PUBLIC SERVICE COMPANY OF COLORADO

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R.F. WALKER
PRESIDENT

March 14, 1986
Fort St. Vrain
Unit No. 1
P-86208

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attn: Mr. H.N. Berkow, Project Director
Standardization and Special
Projects Directorate

Docket No. 50-267

SUBJECT: Fort St. Vrain Equipment Qualification

REFERENCES:
1) NRC Letter Dated November 5, 1985, Butcher to Lee, (G-85452)
2) PSC Letter Dated December 27, 1985, Walker to Berkow, (P-85499)
3) PSC Letter Dated December 31, 1985 Walker to Berkow, (P-85456)

Dear Mr. Berkow:

Reference 2 submitted additional information on the Fort St. Vrain (FSV) Environmental Qualification (EQ) Program as requested by reference 1. In addition, reference 2 submitted the System Description for the new Steam Line Rupture Detection/Isolation System (SLRDIS) and the temperature profiles for the current FSV EQ Program.

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At the time of that submittal, PSC was anticipating a setpoint for the SLRDIS which utilized a fixed temperature value. Further analysis has shown that a rate-of-rise setpoint will give a quicker response and give a greater margin of safety in assuring SLRDIS actuation. In addition, PSC has re-designed SLRDIS to include two independent detection, logic and actuation systems. Each system is redundant to itself and provides actuation/isolation signals to a single loop. PSC is therefore revising the submittals transmitted with reference 2, and those revisions are included in Attachments 1 through 3 to this letter. All responses in Attachment 1 of the original submittal remain unchanged except the response to Auxiliary Systems Branch Request No. 4 as revised in this letter.

The Technical Specification changes and Safety Evaluation associated with the SLRDIS were submitted to the NRC staff via reference 3. Those documents are currently being revised and will be resubmitted in the near future under a separate cover letter.

If you have any questions on this subject please contact Mr. M.H. Holmes at (303) 480-6960.

Very truly yours,

R.F. Walker, President

RFW/FWT:pa

LIST OF ATTACHMENTS

ATTACHMENT 1

to P-86208

AUXILIARY SYSTEMS BRANCH REQUEST NO. 4

Provide information on the capability of the SLRDIS temperature sensors to adequately detect elevated temperatures in the areas of concern.

Verify that the sensitivity of these sensors is sufficient to provide proper indication/actuation in the event of localized temperature effects following steam line breaks.

Include any available manufacturer's test data and/or performance information on similar detectors in comparable applications.

PSC RESPONSE

The thermistor cable temperature sensors are coaxial in design. A 20 AWG nickel center conductor is surrounded by a powder ceramic semi-conductor material which is then covered by an Inconel jacket. The outside diameter of the cable is .09" and weighs 6 grams per linear foot. The small mass of the cable enables it to respond quickly to changes in temperature. The thermistor material has the characteristic of exponentially decreasing resistance with higher temperature (negative coefficient of resistance). It is this change of resistance between the center conductor and the outside sheath that is monitored by the control panel. A change in temperature can be monitored anywhere along the length of the cable. The thermistor cable can withstand temperature extremes from -50 degrees Fahrenheit to +2000 degrees Fahrenheit. Because the primary parameter is resistance, the coaxial thermistor cable is able to monitor open circuit, short circuit, pre-selected temperatures and rate-of-rise.

Being all solid state, the sensors have only two failure modes - open circuit and short circuit. These conditions can be caused only by mechanical damage and are minimized by proper mounting. These two failure modes are continually monitored by the control panels. The thermistor cable has been exposed to radiation levels as high as 150 megarads, with no degradation in performance. This represents a radiation dose level many orders of magnitude higher than the design basis of Fort St. Vrain. The thermistor cable can continue to monitor temperature levels after generating pre-alarm and alarm signals and is the only thermistor type sensor approved by the Factory Mutual Research Corporation for fire protection. Also, due to the parallel circuit (Loop fed) arrangement based on resistance, the cable can be severed and still perform the monitoring, alarm and trip functions.

The coaxial-type thermistor sensors have been specified and utilized in numerous applications such as on reactor coolant pumps and charcoal filters in nuclear power plants. Other uses include power cable trays, coal conveyers, cooling towers, power transformers and offshore oil platforms.

