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JOHNSON,A.R. Project Directorate I-3

SUBJECT: Responds to NRC 920130 ltr re deficiency noted in Svc Water Sys Operational Performance Insp Rept 50-244/91-201. Summary of formalized analysis supporting existing TS 3.3.4 re operability of only one loop header encl.

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September 1, 1992

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U.S. Nuclear Regulatory Commission
Document Control Desk
Attn: Allen R. Johnson
Project Directorate I-3
Washington, D.C. 20555

Subject: Service Water System Operational Performance Inspection (SWSOPI)
Response to Deficiency 91-201-08
Inconsistency between Licensing Basis and Technical Specification Operability Requirements
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Ref. (a): Letter from S. A. Varga, NRC, to R. C. Mecredy, RG&E, Subject: Service Water System Operability Performance Inspection (50-244/91-201), dated January 30, 1992

(b): Letter from R. C. Mecredy, RG&E, to S. A. Varga, NRC, 60-Day Response to NRC SWSOPI, dated April 6, 1992

Dear Mr. Johnson:

In the report, Reference (a), Deficiency 91-201-08 was issued identifying an inconsistency between the licensing basis and Technical Specification operability requirements. RG&E provided a 60-day response to this deficiency in Attachment 2 (Action Item 6) of Reference (b). RG&E had performed a preliminary analysis to evaluate the effects of only one service water pump during the recirculation phase post LOCA and indicated that those results were favorable. RG&E committed to formalize that analysis and provide the results.

Attached is a summary of that formalized analysis. This analysis supports existing Technical Specification 3.3.4, which requires only one loop header and two service water pumps be operable. If a single failure of a pump or diesel generator is assumed, this Technical Specification would result in one pump operating, as required by the attached analysis. All Emergency Procedures have been reviewed to ensure consistency with this Specification.

Very truly yours,

Robert C. Mecredy

Robert C. Mecredy

RWE/237

110061

Cert No P034044134

A001 1/1

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Washington, D.C. 20555

U.S. Nuclear Regulatory Commission
Region I
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US NRC Ginna Senior Resident Inspector

SUMMARY REPORT

Long Term Containment Response to

LBLOCA with One Service Water Pump Operating

Introduction

Technical Specifications require two service water (SW) pumps to be operable. However, the UFSAR states that two SW pumps are used for post-accident heat removal during the recirculation phase of a LOCA. A single failure can be postulated that would result in only one SW pump operating during and after an accident, potentially affecting post-accident containment environmental conditions. This analysis was done to demonstrate long term containment response with one SW pump operating during the time period in question, the post accident recirculation phase.

The only accident that results in sump recirculation is a LOCA. A large break LOCA results in more severe containment temperatures and pressures during the recirculation phase than does a small break LOCA. The single failures that result in only one SW pump operating are a failure of one SW pump or a failure of a diesel generator (DG). Since failure of a DG results in loss of a containment spray pump and loss of two containment fan coolers, the DG failure produces the most limiting containment conditions. This is the failure assumed for this analysis. Also, offsite power is assumed not to be available.

Results

The sequence of events is presented on Table 1. The following summarizes the sequence; a more detailed description of the events is provided in the discussion of results.

The break occurs at t=0. The containment spray setpoint plus uncertainties is reached at 12.2 sec. There are two containment fan coolers per train. Only one train is assumed operating because of a diesel generator failure. The second containment fan cooler on the train with the longest actuation time is calculated to be up to speed at 42.5 sec. Containment spray is stopped when containment pressure decreases below 4 psig. This occurs at approximately 2757 sec. Sump recirculation is initiated when RWST level reaches 28%. This occurs at approximately 3979 sec. the Safety Injection pumps are then switched to draw water from the sump and the simulation is terminated at 87000 sec.

The only effect the number of operating SW pumps has on the recirculation phase is the rate at which heat is removed from containment. This evaluation is done to determine any possible impact on the profiles used to qualify equipment.

Figure 2 illustrates containment pressure. Superimposed on the figure is the pressure profile used for equipment qualification (Ref. 6, Fig. 6.1-2). The calculated response does not exceed the profile and reaches an equilibrium pressure of approximately 0.5 psig.

Figure 3 illustrates containment temperature. Superimposed on the figure is the temperature profile used for equipment qualification (Ref. 6, Fig. 6.1-1). The calculated response does not exceed the profile and decreases as the decay heat decreases.

It is concluded that one SW pump is sufficient to provide heat removal during post-accident recirculation.

Analysis

Containment Model

The containment response is calculated using the Gothic[1] computer code with Ginna specific inputs. The model[2] is illustrated on Figure 1 and consists of four lumped volumes which represent containment, sump A, sump B, and the reactor vessel. The model contains 16 thermal conductors which represent passive heat sinks inside containment. One times the Tagami heat transfer coefficient is used to the end of blowdown followed by an exponential decrease to Uchida for surfaces exposed to containment atmosphere. The effect of spray from one spray pump is accounted for. Two containment fan coolers are modeled. The heat removal rate is adjusted for the SW flows expected during the injection and recirculation phases.

