Public Service

Public Service Company of Colorado

2420 W. 26th Avenue, Suite 100D, Denver, Colorado 80211

September 28, 1988
Fort St. Vrain
Unit No. 1
P-88344

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Docket No. 50-267

SUBJECT: FSV EQ Program

REFERENCE: PSC Letter, Fuller to Document Control Desk, dated Sept. 15, 1988 (P-88340)

Gentlemen:

The purpose of this letter is to update the NRC on the status of recent issues regarding Public Service Company of Colorado's (PSC) Environmental Qualification (EQ) program for Fort St. Vrain (FSV). As reported to the NRC in Licensee Event Report (LER) 88-12, submitted in the above reference, PSC has re-evaluated the FSV EQ program due to a recent error found in the computer code used to generate the environmental qualification temperature profiles.

Contained in Attachment 1 to this letter is a brief background summary of events leading up to the referenced PSC letter, LER 88-12. The results of a rearalysis of the temperature profiles and the impact on equipment qualification are also included, along with a justification for continued operation until formal documentation of our technical position is achieved, specifically the update of EQ binders.

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As part of the justification for continued operation, the Steam Line Rupture Detection/Isolation System (SLRDIS) requires a new fixed temperature trip to be installed. This modification does not involve an unreviewed safety question (see the PSC safety evaluation in Attachment 2). Plans for a future Technical Specification Amendment are discussed in Attachment 1.

Should you have any questions concerning this matter, please contact Mr. M. H. Holmes at (303) 480-6960.

Very truly yours,

D. W. Warembourg

D. W. Warembourg
Manager, Nuclear Engineering

DWW/MHH:jlw

Attachments

cc: Regional Administrator, Region IV
ATTN: Mr. T. F. Westerman
Chief, Projects Section B

Mr. Robert Farrell
Senior Resident Inspector
Fort St. Vrain

RE-EVALUATION OF FSV EQ PROGRAM

A. Background

As documented in LER 88-12, an error was discovered by General Atomics in the computer program (CONTEMPT-G) used to develop the FSV environmental qualification temperature profiles. This error resulted in nonconservative building temperatures (primarily for smaller breaks) with respect to the original EQ temperature profiles.

Upon notification of this error, numerous corrective actions were initiated, one of which was the review and confirmation of the reported error through the utilization of an independent contractor using a different computer program (COBRA). Following confirmation and benchmarking of a previously analyzed High Energy Line Break (HELB) scenario, additional analyses were performed by Numerical Applications, Inc. (NAI) on a variety of HELB break sizes to establish a new composite profile.

During the NAI reanalyses, it was determined that a number of small HELBs produced higher delayed building temperature peaks than previously analyzed. In order to reduce those peaks for enhancing the qualification of the equipment and to enhance building access, a modification to the Steam Line Rupture Detection/Isolation System (SLRDIS) has been designed to add a fixed high temperature trip. This trip will allow automatic detection and isolation of those breaks which do not produce a building temperature rate-of-rise sufficient enough to trip SLRDIS.

Results of the HELB reanalyses and the impact of these reanalyses on the 10CRF50.49 environmental qualification of electrical equipment are presented below. Also presented is a justification for continued operation while documentation requirements per the FSV EQ program are being completed. In the interest of consistency, an amendment request will be submitted to add the new SLRDIS trip setpoint to the FSV Technical Specifications.

The following definitions may be helpful for understanding the development of FSV's EQ temperature profiles.

* Original EQ temperature profiles - HELB profiles approved for use as the basis for FSV's existing EQ program per Reference 1.

* GA modified CONTEMPT-G profiles - HELB profiles developed by GA using the existing SLRDIS setpoints after the computer code error was found.

* Historical EQ composite temperature profile - A bounding profile for the HELB profiles developed by NAI with the existing SLRDIS setpoints.

* Final EQ composite temperature profile - A bounding profile for the HELB profiles developed by NAI with the SLRDIS modified with the new 180 degrees F trip function.

B. Approach

PSC's approach was divided into two major phases to be conducted in parallel. One phase was to evaluate the impact of the computer code error in terms of our existing EQ program and past operation outside of the limits of our program and 10CFR50.49. The second phase was to evaluate the future impact on the EQ program with reference to continued plant operation and program redefinition.

C. Results of the HELB Reanalysis

As a result of a recent finding that the CONTEMPT-G computer code, which was originally used to generate FSV's original EQ temperature profiles, contained an error, PSC has contracted with NAI to reanalyze these profiles. The analysis utilized the COBRA computer code which is a widely used code in the industry. The analysis also took credit for some additional heat sink areas and building volumes for the scenarios as was done during the NRC validation process for the original EQ temperature profiles. The scenarios used in the reanalysis are the same as in the original analysis. Additionally, SLRDIS system actions were also modeled into the NAI analyses, whereas the original EQ temperature profiles were developed using manual SLRDIS input.

The temperature profile reanalysis performed by NAI utilizing the COBRA computer code was used to analyze the building temperature profiles based on inputs provided by PSC. For the scope of the analysis, the following inputs were used:

* The building parameters (except heat sink areas, building volumes and heat transfer coefficients) are the same as in the original analysis which form the EQ program basis.

* The building heat sink areas, building volumes and heat transfer coefficients are the same as that used in the validation process of the original analysis. The data was submitted to the NRC via References 2 and 3 and the NRC approved PSC's original EQ temperature profiles based on this data per Reference 1.

* The reanalysis took credit for radiant heat transfer using the same analysis techniques used in the validation process by the NRC (References 2 and 3).

* The heat sink node points were modeled the same as in the original analysis.

* The COBRA code was modified to model the effects of the SLRDIS system. The original 135 degrees F pre-trip alarm was utilized along with the rate of rise trip setpoint of 55 degrees F/min (analysis value).

* For the scenarios relying on the 135 degrees F pre-trip alarm, a consistent 11 minute time delay was used in the analysis. This time delay followed the alarm and was used to simulate a 10 minute decision period followed by operator action to isolate the break.

As a result of the reanalysis, a revised historical EQ composite temperature profile was developed and is shown in Figures 1 and 2 of this attachment. The single historical EQ composite profile envelops all of the scenarios in both the Reactor and Turbine Buildings. This historical EQ composite temperature profile was used to evaluate the historical status of equipment qualification prior to the new fixed temperature SLRDIS setpoint modifications.

In order to simplify equipment qualification and enhance operator access following a HELB, a fixed temperature setpoint was selected to be used to isolate some of the small HELBs which could create harsh environments, but which were not automatically isolated with the existing SLRDIS system. A fixed temperature setpoint of 180 degrees F (analysis value) was selected and the resulting final EQ composite temperature profile is shown in Figures 3 and 4. The single composite profile again envelops both the Reactor and Turbine Building breaks and will be used as the basis for future equipment qualification.

The modification to the SLRDIS does not affect the existing 135 degrees F alarm or the 55 degrees F/min rate-of-rise trip function. The new 180 degrees F fixed temperature trip function will not involve an unreviewed safety question based on PSC's safety evaluation on the SLRDIS modification (Attachment 2).

D. Impact of New Profiles on Equipment Qualification

As of August 1, 1988, the start date of the binder evaluations, there were a total of 84 approved EQ binders. Because of multiple model numbers, test reports, etc., the EQ binders were broken down into a total of 114 separate evaluations. Each separate evaluation consists of a checklist, the applicable test versus plant temperature profile, and any other supporting data. All of these evaluations will be included in EE-EQ-0068 (Reference 4).

PHASE I - ENVELOPING HISTORICAL EQ COMPOSITE TEMPERATURE PROFILE

Because COBRA is a standard code used in the nuclear industry for calculation of environmental profiles, PSC has decided to utilize the profile generated by NAI as the historical EQ composite temperature profile for this evaluation.

However, because of time constraints involved in using NAI as an approved vendor, the component qualification evaluations were begun using a conservatively estimated enveloping profile based on the GA modified CONTEMPT-G profiles. A total of 59 evaluations were completed based on these GA enveloping profiles. When the NAI historical EQ composite temperature profile was finalized (Figures 1 & 2), it was used as the basis for the remaining evaluations. A total of 55 evaluations were completed using this NAI enveloping profile.

A comparison of the GA modified CONTEMPT-G profile and the NAI historical EQ composite temperature profile shows that the GA profile envelops the NAI profile except for the ramp down to 120 degrees F. The GA profile ramps down to 120 degrees F at 10 hours, while the NAI profile ramps down to 120 degrees F at 16.6 hours. A review of the NAI profile shows that at the 10 hour mark, the temperature is approximately 130 degrees F. This temperature difference is considered insignificant since each of the components was either tested at much higher temperatures for extended times, or the materials of construction all have a material temperature index that is much greater than 130 degrees F. Because of this, the GA profile is considered as severe as the NAI profile, and the 59 evaluations performed based on the GA profile do not require reanalysis.