Over 39 domestic nuclear plants and 10 foreign nuclear plants are utilizing the thermistor cable as sensing elements in their fire detection and deluge control systems. The Commanche Peak Station is using the thermistor cable inside containment for heat detection below cable tray level. At the Davis Besse Nuclear Power Station, coaxial thermistor cable is used to monitor the temperature of the Hot Leg involved in the Reactor Water Level System.

The sensors and control equipment have been tested and certified to meet IEEE Standards 323 and 344. The vendor's Quality Assurance program complies with 10 CFR 50 Appendix B.

The SLRDIS system control panels are designed to 'pre-alarm' at 135 degrees Fahrenheit (analysis value) and 'alarm' and send a tripping signal at a rate-of-rise equal to 55 degrees Fahrenheit per minute (analysis value). Each control panel is programmed to respond to the corresponding equivalent resistances of these temperatures and temperature changes.

The thermistor cable temperature sensors change resistance, as previously stated, inversely and exponentially to temperature change. Each detection panel generates a signal to its respective logic panel when the programmed level of resistance or resistance change is recognized. Because of the exponential curve of resistance versus temperature, the detection panels are very selective, i.e., the elevated temperature to be detected presents a resistance much less in value than a temperature reading relatively close in magnitude. For example, 150 degrees Fahrenheit represents a resistance of 115,000 ohms while 200 degrees Fahrenheit represents 30,000 ohms, and 300 degrees Fahrenheit equals 3500 ohms.

A test has been performed by Factory Mutual Research Corporation (FMRC) on the response time of the thermistor cable to rapidly changing elevated temperatures. The FMRC plunge tests are recognized as one of the most accurate methods of determining thermal response. The tests were conducted on December 10, 1985 at Norwood, Massachusettes. The test measured the resistance versus time response for nine combinations of gas temperature and air velocity and produced data for the environment specified at Fort St. Vrain.

It should be noted that the temperature environment for a steam line rupture at Fort St. Vrain assumes a bulk temperature model. The Reactor Building and Turbine Building will therefore see uniform temperature environments. No 'localized temperature effects' are considered. This means that the entire length of thermistor cable is assumed to sense the same temperature.

A combined 40 year accelerated aging and 20 megarad radiation exposure test (test #2 below) shows little difference between the initial and final readings of resistance versus temperature on the thermistor cable. Heating and cooling does not affect the sensor's 1% repeatability. Based on this the sensor is deemed acceptable over the lifetime of the plant and is considered age insensitive.

Available Manufacturer's Test data includes the following and is available for review at your request:

1) Resistance vs Temperature curve of the 9090-13 thermistor cable (200' lengths used at Fort St. Vrain) Dwg. No. 280023 Rev. A

2) Sensor Center Conductor to Case Resistance vs Temperature - Initial and Final Curves after Accelerated Aging & Radiation Tests

3) Functional Test of Alison Control Panel After Seismic Test - dated 11/18/85

4) Equipment Qualification Package

5) Seismic Test of Control Rack & Sensor Assemblies performed by Wyle Labs, 11/9/85. (witnessed by PSC - all tests passed)

6) Response Time Test of Thermistor Cable performed by Factor Mutual Research Corporation, 12/10/85

Comparable Application Data:

1) Qualification Test Report of 9090-13 Sensor Assembly (Doc. NO. ETR101), dated 2/7/84 for Application at Davis-Besse

The results for the response time test (item #6 above) will be submitted to the NRC staff in the near future under a separate cover letter.

ATTACHMENT 2

to P-86208

SYSTEM DESCRIPTION
STEAM LINE RUPTURE DETECTION/ISOLATION SYSTEM

1.0 PURPOSE

The purpose of the Steam Line Rupture Detection/Isolation System (SLRDIS) is to protect the functional integrity of the Safe Shutdown Electrical Equipment in the event of a steam line rupture in the Reactor or Turbine Building. A steam line rupture is defined as any rupture that would result in a harsh environment in either the Reactor or Turbine Building.

2.0 NORMAL OPERATING REQUIREMENTS

During normal plant operation the SLRDIS is required to:

a) Monitor Reactor Building temperature.

b) Monitor Turbine Building temperature.