During recirculation, water is taken from sump B, passed through the RHR heat exchanger and discharged into the reactor vessel. The discharge mixes with water in the vessel, which is being heated by decay heat, and flows out the break. This modeling is appropriate for Upper Plenum Injection (UPI), where the water is injected above the core and flows through the core, up the downcommer and out the cold leg break.

Decay heat is taken from Ref. 4, increased by 20% until 1000 sec. and 10% after 1000 sec.

The RHR heat removal is based on one RHR heat exchanger with approximately half the nominal component cooling water (CCW) flow. CCW temperature into the RHR heat exchanger is chosen to be constant based on the heat removal rate for two functioning CCW heat exchangers, each assumed at half the nominal SW flow and half the nominal CCW flow. State points from the analysis demonstrate that heat removed during the analysis is less than the heat removal calculated by more detailed heat exchanger calculations. Therefore, the modeling is conservative.

Mass/Energy Input

The mass/energy input to the containment model was taken from Ref. 5. The Ref. 5 data ended at approximately 440 sec. Recirculation is calculated to start around 3979 sec. (28% RWST level). The mass/energy out of the break from 440 to 3979 sec. was simulated by including a Reactor Vessel (RV) volume inside containment. The volume was filled with a saturated water steam mixture saturated at containment pressure at 440 sec. The mixture was heated by decay heat, plus uncertainty, plus an additional 10% decay heat to account for stored energy in the metal and fuel. Low head SI was injected into the volume. The resulting mixture then spilled out the break into containment.

At 3979 sec. RWST level was calculated to be 28%. This is the

level at which the operators are instructed to switch to sump recirculation. The low head SI pump is turned off and suction is switched to the sump. The two high head SI pumps remain running, taking suction from the RWST, until RWST level reaches 15% at which time the high head pumps are turned off. Flow is from the sump though the RHR heat exchanger to the upper plenum of the RV and out the break. This condition continues until the simulation was terminated at 87,000 sec. (24.2 hr.).

Discussion of Results

The sequence of events is presented on Table 1.

Containment Pressure and Temperature - These parameters are shown on Figures 2 and 3. These parameters peak as a result of mass and energy out the break from blowdown and reflood. After the peak, pressure and temperature decrease throughout the injection phase as containment is cooled via spray and the fan coolers. The core is cooled by ECCS water from the RWST.

Spray flow is shown on Fig. 4. The flow (180.3 lbs/sec) corresponds to 1300 gpm which is the minimum expected for one pump operation. Spray is terminated by operator action when containment pressure decreases below 4 psig. (2757 sec.)

ECCS flow continues from the RWST until 28% level is reached. At 4079 sec. sump recirculation flow is started (a conservative 100 sec. is assumed for system realignment. This is less than the 8.5

minutes presented in Ref. 7 but is conservative for this analysis, since the RV water re-saturates at the start of recirculation. More steam is produced if this were done earlier, when decay heat is higher). The warm recirculation water causes boiling to occur in the core resulting in an increase in containment pressure and temperature. After a short period of time decay heat is no longer sufficient to cause boiling. The RV temperature starts decreasing followed by a steady decrease in containment pressure and temperature. Eventually containment pressure reaches an equilibrium and temperature continues to slowly decrease. At approximately 24 hours, containment temperature is below the initial design temperature of 120°F and containment pressure is back within the normal operating band. The containment temperature and pressure are bounded by the values used for equipment qualification.

Containment fan cooler heat removal is illustrated on Fig. 5. The heat removal is for two fan coolers with one SW pump operating in the injection phase. The fan cooler heat removal capacity during recirculation is less than during injection because some SW flow has been redirected to the CCW heat exchanger, which was isolated during the injection phase. Since only one SW pump is running, the flow to the fan coolers decreases.

RHR cooling is illustrated on Fig. 6. At 4079 sec. RHR flow is initiated. Water is taken from sump B at ~218°F and delivered to the reactor vessel upper plenum at ~174°F. The heat exchanger

inlet and outlet temperatures decrease as the sump B water temperature decreases.

RV temperature and flow out the break for 440 to 87,000 sec. is illustrated on Figures 7, 8 and 9. Flow out the break prior to 440 sec. is taken from Ref. 5. At 440 sec. the water in the RV is saturated at containment conditions. RV conditions follow containment pressure and eventually become subcooled. Reductions in the injected flow during the switchover to sump recirculation and the warm sump water causes the water in the RV to again saturate. As decay heat decreases and heat is removed from the sump water the RV becomes subcooled and remains subcooled for the duration of the transient. Steam flow out the break occurs at the times during which the RV liquid is saturated.

Conclusions: This analysis:

1. Demonstrates acceptable containment response and accident mitigation using a single SW pump.
2. Confirms the adequacy of the current Technical Specification requiring two SW pumps operable.