The results of the evaluations show that all of the FSV EQ equipment remains environmentally qualified and is considered qualified for the historical EQ composite temperature profile.

PHASE 2 - IMPACT OF NEW FINAL EQ COMPOSITE TEMPERATURE PROFILE

In order to assure operator access for initiation of manual operations required for safe shutdown cooling, an additional trip setpoint will be added to the SLRDIS. This trip setpoint actuates SLRDIS at a building temperature of 180 degrees F (analysis value).

As a result of the additional SLRDIS setpoint, the historical EQ composite temperature profile was reanalyzed by NAI using the new 180 degrees F setpoint and was changed considerably. The final EQ composite temperature profile, which will be used for all future qualification efforts, is shown in Figures 3 & 4.

A comparison of the two historical profiles (GA's and NAI's)used in this evaluation with the final EQ composite temperature profile, shows that the final EQ composite temperature profile is completely enveloped by both the GA profile and the NAI profile. Thus, the historical evaluations also demonstrate future qualification for all of the EQ components. These evaluations (to be contained in Reference 4) will be used as the basis for accident qualification until all of the EQ binders can be revised to incorporate the final EQ composite temperature profile.

HUMIDITY EVALUATION (PHASE 1 & 2)

Previous qualification for humidity was based on a value of 100% relative humidity. The humidity profiles generated by NAI show a peak relative humidity of 100%, also. Thus, the previous evaluations for humidity are considered acceptable.

DESIGN BASIS ACCIDENT NO. 2 (PHASE 1 & 2)

Previous qualification for DBA-2 was based on the use of the Reactor Building HELB profile for equipment in the Reactor Building (Reference 5). This was based on the fact that surface temperatures during a HELB are higher than during DBA-2. Equipment in the Turbine Building is considered to be in a mild environment and qualification for DBA-2 is not required.

Since all of the Reactor Building equipment was originally qualified to the Reactor Building HELB profile, which envelops the DBA-2 profile, previous qualification for DBA-2 remains valid.

In order to determine the acceptability of the final EQ composite temperature profile, a thermal lag analysis was prepared to compare the final EQ composite temperature profile with the DBA-2 profile. Preliminary analysis has been completed and the final EQ composite temperature profile envelops the DBA-2 profile. Thus, the final EQ composite temperature profile is considered the worst case accident from a peak equipment surface temperature standpoint.

In summary, the evaluations performed demonstrate that previously qualified equipment remains qualified for the revised temperature profiles, both before and after the SLRDIS modification.

E. Justification for Continued Operation (Phase 2)

* Based on the above evaluations, electrical equipment important to safety as defined by 10CFR50.49 has been qualified since NRC approval of the FSV EQ program and during operation of the plant. In addition, equipment remains qualified in the future when the final EQ composite temperature profile is utilized with the SLRDIS modification in place.

* All analyses required to generate the historical and final EQ composite temperature profiles and to evaluate equipment to those profiles have been completed and have been independently verified. The final documentation will be incorporated into References 4 and 6 to put the information into PSC's documentation system.

* Sufficient analyses and evaluations are documented to support continued qualification of all EQ equipment while EQ Binders are updated in accordance with the administrative processing and review requirements of the FSV EQ Program.

* The SLRDIS modification 10CFR50.59 safety evaluation indicates that an unreviewed safety question does not exist.

* It is recognized that a Technical Specification Amendment is desirable and will be pursued, but is not an immediate requirement. The reason for this is included in the Attachment 2 PSC safety analysis.

This approach for evaluating equipment to the new historical and final profiles, modifying SLRDIS and future followup with a Technical Specification Amendment was discussed with NRR, Region IV and the NRC Senior Resident Inspector.

Conclusion:

Continued operation is justified as discussed above with the following actions still to be completed:

* SLRDIS modification will be in place prior to exceeding 2% reactor power following the current outage.

* EQ Binders will be all updated by June 30, 1989.

* A SLRDIS Technical Specification Amendment will be submitted by Dec. 31, 1988. Prior to implementation of the amended Technical Specification, Administrative controls will ensure operability of the new 180 degrees F fixed temperature trip.

References

1) NRC letter G-87071, dated Mar. 13, 1987, Heitner to Williams, "Approval of FSV Temperature and Pressure Profiles"

2) PSC letter P-86664, dated Dec. 12, 1986, Warembourg to Berkow, "Reactor Building Temperature Profiles"

3) PSC letter P-86673, dated Dec. 19, 1986, Warembourg to Berkow, "Turbine Building Temperature Profiles"

4) PSC Engineering Evaluation EE-EQ-0068, Engineering Evaluation on the Impact on Environmental Qualification Resulting from Revised Steam Line Rupture Profiles

5) PSC letter P-86280, dated May 12, 1986, Walker to Berkow, "FSV Design Basis Accidents and Electric Equipment Qualification to 10CFR50.49.

6) PSC Engineering Evaluation EE-EQ-0069, Evaluation of New EQ Temperature Profiles

