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An Alternate Method Of ECCS Pump Room Transient Response For Dresden and Quad Cities Stations

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1. INTRODUCTION

At the request of the Nuclear Licensing Department, the Nuclear Fuel Services Department has performed a confirmatory study to demonstrate the conservatism of the method and model used in the original loss of room cooler combined with LOCA (LOCA/LORC) transient analyses for Dresden and Quad Cities Units.

An alternate method with through-wall heat transfer and explicit modeling of torus area was developed. The method was applied to the Dresden LPCI-2A room only because it has the highest transient temperature (smallest margin) during a LOCA/LORC event.

The results of the study show that the original studies for Dresden (RSA-D-90-01) and Quad Cities (RSA-Q-90-02) are conservative and adequate for design applications.

2. DESCRIPTION OF ANALYSIS

2.1 Description of Transient

The scenario assumes a loss of ECCS room cooler combined with a postulated LOCA (LOCA/LORC). The ECCS subsystems are required to mitigate the consequence of a LOCA. The normal ventilation to the pump rooms would cease for the entire transient period; but the mechanical and electrical heat loads would persist and the temperature in the adjacent areas would increase during this period. This analysis conservatively assumes that all of the coolers would fail simultaneously and the ECCS subsystems would operate at full capacity continuously. As presented herein, the resulting temperature of the ECCS rooms would increase throughout the transient following a LOCA/LORC.

2.2 Scope of Analysis

All of the Dresden and Quad Cities ECCS rooms were analyzed in the original analyses (References 1 and 2). In this analysis, the Dresden LPCI-2A room was recalculated because it has the smallest temperature margin (to the EQ limit of 185 degree F) based on the original calculation.

2.3 Computer Code and Analytical Model

RELAP4/MOD6 (Reference 3 and 4) code was used for the analysis. The ECCS room and the adjacent area model is shown in Figure 1. The model consists of six volume nodes (pump room, reactor building, torus air, earth, torus water and atmosphere) , three air flow junctions, two heat generation slabs (ECCS pump and torus shell) and ten heat sink slabs. The heat load are represented by energy addition of pump heat and LOCA torus water. The heat removal is carried out through heat sinks and natural convection by air movement from pump room to EL-517 (reactor building), then to torus area and back to pump room through the openings of the three compartments. The flow paths are modeled using limiting flow areas with conservatively chosen loss coefficients to minimize the amount of natural circulation flow predicted.

2.4 Method of Analysis

The model used in this analysis is similar to the original model (Reference 1) with the following exceptions:

a. Through-wall heat transfer model is used for all three volumes (pump room, torus area and EL-517). The heat transfer characteristics of the twelve heat slabs are taken from ASHRAE Handbook (Reference 5) and are shown in Table 1.

2. DESCRIPTION OF ANALYSIS (cont'd)

2.4 Method of Analysis

b. Torus area and EL-517/reactor building are explicitly modeled. The limiting LOCA torus water temperature profile (QC UFSAR Fig. 5.2.19, Case d) is used as a forcing function for heat addition to model the torus area transient temperature. The Quad Cities profile is used because the Dresden profile is not available. Dresden profile is expected to be similar to that of Quad Cities.

c. Three additional volumes (Vol-4: earth, Vol-5: torus water, and Vol-6: atmosphere) are added in the revised model (Figure 1).

3. RESULTS OF ANALYSIS

The revised transient temperature for LPCI-2A room resulting from a LOCA/LORC is given in Figure 2. Also shown are the torus water, torus area and original LPCI-2A temperatures. The LPCI-2A room temperature rises are rapid initially. After about two days into the transient, the room temperature assume a more gradual increase and eventually level off at the end of five days. The room's thirty-day maximum temperatures for the original and revised models are 184 and 181 degree F, respectively.

The temperature response in the torus area is similar to the response of the torus water given in Figure 5.2.19 of the QC UFSAR. The temperature increases to a maximum shortly after a LOCA but drops significantly in a short period of time. The initial elevated torus area temperatures do have some effects on the pump room heat-up rate but a small effect on its final temperature. This is mainly due to the through-wall heat transfer model used in the revised model. The original model does not credit the through-wall heat transfer and has yielded a very conservative pump room transient temperature. A comparison of the original and revised results demonstrated that the neglected through-wall heat transfer could be easily offset by a slightly lower long-term steady state temperature in the adjacent areas. Therefore, the original model is determined to be adequately conservative.

A list of computer runs is given in Appendix A and microfiche of the computer runs are maintained in RSA calcnote file RSA-D-92-02.