TABLE 1

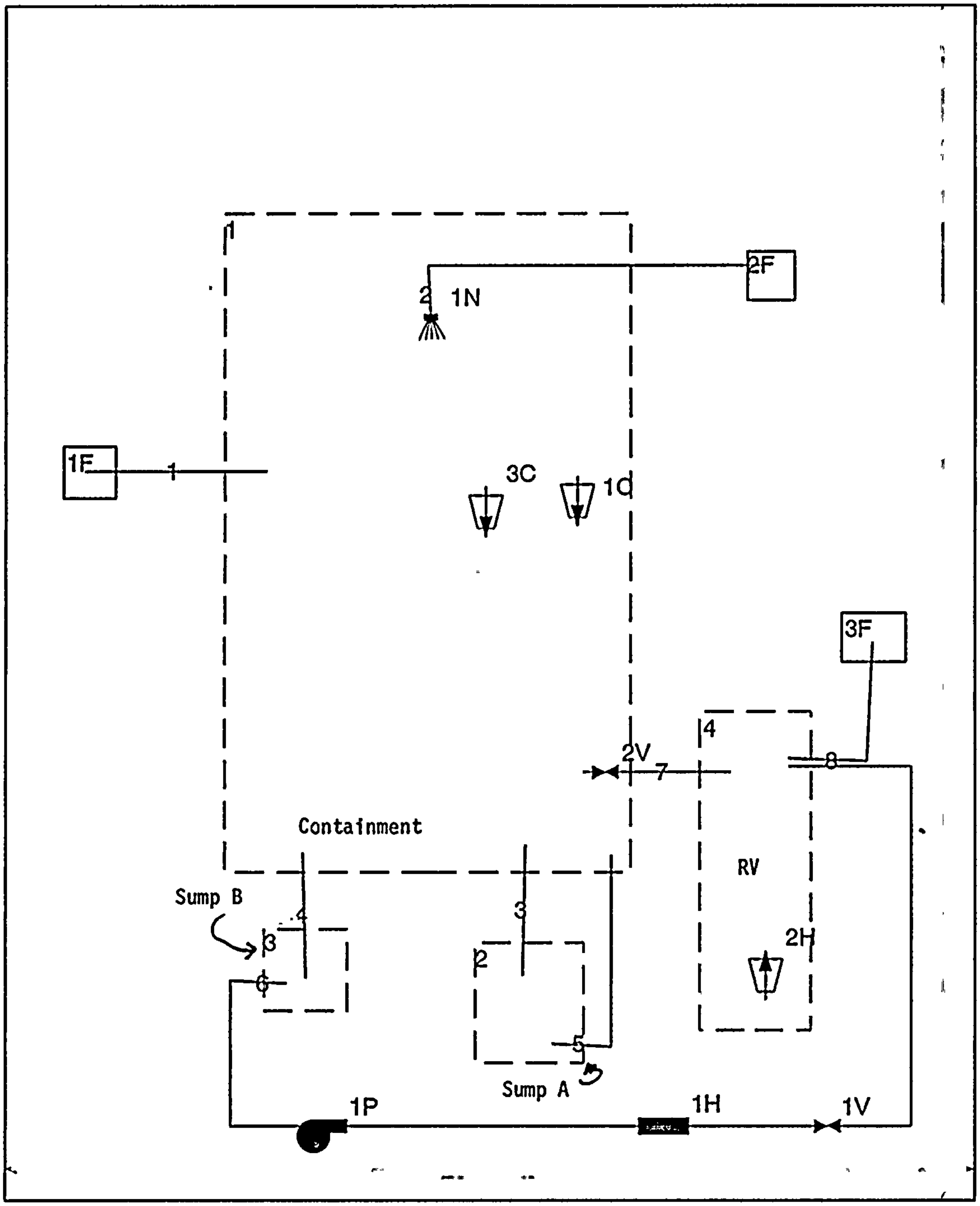
Sequence of Events

Event	Time (sec)
Start	0.0
Containment Spray Setpoint Reached	12.2
End-of-Blowdown	24.8
Start Containment Fan Coolers	42.5
Bottom-of-Core Recovery	44
Stop Containment Spray	2757
28% RWST Level	3979
Reduce Fan Cooler Heat Removal	3984
Start Recirculation Flow from B Sump	4079
Stop High Head SI Flow (15% RWST Level)	7405
Simulation Termination Time	87000