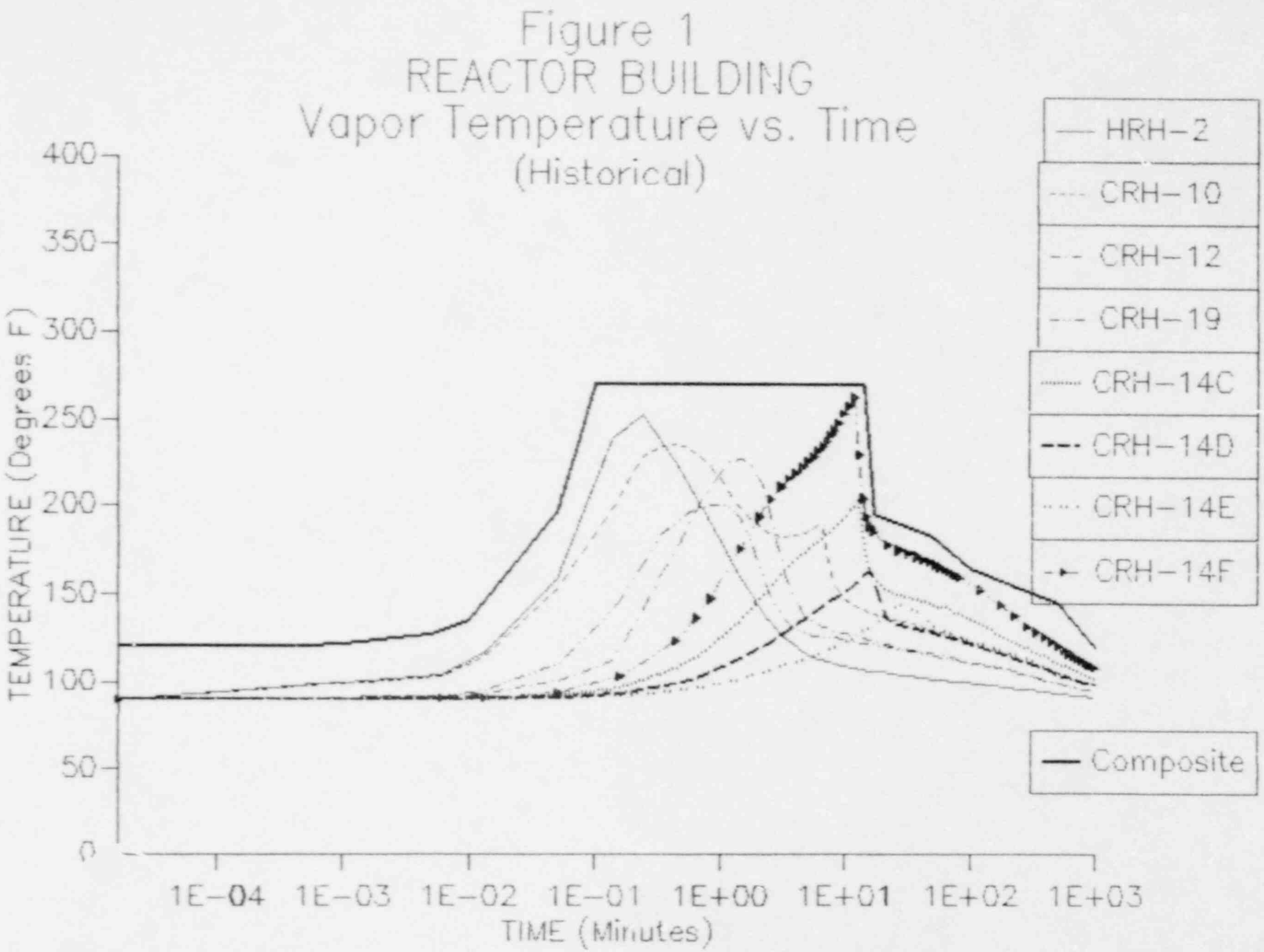
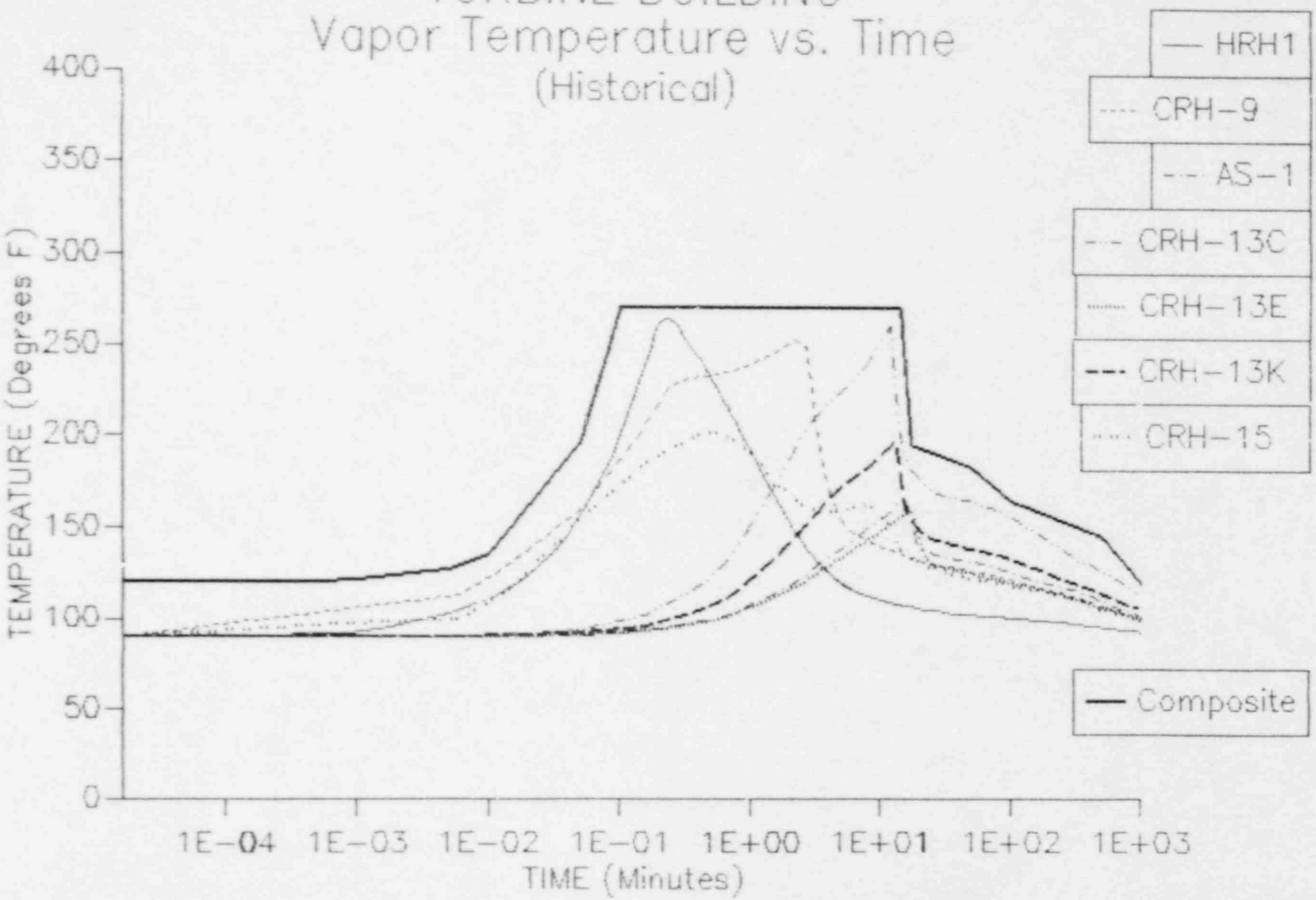


Figure 1
REACTOR BUILDING
Vapor Temperature vs. Time
(Historical)
TEMPERATURE (Degrees F)
400
350
300
250
200
150
100
50
0
1E-04
1E-03
1E-02
1E-01
1E+00
1E+01
1E+02
1E+03
TIME (Minutes)
HRH-2
CRH-10
CRH-12
CRH-19
CRH-14C
CRH-14D
CRH-14E
CRH-14F
Composite

Figure 2
TURBINE BUILDING
Vapor Temperature vs. Time
(Historical)



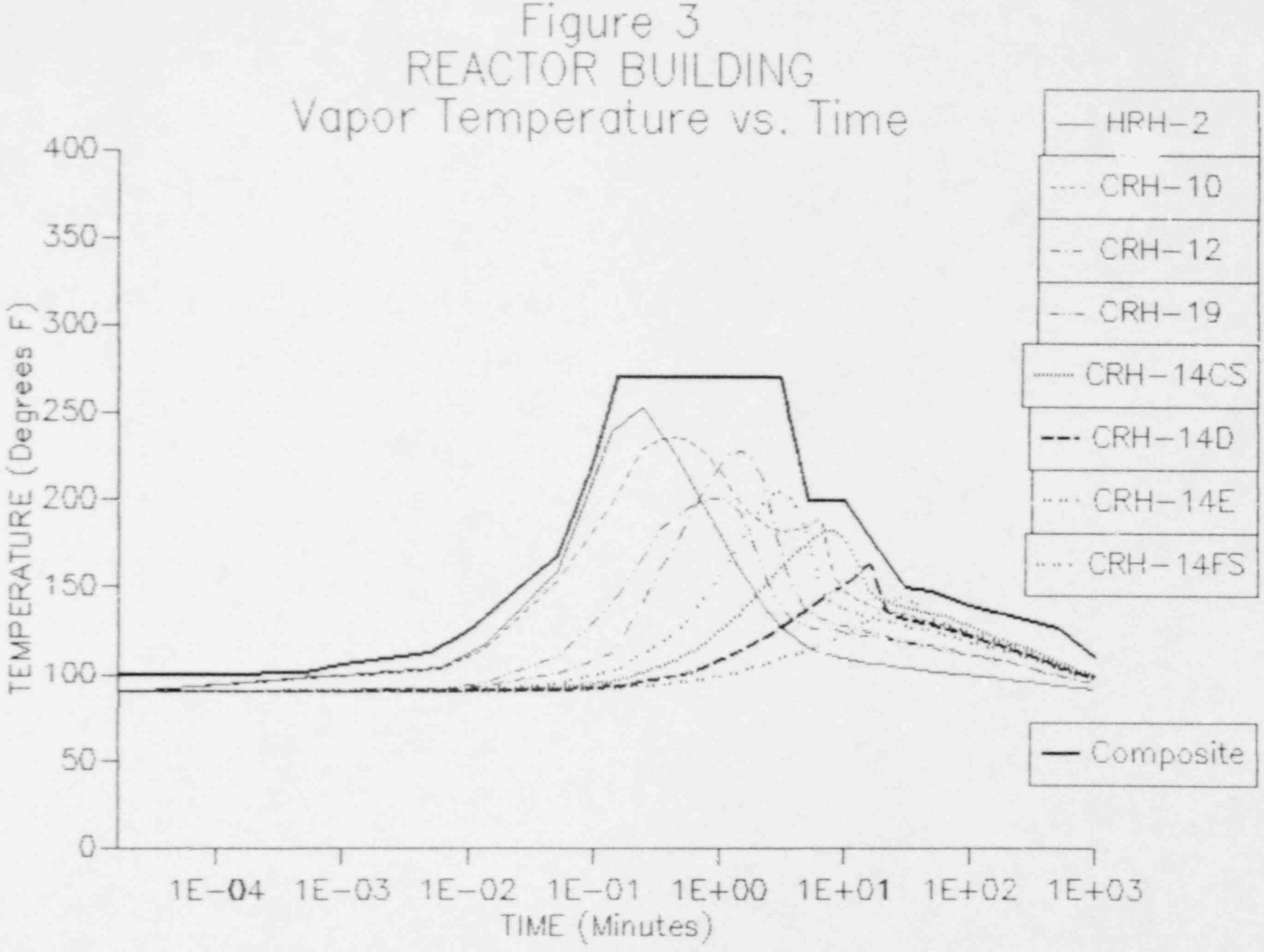
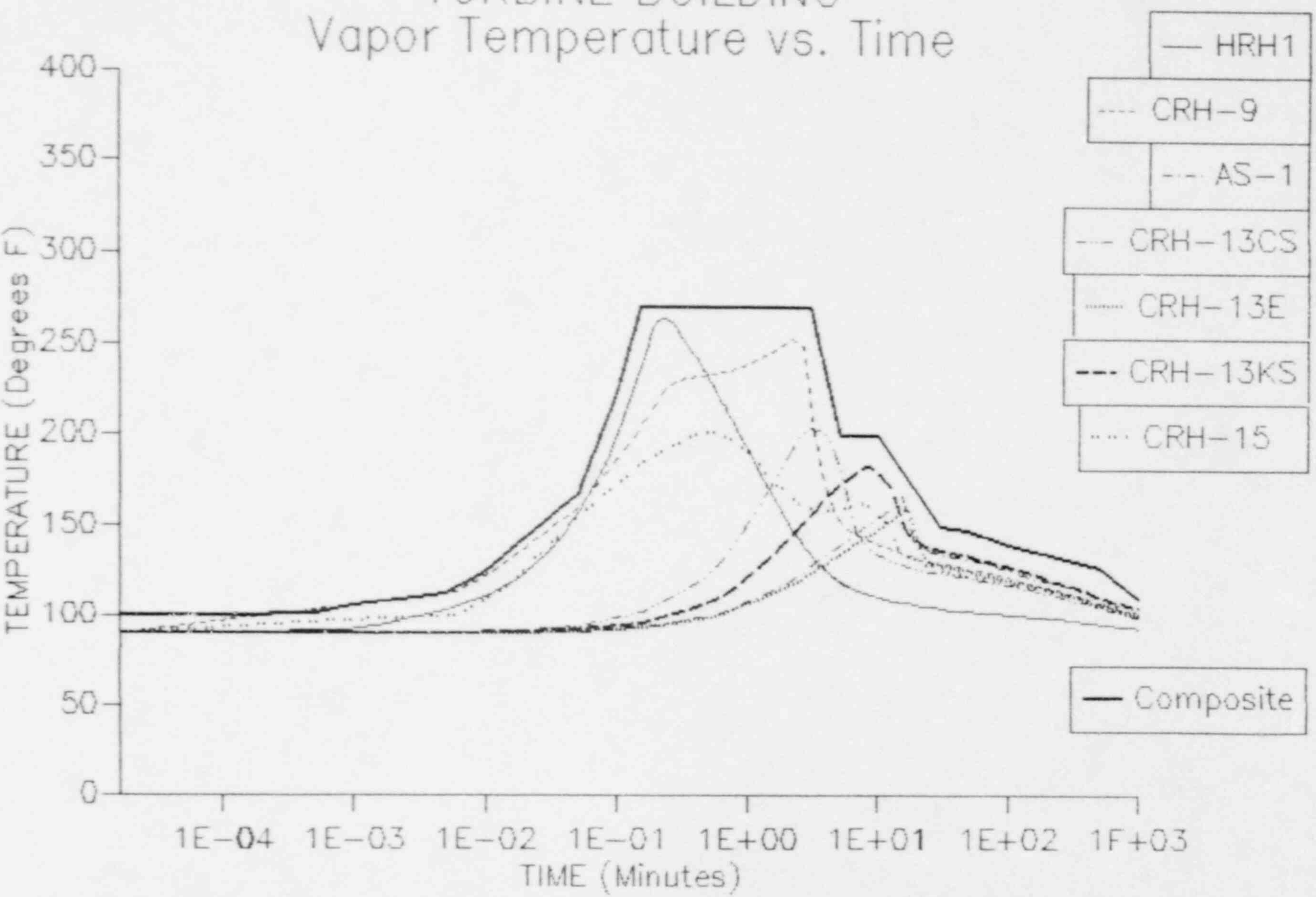