3.0 ABNORMAL OPERATING REQUIREMENTS

a) For Reactor and Turbine Building sensor temperatures exceeding 135 degrees Fahrenheit (analysis value), a pre-trip alarm initiates in the Control Room.

b) For a rate of temperature rise of the Reactor and Turbine Building sensors exceeding 55 degrees Fahrenheit per minute (analysis value), a high level alarm and trip signal are initiated in the Control Room.

c) For short or open circuits within the SLRDIS and along the thermistor sensor cables in either the Reactor or Turbine Buildings, a trouble alarm is initiated in the Control Room.

d) For condition (b) above, the SLRDIS is required to automatically initiate isolation of both secondary coolant system loops and other appropriate interfacing valves included in Table 1, regardless of which loop is leaking.

e) For other abnormal operating conditions, only the requirements for normal operation must be met.

4.0 INSTRUMENT EQUIPMENT ITEMS

The SLRDIS consists of the following components:

a) Sixteen (16) Temperature Sensors - TE-93939, 41, 47 and 49 for Zone 1 Loop 1
TE-93938, 40, 46 and 48 for Zone 1 Loop 2
TE-93943, 45, 51 and 53 for Zone 2 Loop 1
TE-93942, 44, 50 and 52 for Zone 2 Loop 2

b) Two (2) Monitoring and Control Racks (I-93543 Loop 1 and I-93544 Loop 2) each consisting of:

(1) Four (4) Temperature Monitors
(2) Two (2) Logic Controllers
(3) Two (2) Data Loggers
(4) Two (2) Temperature/Current Converters

c) Eight (8) Inputs (two per circulator - one each for Logic A & B on a loop basis) to the Circulator Trip Logic Portion of PPS.

d) Two (2) Inputs (one each for Logic A & B on a loop basis) to the Valve Actuation of PPS.

Other equipment important to the SLRDIS operation but included in the equipment scope of other systems:

a) Plant Protective System (PPS)

b) Valves (and their associated controls) as outlined in Table 1 & Figure 2. Figure 2 depicts the overall relationship of these components and systems.

5.0 REFERENCE DOCUMENTS

a) Composite Logic Diagrams - Plant Protective System (I.B. 93-6 thru 93-8).

6.0 FUNCTIONAL DESCRIPTION - NORMAL OPERATION

The SLRDIS provides continuous monitoring of area temperatures in both the Reactor and Turbine Buildings. The total area monitored is dividied into two distinct zones, one in the Reactor Building and one in the Turbine Building. The zones selected provide for coverage consistent with measuring average ("bulk") area temperature in each zone (see Figure 3).

Each thermistor cable acts independently as a zone temperature sensor and provides a resistive signal inversely proportional to the area temperature.

Each zone contains eight thermistor cables providing for redundant and divisionalized temperature sensing capability. The eight signals are routed independently, four to each Loop Panels' channel monitors such that each zone's "A" cable is input to the respective "A" cable monitor, and so on for Cables B, C and D as shown on Figure 4.

The cable monitors are capable of sensing the resistive signal from each cable and independently annunciating the following preset alarms:

a) Pre-trip alarm at 135 degrees Fahrenheit (adjustable between 110 degrees & 320 degrees Fahrenheit).

b) High level alarm and trip at 55 degrees fahrenheit per minute (adjustable between 20 degrees & 160 degrees Fahrenheit per minute.)

c) Trouble for short or open circuit conditions.

Dry contacts are provided, connecting to Control Room annunciators. Specifically, the alarms (pre-trip alarm, alarm, trouble, rate of rise) from the Turbine Building Loop 1 sensors are combined into a Control Room annunciator window. Likewise, the alarms from the Reactor Building Loop 1 sensors are similarly combined into the same Control Room annunciator window. Loop 2 Turbine and Reactor Building Sensor alarms are combined like that described for Loop 1, and input to another Control Room Annunciator window. Appropriate "reflash" provisions exist so that subsequent valid alarms are presented to the Control Room operator. Also provided are silence/acknowledge/test buttons.

Testing is facilitated in the two-out-of-four configuration by conversion to a two-out-of-three configuration during test of any one temperature element in a zone.

The SLRDIS employs "transmission logic" in that it takes power to cause an isolation signal. This is consistent with the use of "transmission logic" in portions of the existing Plant Protective System.