4. CONCLUSIONS

The temperature response following a LOCA/LORC for Dresden LPCI-2A room was recalculated using the revised model. This room was selected because it has the highest transient temperature (smallest margin to the EQ limit of 185 degree F) based on the original calculation. The revised maximum temperature is 181 degree F which is bounded by the original results of 184 degree F. Based on the calculation using the revised model, we conclude that the results presented in RSA-D-90-01 (for Dresden) and RSA-Q-90-02 (for Quad Cities) are a conservative representation of LPCI/RHR pump room transient temperature during a postulated LOCA/LORC event for Dresden and Quad Cities Stations.

5. REFERENCES

1. "ECCS Pump Room Transient Response to Loss of Room Cooler for Dresden Station Units 2 and 3", RSA-D-90-01, Rev. 0, April 1990.
2. "ECCS Pump Room Transient Response to Loss of Room Cooler for Quad Cities Station Units 1 and 2", RSA-Q-90-02, Rev. 0, August 1990.
3. "RELAP4/MOD6 - A Computer Program for Transient Thermal-Hydraulic Analysis of Nuclear Reactor and Related Systems", EG&G Idaho, Inc., CDAP TR 003, January 1978.
4. "RELAP4/MOD6 Certification", RSA-M-85-01, Rev. 0, 2/28/85.
5. ASHRAE Handbook of Fundamentals