Figure 3
REACTOR BUILDING
Vapor Temperature vs. Time
TEMPERATURE (Degrees F)
400
350
300
250
200
150
100
50
0
1E-04
1E-03
1E-02
1E-01
1E+00
1E+01
1E+02
1E+03
TIME (Minutes)
HRH-2
CRH-10
CRH-12
CRH-19
CRH-14CS
CRH-14D
CRH-14E
CRH-14FS
Composite

Figure 4
TURBINE BUILDING
Vapor Temperature vs. Time



Attachment 2
to P-88344
September 23, 1988

ATTACHMENT 2

SLRDIS FIXED

TEMPERATURE TRIP

MODIFICATION

SAFETY EVALUATION

Public Service™

FORT ST. VRAIN NUCLEAR GENERATING STATION

PUBLIC SERVICE COMPANY OF COLORADO

SAFETY EVALUATION

(CN) TCR/SCR/PC/TR
NO. 2842
PAGE 2.0

CATEGORY

TYPE:

- [X] CN OVERALL
- [ ] CN SUBMITTAL
- [ ] SETPOINT CHANGE REPORT
- [ ] TEST REQUEST
- [ ] TEMPORARY CONFIGURATION REPORT
- [ ] PROCEDURE CHANGE (FSAR)
- [ ] OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

	YES	NO		YES	NO
CLASS I	X		ENGINEERED SAFEGUARD		X
SAFE SHUTDOWN	X		PLANT PROTECTIVE SYSTEM	X	
SAFETY RELATED	X		SECURITY SYSTEM		X

REMARKS ____

EVALUATION **Use Additional Sheets If Required**

1. DOES THIS ACTIVITY AFFECT STRUCTURES, SYSTEMS, COMPONENTS, EQUIPMENT, TESTS, EXPERIMENTS OR PROCEDURES DESCRIBED IN THE FSAR OR TECH SPECS? [X] YES [ ] NO

LIST THE APPLICABLE SECTIONS REVIEWED: FSAR: 1.4.5, 1.4.6, 1.6.17, 4.3.2, 6.2.2, 7.1, 7.3.10, 10.3, 12.3.2.6, 14.4, 14.5, 14.8, 14.10, 14.11, Criterions 6, 11, 12, 14, 15, 20, 21, 23, 25, Appendix D, Appendix I
Tech Specs: LCO 4.4.1/SR 5.4.1
FPPP: FP.4.

2. DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE FSAR OR TECH SPEC? [ ] YES [X] NO

LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE: The FSAR and Technical Specifications should be updated to reflect the new fixed trip set point per Attachment 1. SLRDIS will continue to meet all existing Technical Specifications with the new fixed trip set point, which adds an additional degree of conservatism. Therefore, plant operation under the existing Tech Specs with the additional trip set point is permitted prior to obtaining the Tech Spec change approval.

3. DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES:

(A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE FSAR BEEN INCREASED?
[ ] YES [X] NO STATE BASIS: See Attachment 2

(B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE FSAR BEEN CREATED? [ ] YES [X] NO STATE BASIS: See Attachment 2

(C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE FSAR BEEN REDUCED?
[ ] YES [X] NO STATE BASIS: See Attachment 2

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION [ ] YES [X] NO
BE SAFETY SIGNIFICANT [X] YES [ ] NO

BY: J R Johns (SIGNATURE) 9-23-88 (DATE)
James C. [illegible] 9-23-88

APPROVED: M H Holmes (SIGNATURE) 9-23-88 (DATE)

Form QCL-72-02 3382

FSAR Section 7.3.10 should be revised to include a discussion of the new fixed high temperature SLRDIS trip setpoint. Following the change to the SLRDIS software to input the new fixed high temperature trip setpoint, the SLRDIS will continue to meet existing Technical Specification requirements of LCO 4.4.1 and SR 5.4.1, and no immediate Technical Specification change is required. The additional SLRDIS trip setpoint is conservative in that it will enable SLRDIS to automatically isolate relatively small HELBs. In the past the 135 degrees F SLRDIS pre-trip alarm warned operators of high building temperatures resulting from HELBs which don't result in a high building temperature rate-of-rise, and operators were relied upon to accomplish the necessary manual actions to isolate these HELBs. With the new fixed high temperature SLRDIS trip setpoint, SLRDIS will automatically isolate both the large HELBs which produce high building temperature rate-of-rise as well as selected smaller HELBs which don't produce building temperature rate-of-rise above 55 degrees F per minute but could eventually result in relatively high average building temperatures. The SLRDIS software modifications necessary to input the additional setpoint, which reduces reliance on operator manual actions while conforming to existing Technical Specifications, do not necessitate immediate changes to the Technical Specifications. However, a future amendment to the Technical Specifications associated with SLRDIS to reflect addition of the new fixed high temperature trip to the SLRDIS software would be desirable and will be pursued.

Attachment 2

Background

The purpose of the Steam Line Rupture Detection/Isolation System is to detect and automatically isolate selected high energy line breaks (HELBs) in the secondary coolant system in both the Reactor and Turbine Buildings. The high energy lines selected for isolation by SLRDIS are those whose rupture may render safety-related electrical equipment inoperable before operator isolation due to exceeding design temperature or humidity parameters. PSC agreed to use very conservative assumptions for operator response times, i.e. no operator actions are assumed for ten minutes after a HELB with one minute between operator actions taken from the Control Room after ten minutes. SLRDIS detects and automatically isolates ruptures in main steam, hot reheat steam, cold reheat steam and auxiliary steam lines. SLRDIS was not designed to isolate feedwater, condensate or extraction steam lines since the original temperature profiles for these breaks demonstrated that operator action was sufficient to limit the resultant harsh environments. This will not change with the addition of a fixed high temperature SLRDIS trip.