References

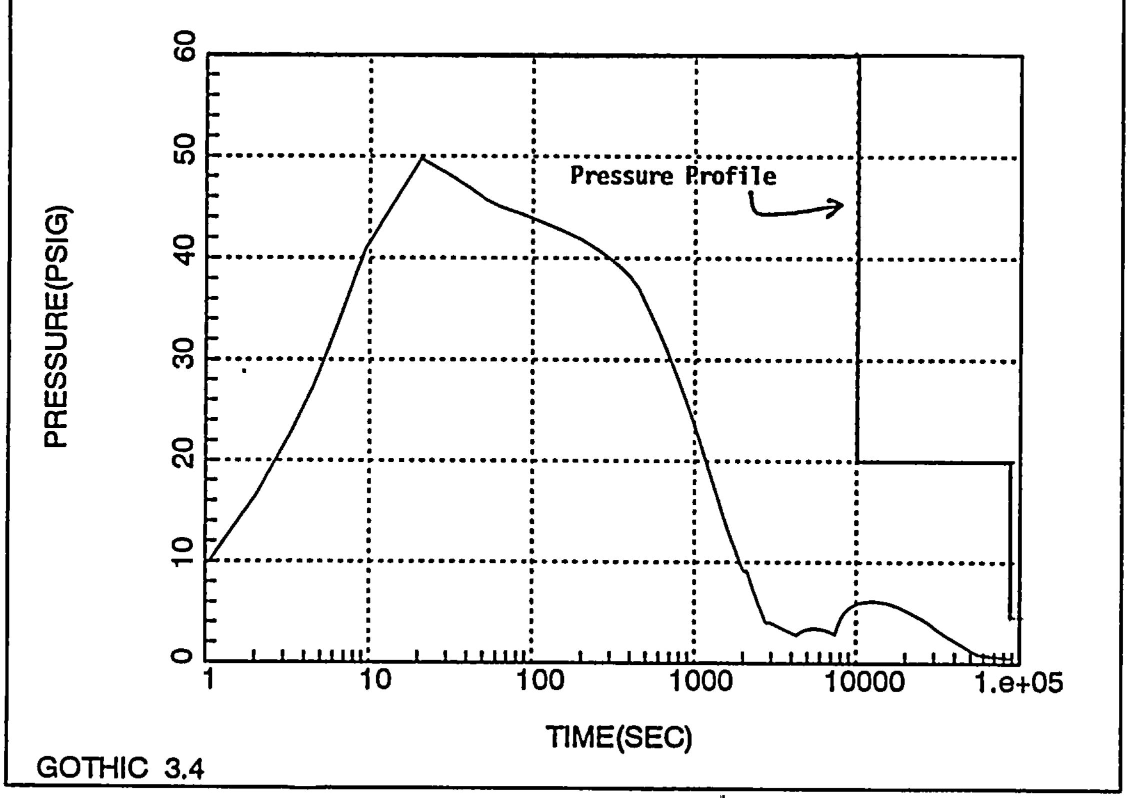
1. Gothic Computer Code Version 3.4 - April 1991
2. Design Analysis, NSL-0000-DA049 "LOCA Recirculation with one SW Pump" Rev. 0, approved 8/31/92
3. Design Analysis, DA-ME-92-019, "Containment Air Cooler SW Flow Sensitivity Study", Rev. 0, approved 8/27/92
4. BTP ASB 9-2 "Residual Decay Energy for Light Water Reactors for Long-Term Cooling" from NUREG 75/087 "Standard Review Plan" dated September 1975
5. Westinghouse Report, "Steam Generator Tube Plugging Increase Licensing Report for Ginna Nuclear Power Station" dated Oct. 1987
6. R. E. Ginna, UFSAR, Rev. 7, dated 12/91
7. J. E. Maier (RG&E) to D. M. Crutchfield (NRC) letter dated June 25, 1982, "SEP Topic VI-7.B, ESF Switchover"

