-°F per Reference 7.1).

3.6 The reactor containment is at atmospheric pressure. This is conservative since the containment pressure is slightly above atmospheric pressure which would decrease the rate of evaporation.

4.0 METHOD OF CALCULATION

Hand calculation which calculates evaporation using plant operating and design data.

5.0 ANALYSIS

The mass transfer at the water surface was calculated using the following expression:

$$M_w = h_m A \rho (W_w - W_{room})$$ Equation 12-13a Ref. 7.2

where:
- A = exposed pipe area
- h_m = mass transfer coefficient
- W_w = water surface humidity ratio (100% saturated at the surface)
- W_{room} = room humidity ratio given room dry bulb temperature and dew point temperature
- ρ = density of dry air

The mass transfer coefficient was calculated using the following expression:

$$h_m = h / \rho C_p$$ Equation 12-16a Ref. 7.2

where:
- h = surface heat transfer coefficient (1.65 Btu/hr-ft^2-°F)
- C_p = specific heat for air (0.24 Btu/lbm °F)

Reactor Containment Conditions:

Room dry bulb	88 °F (548 °R)	
Room dew point temperature	70 ° F per Attachment 1	
Room humidity ratio (W_{room})	0.016 lb moisture/lb dry air -	Psychrometric Chart

Water Conditions

Water temperature	88 °F (548 °R)	
Water humidity ratio (W_w)	0.029 lb moisture/lb dry air -	Psychrometric Chart- assuming saturated at the water surface.

1

Calculation of room air density:

$$\rho_{room} = P / RT = (14.7*144) / (53.34*548) = 0.0724 \text{ lb/ft}^3$$ Ref. 7.1 Eq 6.45

Calculation of mass heat transfer coefficient h_m:

$$h_m = h / \rho C_p$$

$$h_m = 1.65/(0.0724*0.24) = 94.95 \text{ ft/hr}$$

Calculation of cross sectional area of 30 inch diameter stand pipe:

$$\text{Area} = [\pi (D^2)] / 4 = [\pi (30/12)^2] / 4 = 4.9 \text{ ft}^2$$

Calculation of cross sectional area of 24 inch Sch 10S pipe section:

$$\text{Area} = [\pi (23.5/12)^2] / 4 = 3.01$$

Calculation of mass transfer M_w for the 30 inch pipe stand:

$$M_w = h_m A \rho (W_w - W_{room})$$

$M_w = (94.95)*(4.9)*(0.0724)*(0.029 - 0.016) = 0.438$ lb/hr

Calculation of mass transfer M_w for the 24 inch pipe:

$$M_w = h_m A \rho (W_w - W_{room})$$

$M_w = (94.95)*(3.01)*(0.0724)*(0.029 - 0.016) = 0.269$ lb/hr

Calculation of the 30 inch pipe evaporation period:

The 30 inch pipe is 15 inches in length and has a 6 inch transition to the 24 inch pipe as shown on Reference 7.3 . Since the larger pipe has more surface area, the transition length will be calculated at the larger diameter.

Time = (62.4 lb/ft^3)(21/12 ft)(4.9 ft^2)/ 0.438 lb/hr = 1221.6 hours

Calculation of the 24 inch pipe evaporation period:

The 24 inch section is 1.88 ft from the reducer to Elevation - (24'-0") as shown on Reference 7.3.

Time = (62.4)(1.88)(3.01)/(0.269) = 1312.7 hours

Calculation of total time for evaporation:

Total time = 1221.6 + 1312.7 = 2534.3 hours (105.6 days)

6.0 SUMMARY OF RESULTS

During normal operation the containment sump piping will evaporate from "full" to an Elevation of - (24'-0") in a period of approximately 2534.3 hours (105.6 days).