Detection of a harsh temperature environment resulting from a high energy line break is accomplished by continuous monitoring of bulk average building temperatures in both the Reactor and Turbine Buildings. The SLRDIS has two Detection Racks located in the Control Room. Each Detection Rack receives input from four temperature sensing cables in the Reactor Building and four temperature sensing cables in the Turbine Building. The four temperature sensors in either building associated with one of the two Detection Racks are combined in a two-out-of-four sensing logic. The Detection Racks process the incoming temperature signals to determine the building temperature and the temperature rate-of-rise for each channel (one channel per temperature sensing cable). As SLRDIS is presently programmed, actuation of the SLRDIS only occurs when average building temperature rate-of-rise in either building exceeds 55 degrees F per minute (Analysis Value) continuously for 5.1 seconds. Initiation of a SLRDIS actuation occurs when two-out-of-four sensors (in each set of sensors in one building) exceed the high temperature rate-of-rise trip setpoint which causes a logic trip signal. The trip signal from ei[illegible] redundant Logic A or Logic B from one Detection Rack is then "a[illegible]ed, utilizing relay logic, with the similar Logic A or Logic B [illegible]ignal from the second Detection Rack. Satisfying the "and" relay t[illegible] logic requirements results in a final output trip signal to the PPS. This overall logic design results in a one-out-of-two taken twice type trip logic. A trip signal from a single SLRDIS Detection Rack only results in an alarm annunciation in the Control Room. A fixed temperature alarm will occur on a single sensor reaching a temperature less than or equal to 135 degrees F (Analysis Value).

The SLRDIS logic described above will be utilized for the new fixed high temperature SLRDIS trip and no changes to the logic will result from inclusion of the new trip feature.

SLRDIS Safety Analysis

The Safety Analysis for the existing SLRDIS design is Engineering Evaluation EE-EQ-0014, Rev. I. The NRC approved the existing SLRDIS design in NRC letter dated 1/15/87, Heitner to Williams, Safety Evaluation Report for SLRDIS (G-87023). The NRC approved the requirements associated with SLRDIS in NRC letter dated 2/26/87, Heitner to Williams, Amendment 50 to the FSV Facility Operating License (G-87058).

HELB Temperature Profiles

The original S & L composite temperature profiles for the Reactor and Turbine Buildings enveloped all the temperature profiles computed by GA's CONTEMPT-G code for the individual HELB scenarios evaluated using a variable convective heat transfer coefficient, smaller building volumes and no radiation heat transfer. While the NRC and its contractor, Pacific Northwest Laboratories (PNL), challenged use of GA's variable convective heat transfer coefficient for computation of the individual HELB temperature profiles, they reached the conclusion that the original S & L composite temperature profiles provide an upper bound for expected average temperatures during postulated HELBs in both the Reactor and Turbine Buildings. This conclusion was reached after PNL evaluated four of the six cases reanalyzed by GA, three HELB cases in each building which represented a spectrum of break sizes from different steam pipes. Both GA and PNL analyses of these HELBs assumed actual building volumes, a convective heat transfer coefficient of one, and radiation heat transfer. PNL's conclusions were supported by their own independent analyses utilizing a different calculative model (COBRA code). The NRC documented acceptance of the FSV temperature and pressure profiles in NRC letter dated 3/13/87, Heitner to Williams (G-87071).

Since that time, GA made revisions to their CONTEMPT-G code to eliminate sensitivity of predicted building temperatures to the size of computational time steps used in the analysis. This code modification was determined to have a pronounced effect on predicted building temperatures for some HELB scenarios.

For instance, scenario CRH-14F, which was utilized in the original analysis in establishing the building temperature envelope for the Reactor Building, had a break size of 2.0% of a full offset rupture. However, the prior analysis using variable heat transfer coefficients, smaller building volumes and the unmodified CONTEMPT-G code resulted in a peak calculated temperature of 145 degrees F.

CRH-14F was recalculated using the old assumptions but with the CONTEMPT-G code modified to eliminate temperature sensitivity to computational time steps. The new calculated peak temperature was 260 degrees F, a major difference from the prior calculation.

After GA corrected the CONTEMPT-G problem wherein predicted temperatures were sensitive to computational time steps, GA reanalyzed each individual HELB scenario used to develop the original S&L composite temperature profiles. In the reanalysis, CONTEMPT-G was programmed to model a convective heat transfer coefficient of 1, actual building volumes and radiation heat transfer. A number of the reanalyzed HELB scenarios had temperature profiles which exceeded the original S&L composite profiles. These predominantly involved very small HELBs having rupture areas equal to or below 2% of the full offset rupture area, and full offset ruptures in locations where the rupture continued to be fed (i.e. by a steam generator or the bypass flash tank) for several minutes after isolation valves are shut. The most pronounced departure from the original S&L composite profiles were new cold reheat leak scenarios intentionally sized to produce a building temperature rate-of-rise slightly below the SLRDIS temperature high rate-of-rise trip (55 degrees F per minute Analysis Value). Worst case leak areas were determined to be 0.87% of full offset rupture area for a cold reheat line break in the Turbine Building and 2.06% of full offset rupture area for a cold reheat line break in the Reactor Building. CONTEMPT-G predicted peak temperatures of 288 degrees F and 280 degrees F, occurring about 20 minutes from the HELB initiation, resulting from these breaks for the Turbine and Reactor Building, respectively.

LER 88-012, submitted by PSC letter dated September 15, 1988, Fuller to Document Control Desk (P-88340), describes the problems discovered in GA's CONTEMPT-G code utilized to model average building temperature response resulting from HELBs.

Temperature Profiles for Design Basis Accident No. 2 and the Maximum Credible Accident

As discussed in FSAR Section 7.3.10.4.2, the Maximum Credible Accident and Design Basis Accident No. 2 were analyzed to determine the interaction with SLRDIS. Analysis of these accidents uses the "closed" building version of the Contempt-G code.

The previously discussed inappropriate modeling that existed was found in the "open" building version of the code and as such does not impact previous accident analyses using the "closed" building version. GA documented this conclusion in GA letter dated August 19, 1988, Alberstein to Brey (GP-3167). The "closed" version uses different computational methods, the full building volume and associated heat sinks, and a convection heat transfer coefficient of about 1 BTU/ft2/h-degrees F for helium.

The resultant analyses as referenced in FSAR Section 7.3.10.4.2. for MCA and DBA-2 indicates a resultant peak building temperature of 94 degrees F and greater than 600 degrees F, respectively. While the MCA will not cause a SLRDIS actuation at the new 180 degrees F trip setpoint, DBA-2 will. Since it was considered that DBA-2 could actuate SLRDIS due to high temperature rate-of-rise, this accident was reanalyzed using a 60 minute interruption of forced circulation to accommodate SLRDIS recovery. This is reflected in FSAR Section 14.11. The consequences of DBA-2/SLRDIS actuation at the new trip setpoint is no different than the previous analysis for the rate-of-rise trip.

SLRDIS Modifications to Mitigate Delayed Building Temperature Peaks

The new fixed high temperature SLRDIS trip will enable SLRDIS to automatically isolate a number of small HELBs that do not produce an average building temperature rate-of-rise as high as 55 degrees F per minute but would result in relatively high average building temperatures at times up to one hour after occurrence of the HELB. It was determined that a new SLRDIS trip setpoint, in addition to the existing high temperature rate-of-rise trip, would significantly mitigate the delayed temperature peaks. Analyses of numerous postulated HELBs have established that a SLRDIS fixed high temperature trip setpoint of equal to or less than 180 degrees F will accomplish the objective of limiting the magnitude of the delayed building temperature peaks.

New Building Temperature Profiles for HELBs

PSC decided to model HELBs with the COBRA code, instead of GA's CONTEMPT-G code, to assess the impact of the new fixed high temperature SLRDIS trip setpoint and develop completely new temperature profiles for FSV HELBs. PSC considers that the COBRA code is more widely used in the nuclear industry than CONTEMPT, and its results more readily accepted than those of the CONTEMPT code. PSC contracted with NAI since NAI's version of the COBRA code has been verified and validated. NAI's version of the COBRA code is predicting building temperatures in good agreement with those predicted by the revised version of GA's CONTEMPT-G code for identical HELB scenarios. NAI is using actual building volumes, a convective heat transfer coefficient of 1 and assumes radiation heat transfer in their modelling of the HELB scenarios. The new building temperature profiles for individual HELB scenarios, as well as the new composite temperature profiles for both the Reactor and Turbine Buildings, are attached (Figures 1 through 2). These new temperature profiles take credit for the existing 55 degrees F per minute (Analysis Value) rate-of-rise SLRDIS trip as well as the proposed 180 degrees F (Analysis Value) fixed high temperature SLRDIS trip. The new temperature profiles are based on the same assumptions used to develop the original temperature profiles, as itemized in Section 2.7 of EE-EQ-0014, Rev. I. Table 1, Steam Leak Summary Data, documents information associated with each HELB scenario analyzed by NAI.