Figure 1: RELAP4/MOD6 ECCS PUMP Room Model

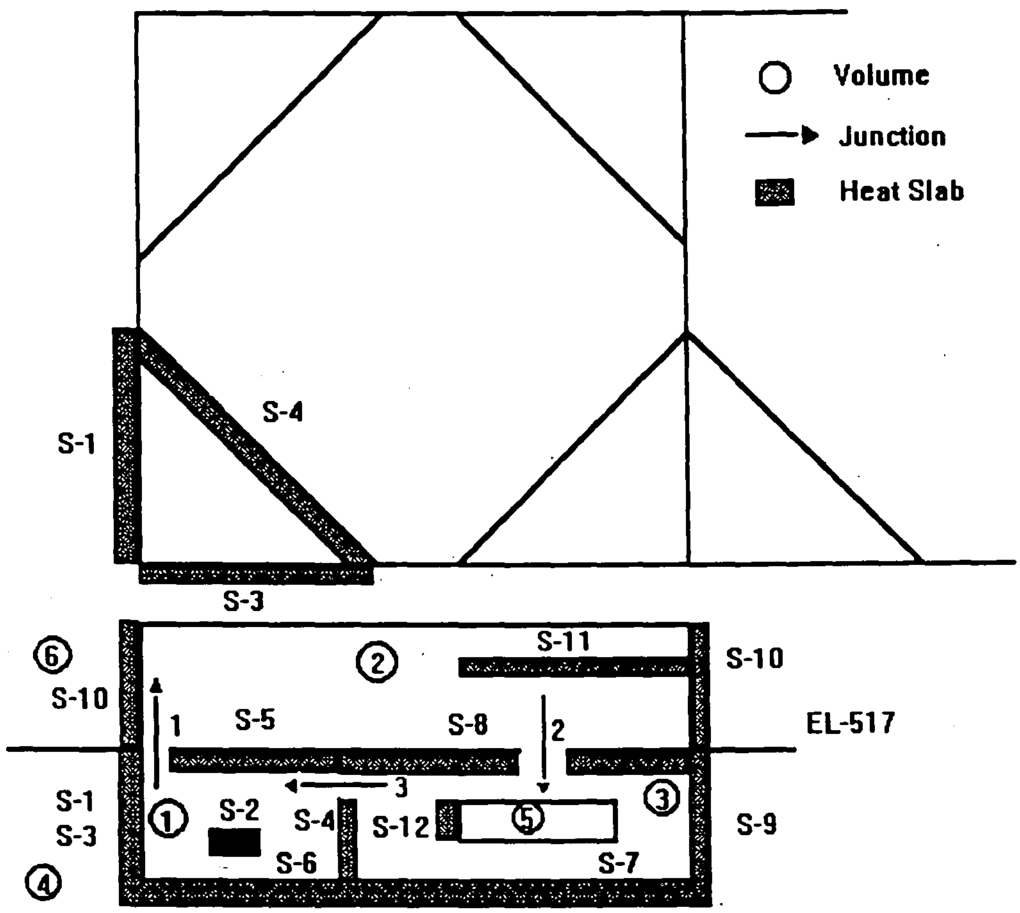

Figure 2: ECCS Pump Room Temperature Following LOCA/LORC

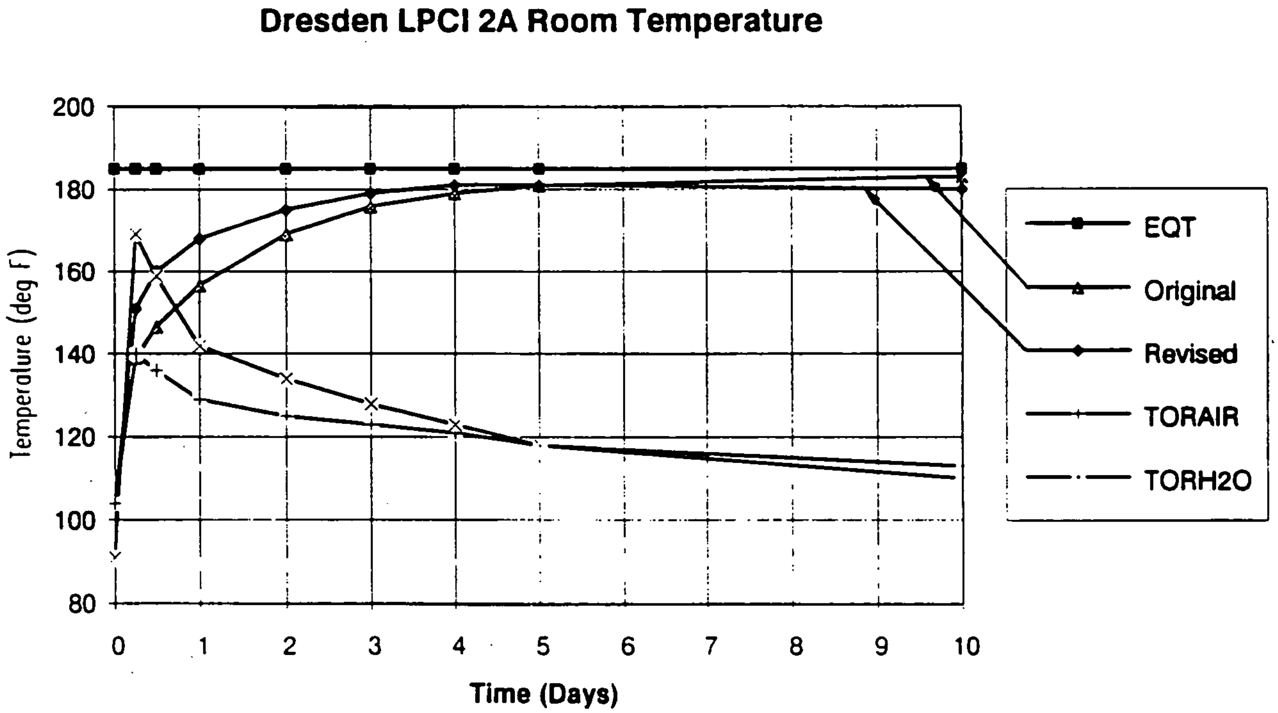

Table 1: Heat Slab Characteristics

DRSLAB.XLS

Slab No.	Description	LV	RV	Area (ft2)	AHTL (ft2)	AHTR (ft2)	Vol (ft3)	hi (*)	ho (*)	T (ft)
1	Pump room side wall to earth	1	4	1480	1480	15	2960	5	0.05	2
2	Pump	0	1	100	0	100	10			
3	Pump room side wall to earth	1	4	1480	1480	15	2960	5	0.05	2
4	Pump room side wall to torus	1	3	2080	2080	607	4160	5	1.46	2
5	Pump room side wall to EL-517	1	2	640	640	138	1280	5	1.08	2
6	Pump room floor to earth	1	4	685	148	7	2055	1.08	0.05	3
7	Torus area floor to earth	3	4	6515	1407	65	19545	1.08	0.05	3
8	Torus area ceiling to EL-517	3	2	6515	2124	1407	13030	1.63	1.08	2
9	Torus area side wall to earth	3	4	4560	1332	46	9120	1.46	0.05	2
10	Reactor building outside walls	2	6	35368	10327	28294	70736	1.46	4	2
11	Reactor building interior walls	2	2	38695	12615	8358	77390	1.63	1.08	2
12	Torus shell to torus area	5	3	16137	1.00E+06	4712	20	300	1.46	0.001
	* = BTU/ft2-hr-F									

Appendix A: Listing of Computer Runs

Job ID #	Date	# of Fiche	Description
NFSRTA(3896)	8/03/92	4	LPCI2A

ENCLOSURE 2

CECo Calculation RSA-D-92-04

An Evaluation of Loss of HPCI Room Cooler at Dresden Station