Figure 1

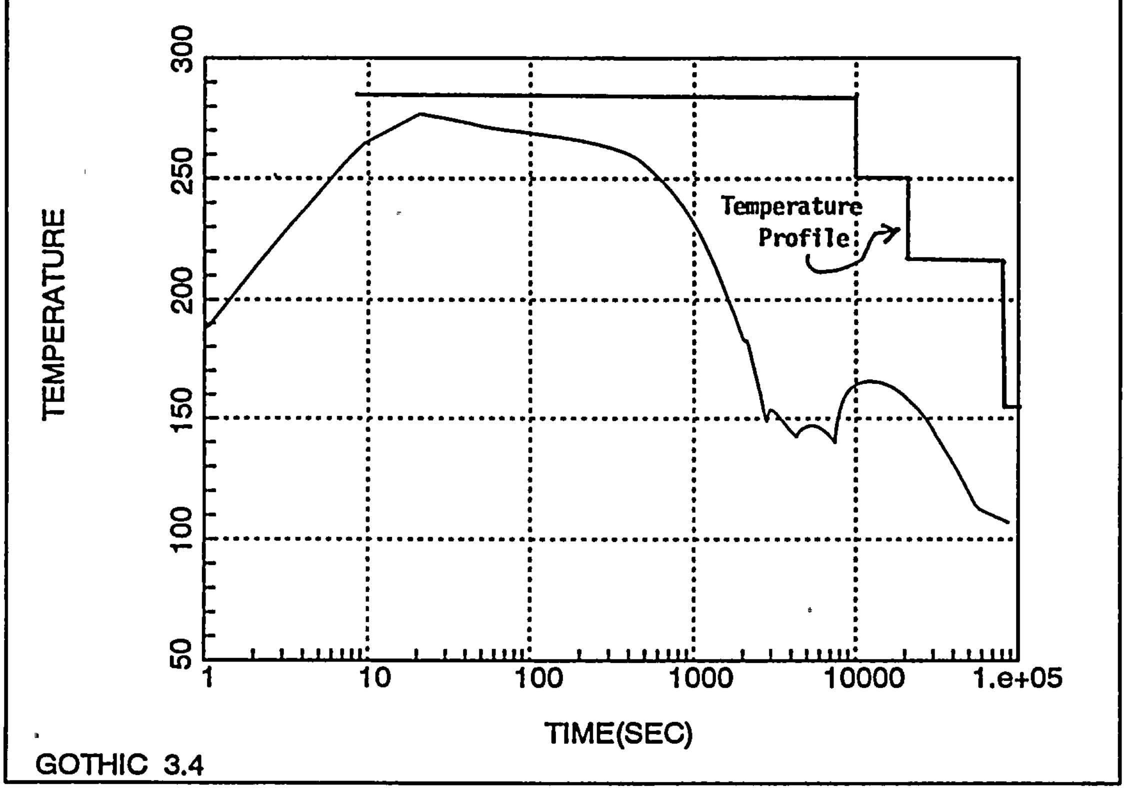


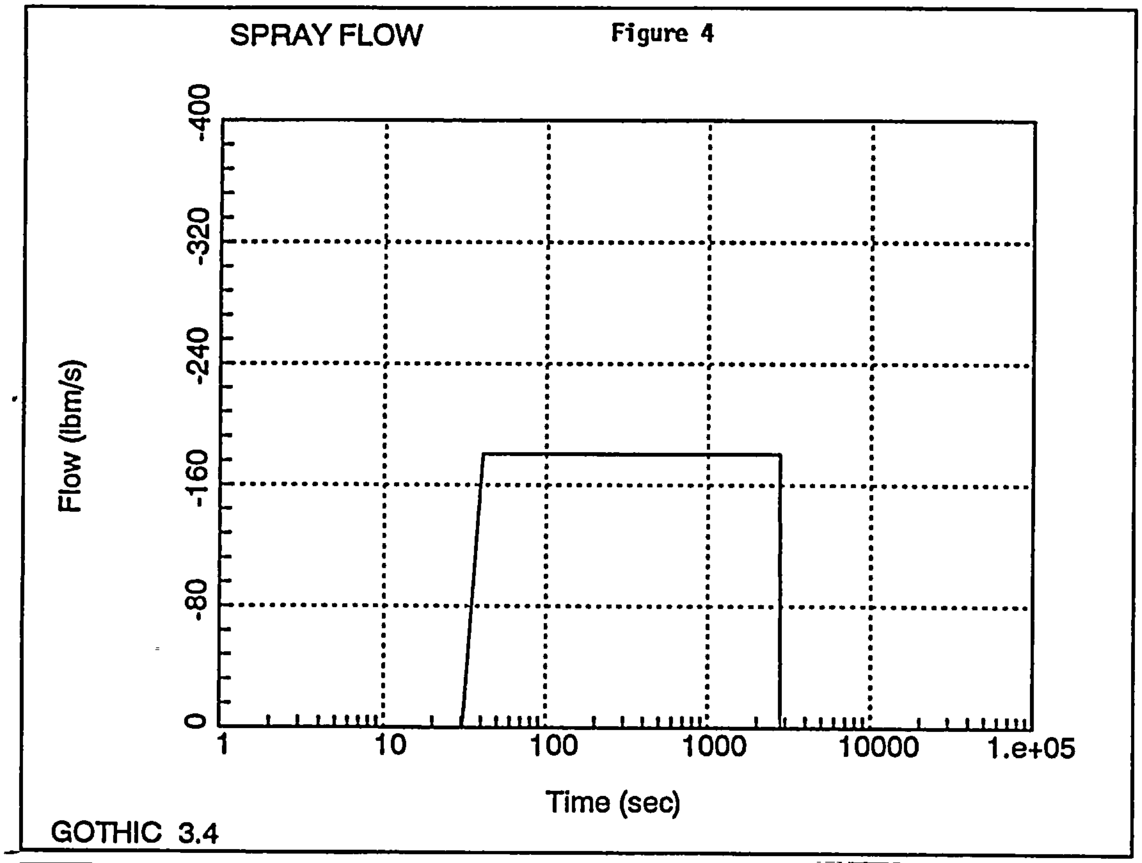
1 through 8	flow paths
1F through 3F	forcing functions (boundary conditions)
1C and 3C	containment fan coolers
1N	containment spray
1V and 2VV	valves
2H	decay heat simulator
1P	low head SI pump
1H	heat exchanger