Equipment Qualification

FSAR Section 1.4.6 describes FSV's Environmental Qualification Program (EQ Program), which must comply with the requirements of 10 CFR 50.49. The EQ Master Equipment List (MEL) lists safety related electrical equipment located in a potentially harsh environment and relied upon to mitigate EQ Design Basis Events. Equipment listed on the MEL is being evaluated against the new composite temperature profiles, shown in Figures 1 and 2, to determine whether or not it is environmentally qualified. The results of this evaluation are being documented in Engineering Evaluation EE-EQ-0068. Addition of the fixed high temperature SLRDIS trip reduces average building temperatures for those HELBs which do not result in 55 degrees F per minute temperature rate-of-rise but do raise average building temperature to the new fixed 180 degrees F (Analysis Value) high temperature SLRDIS trip. Therefore, the new SLRDIS trip enhances equipment qualification by reducing the severity of the harsh environment (temperature). Without this new fixed high temperature SLRDIS trip, equipment would need to be qualified to temperature composite profiles with higher temperatures after the initial peak.

Design Bases

The SLRDIS, when modified to include the proposed fixed high temperature setpoint, will continue to meet the design standards committed to in Section 2.3.1 of EE-EQ-0014, Rev. I. The fixed high temperature trip setpoint will have an accuracy (sensor and signal processing) of ±3% with repeatability of ±1%.

The program logic for the new fixed high temperature trip setpoint will not use the existing confirmatory time sequence to initiate a valid trip signal. The new fixed high temperature trip will be initiated upon the temperature exceeding the trip setpoint.

Operator Access

The results of the analysis of Safe Shutdown Cooling following a HELB are contained in GA Report 909269 Issue A, and summarized in FSAR Section 14.4.2.2. This analysis assumes that forced circulation cooling is established 90 minutes after the interruption of forced circulation which was caused by the SLRDIS, or operator action, to isolate the HELB. Firewater is supplied to one of the emergency water booster pumps and then to a helium circulator water turbine drive, as well as to one steam generator EES section, via the emergency condensate header. No single active failure of environmentally qualified equipment could preclude use of this flow path for Safe Shutdown Cooling.

In order to establish Safe Shutdown Cooling by 90 minutes following the interruption of forced circulation caused by isolation of a HELB in either building, operator access into a potentially harsh environment should be achieved by 45 minutes after the interruption of forced circulation. This will permit the operators sufficient time to take the actions identified in EE-EQ-0023, Rev. B, so that Safe Shutdown Cooling, with firewater supplied via the emergency condensate header, is established by 90 minutes.

Technical Specification LCO 4.4.1 does not permit SLRDIS to be bypassed unless reactor power is equal to or less than 2% of rated thermal power. Evaluation of the individual HELB scenarios determined that the worst case HELBs, from an operator access standpoint, are offset ruptures of main steam piping occuring when the reactor plant is operating at 2% of rated power with the SLRDIS bypassed. MS-16, offset rupture of a main steam line in the Reactor Building from 2% reactor power, is assumed to be manually isolated by the operators at 11 minutes after actuation of the SLRDIS pre-trip alarm (135 degrees F Analysis Value). The SLRDIS pre-trip alarm actuates at 221 seconds after initiation of MS-16. Average Reactor Building temperature 45 minutes after operator isolation of this HELB is 144 degrees F, which is considered to be low enough that operators could gain access to the Reactor Building and accomplish manual actions. At 20 minutes after isolation of MS-16, Reactor Building average temperature is 148 degrees F. PSC does not consider that this temperature would preclude building entry and manual actions.

MS-15, offset rupture of a main steam line in the Turbine Building, is assumed to be manually isolated by the operators at 11 minutes after actuation of the SLRDIS pre-trip alarm (actuates 266 seconds after initiation of MS-15). Average Turbine Building temperature 45 minutes after operator isolation of MS-15 is 140 degrees F. At 20 minutes after isolation of MS-15, Turbine Building average temperature is 143 degrees F. These temperatures are low enough to permit operator access and accomplishment of manual actions.

The SLRDIS pre-trip alarm will be administratively controlled, and required to remain operable from at least one of the two SLRDIS Detection Racks at all times, including reactor shutdown conditions.

When the SLRDIS is operable, as required by Technical Specification LCO 4.4.1 above 2% of rated thermal power, building environments following HELBs are less harsh at the time operator access is required, as evaluated below:

CRH-14CS is the limiting HELB scenario in the Reactor Building, from an operator access standpoint, that is automatically isolated by SLRDIS. SLRDIS actuation by the new 180 degrees F fixed high temperature trip is computed to occur 395 seconds after initiation of CRH-14CS. At 45 minutes after this SLRDIS actuation (51.6 minutes after initiation of CRH-14CS) Reactor Building average temperature is 135 degrees F. At 20 minutes after SLRDIS actuation in the CRH-14CS scenario, Reactor Building average temperature is 140 degrees F, a temperature low enough that operators could gain access to the Reactor Building and accomplish the necessary manual actions. FW-6 is an offset rupture of one of the loop feedwater headers in the Reactor Building from 100% reactor power. It is assumed to be manually terminated by the operators at 12 minutes following actuation of the SLRDIS pre-trip alarm, which actuates 600 seconds after initiation of FW-6. Reactor Building average temperatures are 147 degrees F 20 minutes after break termination and 139 degrees F at 45 minutes after break termination.

Likewise, CRH-13KS is the limiting HELB in the Turbine Building, from an operator access standpoint, that is automatically isolated by SLRDIS. SLRDIS actuation by the new 180 degrees F fixed high temperature trip is computed to occur 455 seconds after initiation of CRH-13KS. At 45 minutes after the SLRDIS actuation (52.6 minutes after initiation of CRH-13KS), Turbine Building average temperature is 133 degrees F. At 20 minutes after SLRDIS actuation in the CRH-13KS scenario, Turbine Building average temperature is 137 degrees F, a temperature low enough that operators could gain access to the Turbine Building and accomplish manual actions. FW-3 is an offset rupture of the common feedwater header in the Turbine Building from 100% reactor power. It will result in an immediate Plant Protective System actuation of circulator trips of all four circulators on low feedwater flow, causing a two-loop trouble scram. No operator action is relied upon to mitigate building temperatures in this scenario since the feedwater pumps are assumed to pump the entire contents of the Deaerator tank into the Turbine Building. Turbine Building average temperatures are 142 degrees F at 20 minutes and 137 degrees F at 45 minutes after occurrence of FW-3.

The HELBs discussed above are the worst case HELBs from the standpoint of operator access. The building temperature profiles are such that operators can achieve early access to either building 20 minutes after isolation of any HELB. Since manual operator actions in a harsh environment are not required until about 45 minutes following SLRDIS actuation, to establish Safe Shutdown Cooling with firewater supplied via the emergency condensate header, the new fixed high temperature SLRDIS trip setpoint supports the HELB accident analysis.

Safety Evaluation

3.(A) Has the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the FSAR been increased?

No. Recent analyses determined that certain postulated HELBs could result in temperatures in excess of the original S & L composite temperature profiles which served as the basis for environmental qualification of electric equipment important to safety under 10 CFR 50.49. Analyses demonstrate that a new fixed 180 degrees F (Analysis Value) SLRDIS trip, in addition to the existing high temperature rate-of-rise trip, reduces severity of the composite temperature profiles. Electric equipment important to safety is being assessed to demonstrate that it will be capable of performing its safety function during and following a HELB. The new fixed high temperature SLRDIS trip helps to assure that building temperatures will not prevent operator access as necessary to establish Safe Shutdown Cooling following a HELB. Addition of the new fixed high temperature SLRDIS trip to the SLRDIS programming is such that SLRDIS actuation is dependent upon receiving signals satisfying the 2 out of 4 sensing logic from either a temperature high rate-of-rise condition or a fixed high temperature condition and not any combination of fixed high temperature and rate-of-rise signals.