7.0 REFERENCES

7.1 Mechanical Engineering Reference Manual, Eighth Edition, Michael R. Lindeburg, Copyright 1990.

7.2 Heating Ventilating and Air Conditioning Analysis and Design, Second Edition, Faye C. McQuistion, Copyright 1982.

7.3 Piping Drawing Number 25203-24030, Section A-A

8.0 ATTACHMENTS

8.1 Trend Data

9.0 APPENDICES - None

Attachment 1

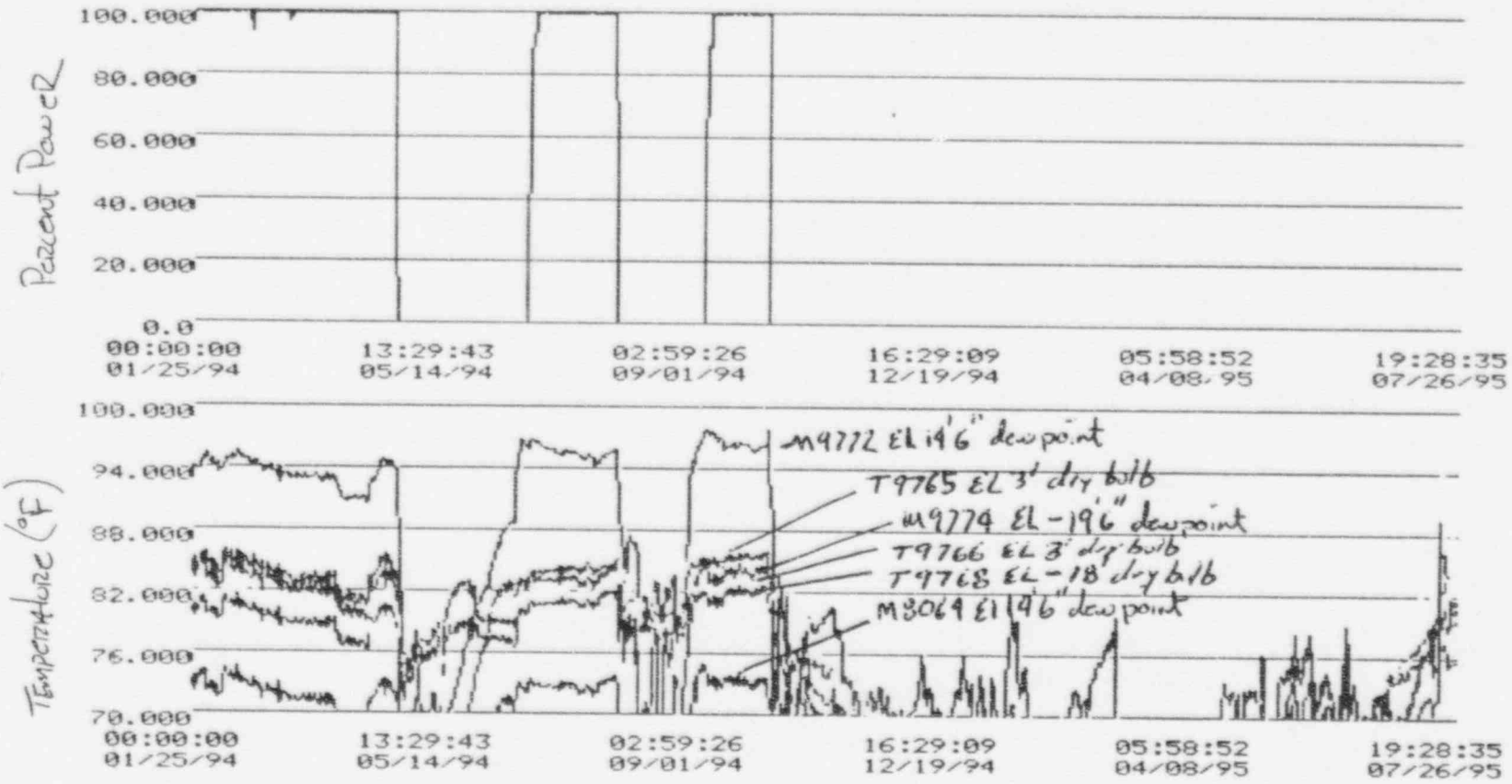
Calculation 6489: 24342
10 of 10

19:35:58
MASTER HOST B

VISUAL TREND 2

as defined by CRT OPSA

OPSAT2 26-JUL-95
Page 1 of 1



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T9765	DEGF	M9772	DEGF						
81.548		80.967		88.745					

ARCHIVE TREND COMPLETE

v1