7.0 FUNCTIONAL DESCRIPTION - ABNORMAL OPERATION

The SLRDIS is designed to automatically isolate significant steam leaks that cannot be isolated in sufficient time by the reactor operator to preclude building temperatures which could:

(a) potentially damage safe shutdown electrical equipment that could be exposed to these steam leaks; or

(b) potentially prevent access to various plant locations where manual actions would be required to recover from such an event.

The discussion below describes the system operation within the Reactor or Turbine Buildings.

1. Steam Leaks of Sufficient Size to Initiate Automatic Shutdown of the Loops

   In order for each Loop logic to initiate a shutdown, a two-out-of-four tripping scheme is required for each zone. The zones selected provide for coverage (see Figure 2) in the event of a rupture in the high-energy steam lines. The routing of the eight (8) redundant lines is such that the sensors are able to monitor the "bulk" building temperature while minimizing the potential for spurious actuation.

   Each thermistor cable independently acts as a zone temperature sensor and provides a resistive signal inversely proportional to the area temperature. Both ends of each sensor cable are connected to the associated temperature monitor in a "loop" configuration. A break in a sensor cable will not negate the capability for a valid high temperature signal from being produced by the remaining ends. The sensor break itself actuates the Trouble Alarm.

The automatic isolation feature of each Loop SLRDIS is provided by redundant microprocessor-based logic. Each cable monitor, upon actuation of the high level alarm/trip, transfers this information through optical isolators to the two redundant (Logic A and Logic B) microprocessors per Loop panel.

Each microprocessor combines the four cable alarms from any single zone into a two-out-of-four logic trip signal. Upon actuation, the trip logic scheme provides dry relay contacts to the PPS.

The activation of relay contacts to PPS results in the closure of the valves in Table 1. This is achieved via two paths: (1) input into the Circulator Trip Logic for certain valves that are already closed by Circulator Trip Logic, and 2) input into Valve Actuation Logic for the remaining valves.

These two separate paths achieve the following:

a) Circulator Trip Logic trips all four helium circulators and their associated valves, initiates two Loop Trouble Trips, and a Reactor Scram.

b) Valve Actuation Logic closes (or prevents opening) of any valve required to be closed but not closed by the Circulator Trip Logic.

2) Steam Leaks of Insufficient Size to Initiate An Automatic Shutdown of the Loops

A steam leak of insufficient size may not initiate shutdown of the loops for two reasons. It may not cause a two-out-of-four pre-trip alarm or high level alarm/trip due to the spacing of the four thermistor cables or, due to the unrestricted nature of the area, the heat input may be dissipated, with the sensor temperature remaining under the 55 degrees Fahrenheit per minute set point of the trip. However, it is likely that in either of these conditions, the pre-trip alarm (of 135 degrees Fahrenheit) on any sensor would alert the operator to this size leak.

8.0 CONTROL AND SAFETY REQUIREMENTS

The SLRDIS has been designed in accordance with IEEE-279-1971, which exceeds the requirements of IEEE-279-1968, the design basis for the Plant Protective System. Redundant temperature channels are provided such that a single thermistor or monitor failure would not prevent the system from performing its protection function. The two-out-of-four logic precludes a trip initiation in the event of a spurious channel trip. Spurious or true single channel trip annunciators are provided to alert the operator to any channel trips. Two annunciator windows on the main control board alerts the operator to acknowledge the SLRDIS monitor and control rack (I-93543 Loop 1 and I-93544 Loop 2) if any problem occurs. Annunciators on the monitor and control racks provide the following status conditions of each sensor cable: Pre-Alarm, Alarm, Rate-of-Rise, or Trouble. In addition, each detection rack has a window that annunciates when any sensor is in the "test" mode and when power is on. A data logger in each logic rack prints out the temperature, time, and anomaly mode when any alarm occurs. A data logger, on each rack, prints out the temperature in degrees Fahrenheit any time an alarm occurs.