In the event that SLRDIS actuates as a result of the fixed high temperature trip, operators cannot reset SLRDIS until the building temperature, as sensed by the SLRDIS temperature sensors, decreases below the Trip Setpoint (which will be several degrees F below the 180 degrees F Analysis Value). As long as two out of four temperature sensors for Detection Rack A and Detection Rack B sense a temperature above the Trip Setpoint in the affected building, SLRDIS cannot be reset. The SLRDIS sensor temperatures for all HELBs analyzed decrease below 170 degrees F in less than 10 minutes following actuation of SLRDIS. Therefore, operators will be able to reset SLRDIS starting at 10 minutes after a HELB in either building, which is the earliest time this action was assumed to be taken in the time line analysis of EE-EQ-0023, Rev. B.

Even if average building temperature were to remain above 180 degrees F in an emergency, the operators have the capability of bypassing SLRDIS by means of the key operated switches behind each SLRDIS Detection Rack, located in the Control Room. Once SLRDIS is bypassed, valves closed by SLRDIS could be remote - manually opened from the Control Room as necessary to establish forced circulation core cooling. It is not anticipated that this SLRDIS bypass feature would need to be used in any credible event. It is thus concluded that the new fixed high temperature SLRDIS trip does not have an adverse impact on the ability to recover from an event in which SLRDIS is actuated.

A new fixed 180 degrees F (Analysis Value) SLRDIS trip setpoint does not increase the probability of a spurious interruption of forced circulation cooling. As is the case with the existing SLRDIS, operator error during surveillance/maintenance of the final output relay trip logic or any short circuit in one Detection Rack will only, at worst case, cause actuation of the valves associated with a single loop and/or trip of circulators in one loop (single loop shutdown). A single SLRDIS Detection Rack actuation, due to temperature conditions, only results in an alarm annunciation. No single failure/malfunction can result in the actuation of the SLRDIS safety function or preclude the safety function from occurring. It is reasonable to conclude that loss of HVAC in either building will not result in elevating the building temperature to exceed the SLRDIS fixed high temperature trip setpoint and cause a SLRDIS actuation. There would be sufficient time to implement corrective action prior to building temperatures approaching 180 degrees F. EE-EQ-0033, Rev. B is currently being revised to address this SLRDIS change and include the results of calculations currently in progress to predict maximum Reactor and Turbine Building temperatures with a loss of HVAC. The new trip setpoint is slightly higher than the existing reactor building high temperature scram setpoint of ≤ 161 degrees F, which has not actuated in the past and would not be expected to actuate except during a HELB or Design Basis Accident No. 2. Based on the above, it is concluded that the probability for inadvertent actuation of SLRDIS is not increased by the 180 degrees F fixed high temperature trip.

The SLRDIS Safety Analysis Report, EE-EQ-0014, Rev. I, has already assessed the consequences of SLRDIS actuation during a major fire and Design Basis Accident No. 2 (hypothetical rapid PCRV depressurization). The SLRDIS high temperature rate-of-rise setpoint would be actuated by DBA-2. While it was considered unlikely that a fire could result in a 55 degrees F average building temperature rate-of-rise, EE-EQ-0014, Rev.I, assumed it could occur, complicating post-fire restoration of cooling. Some of the valves closed by the SLRDIS must be opened to restore cooling using Fire Protection Shutdown/Cooldown Train A or B. Means exist to re-establish forced circulation cooling using either Train A or B within the 90 minutes analyzed should SLRDIS actuate as a result of a major fire. While addition of the 180 degrees F fixed high temperature SLRDIS setpoint increases the likelihood of SLRDIS actuation during a major fire (it is more likely that a major fire would cause average building temperatures to approach 180 degrees F then 55 degrees F per minute average temperature rate-of-rise), SLRDIS actuation does not increase the consequences of a major fire. Consequences of fires at FSV are discussed in Section FP.4 of the Fire Protection Program Plan (FPPP).

As discussed in Section 3.2.2 of EE-EQ-0014, Rev. I, maximum average temperature in the Reactor Building during the Maximum Credible Accident is less than 100 degrees F, and temperature rate-of-rise is well below the SLRDIS trip setpoint. The consequences of this accident (FSAR Section 14.8) are unaffected by the proposed 180 degrees F fixed high temperature SLRDIS trip, since SLRDIS will not actuate.

Based on the above, addition of the proposed 180 degrees F fixed high temperature trip to the SLRDIS does not increase the probability or consequences of accidents or malfunctions of equipment important to safety previously evaluated in the FSAR. The new trip enhances the effectiveness of the SLRDIS by enabling SLRDIS to automatically isolate certain postulated HELBs which, if not isolated in a relatively short time, could produce delayed temperature peaks that make operator access difficult.

3.(B) Has the possibility of an accident or malfunction of a different type than any evaluated previously in the FSAR been created?

No. The required function of SLRDIS is to isolate both primary and secondary coolant loops in the event of a HELB resulting in an interruption of forced circulation cooling (IOFC). The FSAR evaluates the consequences of an IOFC up to the bounding case of a "permanent loss" of forced circulation cooling (FSAR 14.10). The FSAR evaluates the consequences of a SLRDIS actuation in FSAR Section

7.3.10.4. The addition of a fixed high temperature trip (180 degrees F, Analysis Value) to SLRDIS merely provides a new point, in the elevation of bulk building average temperature, at which SLRDIS will actuate. This new point ensures that certain postulated HELBs are detected and automatically isolated to reduce the delayed building peak temperatures to enhance equipment qualification and to permit timely building access. Since this new trip setpoint results only in changing the programming, all previous failure modes and malfunctions remain unchanged. Recovery following a SLRDIS actuation will be performed as previously analyzed.

Based on the above, addition of the proposed 180 degrees F fixed high temperature trip to SLRDIS does not create the possibility of a new or different accident or malfunction than any previously evaluated.

3.(C) Has the margin of safety, as defined in the basis for any Technical Specification or in the FSAR been reduced?

No. The basis for SLRDIS in LCO 4.4.1 states that detection of steam leaks is required for environmental qualification of safe shutdown cooling systems. The detection system utilizes a pre-trip fixed temperature alarm (135 degrees F) to initiate manual operator actions to isolate the steam leak and a rate-of-rise trip (55 degrees F/minute) to initiate an automatic isolation. Both detection points ensure that the resultant harsh environment from a postulated steam leak is limited such that the safe shutdown systems will be capable of performing their safety function under the environmental conditions and permit timely building access. Adding a 180 degrees F fixed temperature trip enhances the required detection and resultant protective actions to limit the harsh environment. The same level of system accuracy and associated setpoint uncertainties are applied to the new fixed high temperature trip setpoint. The added trip setpoint neither causes any new single failure points nor compromises the system detection. The operability requirements as defined in the Technical Specifications remain unchanged for the new HELB analyses and subsequent required SLRDIS modification.

Based on the above, the margin of safety for assuring the detection of steam leaks is enhanced by the addition of a new detection point at which protective action is automatically initiated as required for the environmental qualification of safe shutdown systems.

TABLE 1

STEAM LEAK SUMMARY DATA

RUN	BLDG	HIGH ENERGY LINE-SOURCE	POWER LEVEL %	BREAK AREA (% OF LINE AREA)	TERMINATION ACTION	SLRDIS ACTION TIME (SEC)	LEAK TERMINATED (SEC)	ACCESS TEMP (F) *		PEAK TEMP	
								20 min	45 min	F	TIME (sec)
HRH-1	Turbine	Hot Reheat	100	100	SLRDIS-Rate of Rise	6	16	106	103	265	13.4
CRH-9	Turbine	Cold Reheat	100	100	SLRDIS-Rate of Rise	8	151	133	128	257	156
CRH-15	Turbine	Cold Reheat	100	25	SLRDIS-Rate of Rise	8	791	131	124	201	32.4
AS-1	Turbine	Aux Steam	100	100	Operator-Alarm	280 (A)	1536	134	131	168	941
CRH-13CS	Turbine	Cold Reheat	100	0.74	SLRDIS-Temp Trip	136	357	126	122	205	191
CRH-13E	Turbine	Cold Reheat	100	0.18	Operator-Alarm	346 (A)	1870	127	124	161	1000
CRH-13KS	Turbine	Cold Reheat	100	0.37	SLRDIS-Temp Trip	452	889	137	133	183	501
FW-3	Turbine	Feedwater	100	100	Self Terminated	None	720	142	137	147	660
MS-15	Turbine	Main Steam	2	100	Operator-Alarm	266 (A)	1352	143	140	174	920
HRH-2	Reactor	Hot Reheat	100	100	SLRDIS-Rate of Rise	6	13	106	103	260	11.4
CRH-10	Reactor	Cold Reheat	100	100	SLRDIS-Rate of Rise	8	391	138	131	236	27.4
CRH-12	Reactor	Cold Reheat	29	100	SLRDIS-Rate of Rise	6	156	123	118	229	87.6
CRH-19	Reactor	Cold Reheat	100	10	SLRDIS-Rate of Rise	8	112	121	117	202	55.6
CRH-14CS	Reactor	Cold Reheat	100	1.0	SLRDIS-Temp Trip	394	818	140	135	183	441
CRH-14D	Reactor	Cold Reheat	100	0.5	Operator-Alarm	300 (A)	1799	131	127	164	961
CRH-14E	Reactor	Cold Reheat	100	0.25	Operator-Alarm	1120 (A)	3458	132	128	147	1750
CRH-14FS	Reactor	Cold Reheat	100	2.0	SLRDIS-Temp Trip	126	344	131	125	205	176
FW-6	Reactor	Feedwater	100	100	Operator-Alarm	600 (A)	1325	147	139	149	1351
MS-16	Reactor	Main Steam	2	100	Operator-Alarm	221 (A)	1307	148	144	180	881