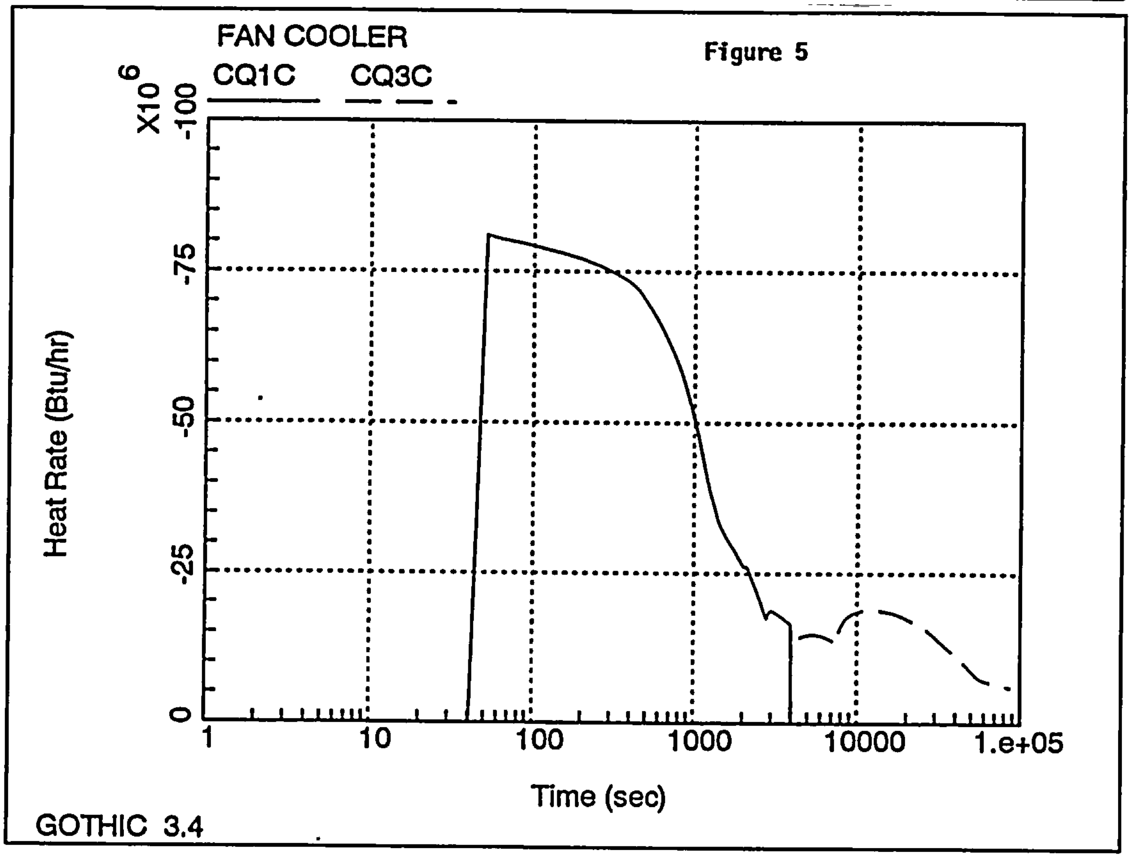
CONTAINMENT PRESSURE Figure 2

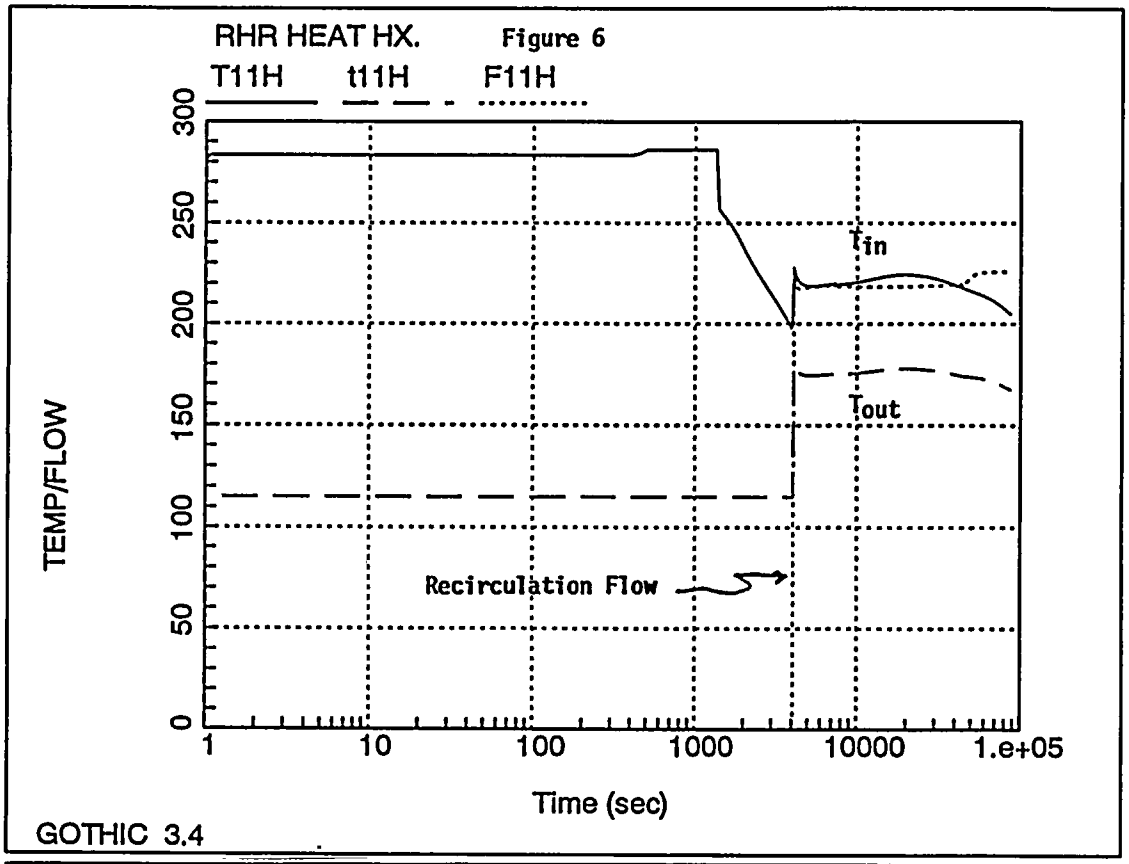


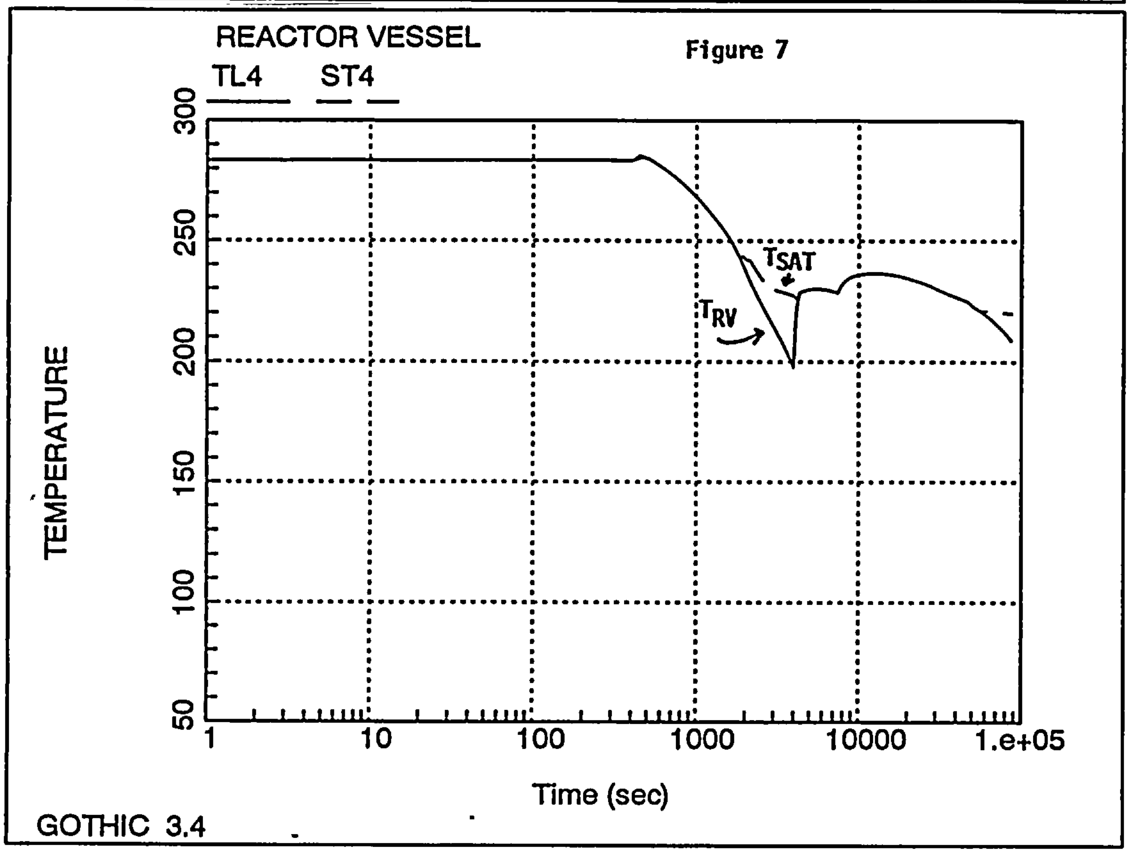
CONTAINMENT TEMPERATURE Figure 3



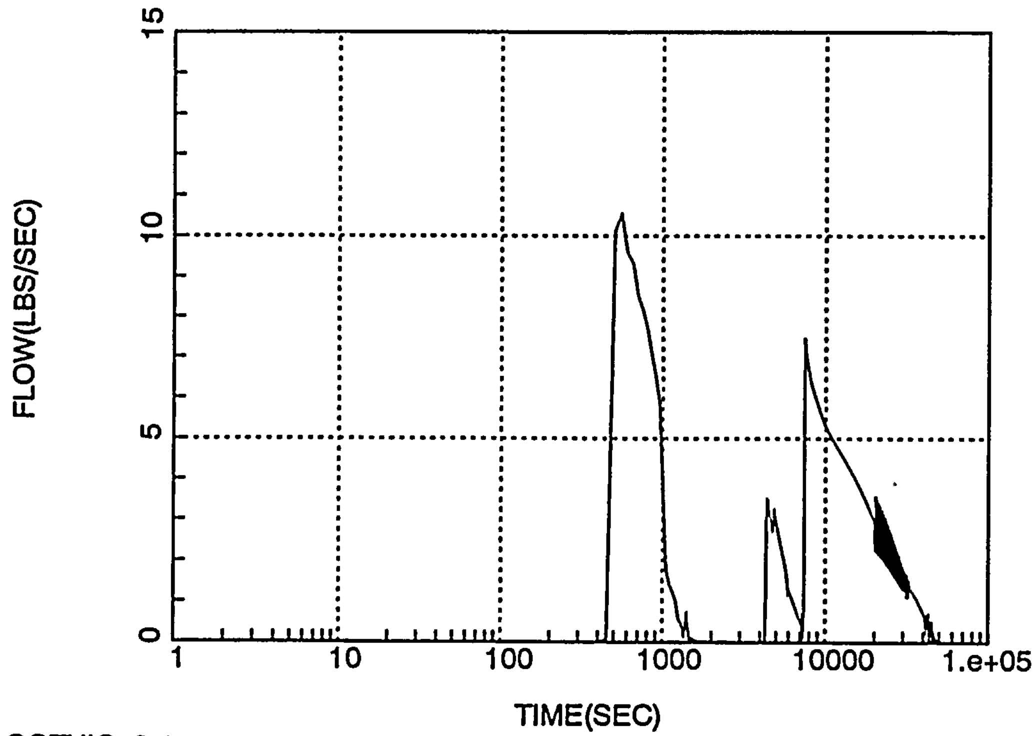

SPRAY FLOW
Figure 4