*Temperature at time 20 min & 45 min after break isolation (SLRDIS trip or manual termination)

FIGURE 1

REACTOR BUILDING
Vapor Temperature vs. Time

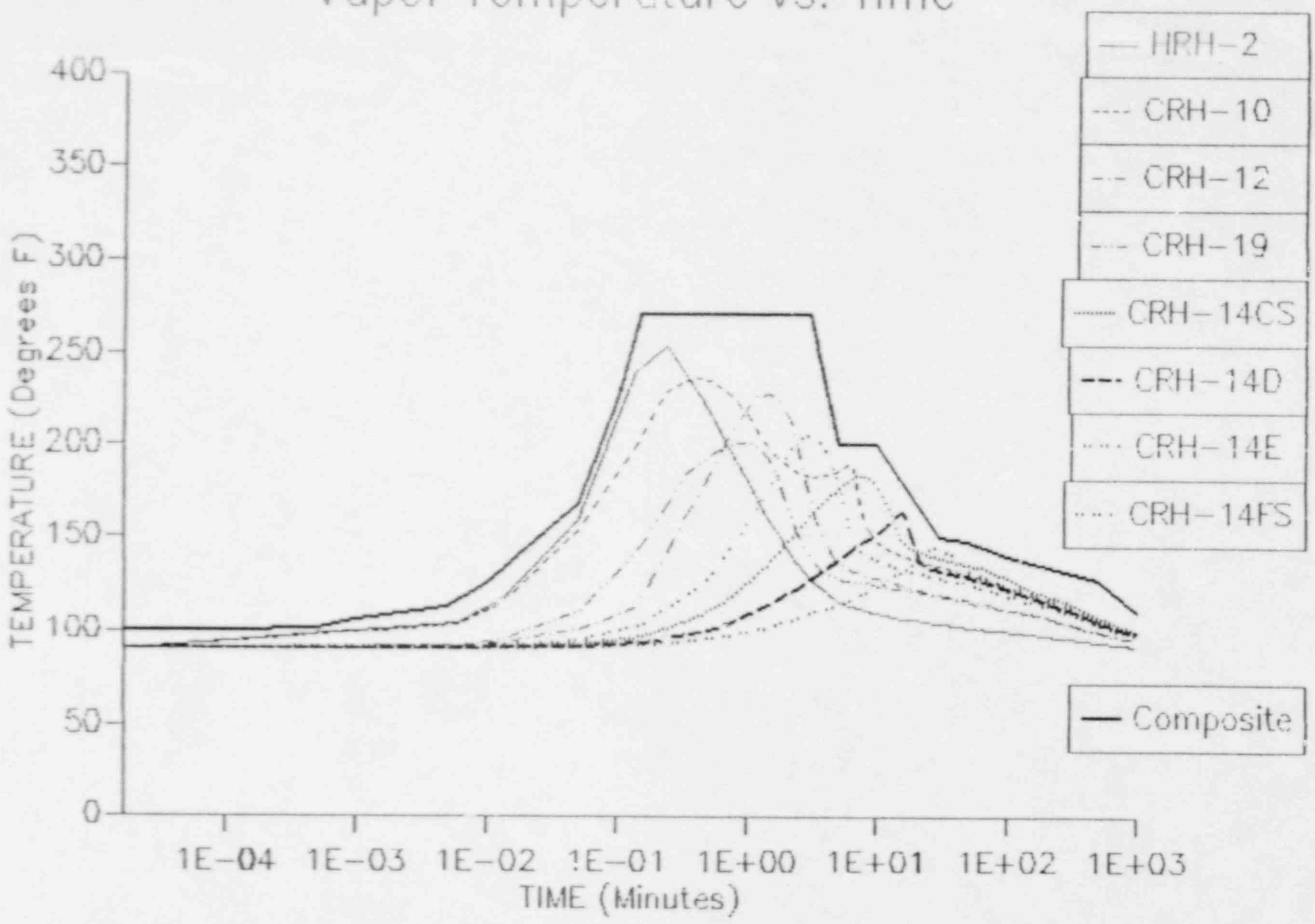
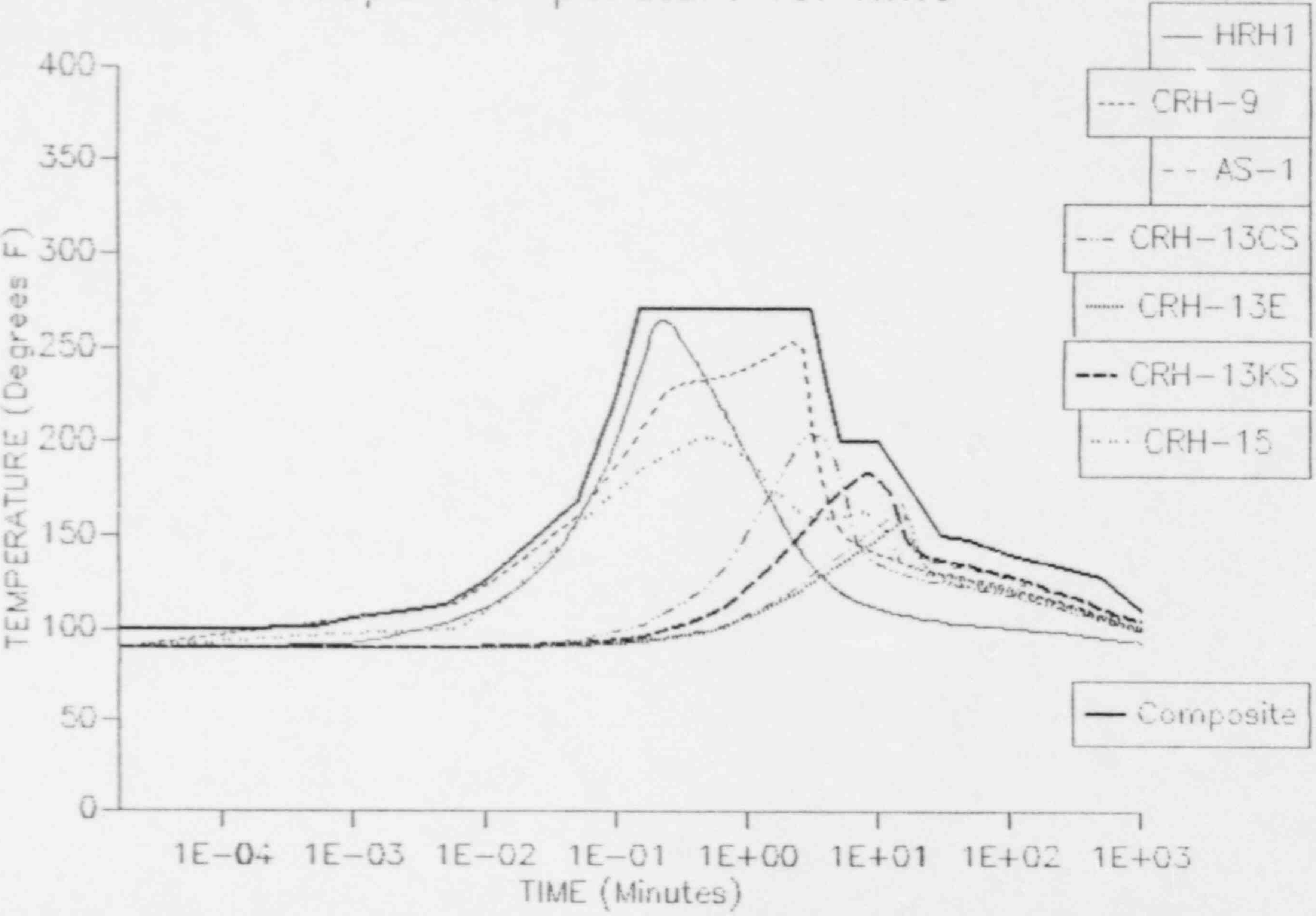


FIGURE 2

TURBINE BUILDING
Vapor Temperature vs. Time



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