Flow (lbm/s)
-400
-320
-240
-160
-80
0
1
10
100
1000
10000
1.e+05
Time (sec)
GOTHIC 3.4


FAN COOLER
Figure 5
CQ1C
CQ3C
X10^6
Heat Rate (Btu/hr)
-100
-75
-50
-25
0
1
10
100
1000
10000
1.e+05
Time (sec)
GOTHIC 3.4


RHR HEAT HX.
Figure 6
T11H
t11H
F11H
TEMP/FLOW
Tin
Tout
Recirculation Flow
Time (sec)
GOTHIC 3.4

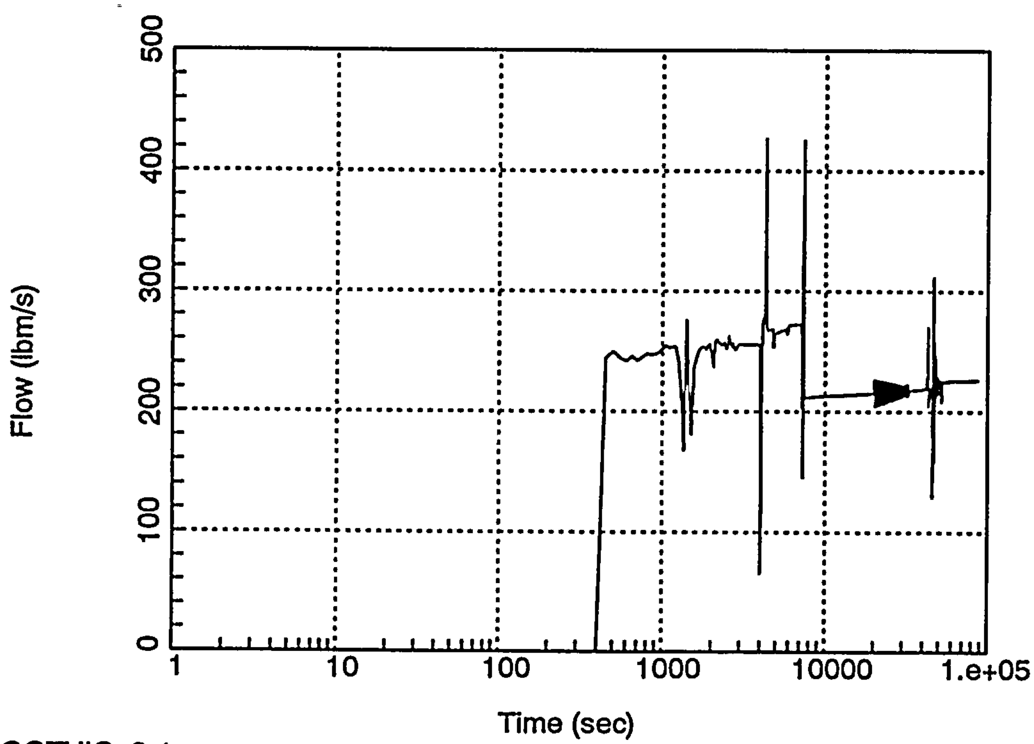

REACTOR VESSEL
Figure 7
TL4
ST4
TEMPERATURE
TSAT
TRV
Time (sec)
GOTHIC 3.4

RV BREAK FLOW VAPOR Figure 8



GOTHIC 3.4

RV BREAK FLOW LIQUID Figure 9



GOTHIC 3.4