In-operation testing features are provided to assure the operability of the system. The operator can test the system (in the Control Room) from individual sensor to output relay coil, independent of plant operation. Surveillance testing will not cause tripping. In addition to testing, the channels are calibrated periodically per the Technical Specifications. Inputs are optically isolated between the detection equipment (temperature monitors) and the logic portion of the monitoring and control rack. Outputs are isolated by virture of coil to contact separation. The portions of SLRDIS shown on Figure 3 have been designed and constructed to provide a very high degree of reliability, per NUREG-0696 with an operational unavailability goal of 0.01.

The temperature monitors, logic and associated circuitry are mounted in instrument racks located in the Control Room. Physical and electrical separation, including input/output cabling wireways, is achieved thru compartmentalization or physical separation greater than six (6) inches.

TABLE 1

TAG NO.	LOOP	DESCRIPTION	SLRDIS ACTUATION LOGIC	SLRDIS ACTUATION METHOD(1)	RESET ACTION
SV-2105	1	CIRC 1A SPEED CONT	A&B	LOOP 1 CT A&B	(2)
SV-2106	2	CIRC 1C SPEED CONT	A&B	LOOP 2 CT A&B	"
SV-2109	1	CIRC 1A WATER TURB CONT	A&B	LOOP 1 CT A&B	"
SV-2110	2	CIRC 1C WATER TURB CONT	A&B	LOOP 2 CT A&B	"
SV-2111	1	CIRC 1B SPEED CONT	A&B	LOOP 1 CT A&B	"
SV-2112	2	CIRC 1D SPEED CONT	A&B	LOOP 2 CT A&B	"
SV-2115	1	CIRC 1B WATER TURB CONT	A&B	LOOP 1 CT A&B	"
SV-2116	2	CIRC 1D WATER TURB CONT	A&B	LOOP 2 CT A&B	"
HV-2109-1	1	CIRC 1A WATER TURB SUP	A&B	LOOP 1 CT A&B	(2)
HV-2110-1	2	CIRC 1C WATER TURB SUP	A&B	LOOP 2 CT A&B	"
HV-2115-1	1	CIRC 1B WATER TURB SUP	A&B	LOOP 1 CT A&B	"
HV-2116-1	2	CIRC 1D WATER TURB SUP	A&B	LOOP 2 CT A&B	"
HV-2109-2	1	CIRC 1A WATER TURB DISCH	A&B	LOOP 1 CT A&B	(2)
HV-2110-2	2	CIRC 1C WATER TURB DISCH	A&B	LOOP 2 CT A&B	"
HV-2115-2	1	CIRC 1B WATER TURB DISCH	A&B	LOOP 1 CT A&B	"
HV-2116-2	2	CIRC 1D WATER TURB DISCH	A&B	LOOP 2 CT A&B	"
HV-2201	1	FW INLET	A&B	LOOP 1 XCR	(2)
HV-2202	2	FW INLET	A&B	LOOP 2 XCR	"
FV-2205	1	FW CONTROL	A&B	LOOP 1 XCR	(2)
FV-2206	2	FW CONTROL	A&B	LOOP 2 XCR	"
HV-2203	1	EMER FW INLET	A&B	LOOP 1 XCR	(2)
HV-2204	2	EMER FW INLET	A&B	LOOP 2 XCR	"
HV-2223	1	SHT STM STOP CHECK	A&B	LOOP 1 CT A&B	(2)
HV-2224	2	SHT STM STOP CHECK	A&B	LOOP 2 CT A&B	"
PV-2229	1	SHT STM BYPASS	A&B	LOOP 1 XCR	(3)
PV-2230	2	SHT STM BYPASS	A&B	LOOP 2 XCR	(4)
HV-2292	2	SHT STM STARTUP BYPASS	A&B	LOOP 2 XCR	(4)
HV-2293	1	SHT STM STARTUP BYPASS	A&B	LOOP 1 XCR	(3)
HV-2241	1	RHT STM BYPASS	A&B	LOOP 1 XCR	(3)
HV-2242	2	RHT STM BYPASS	A&B	LOOP 2 XCR	(4)
PV-2243	1	RHT STM BYP PRESS RATIO CONT	A&B	LOOP 1 XCR	(3)

TAG NO.	LOOP	DESCRIPTION	SLRDIS ACTUATION LOGIC	METHOD(1)	RESET ACTION
PV-2244	2	RHT STM BYP PRESS RATIO CONT	A&B	LOOP 2 XCR	(4)
HV-2249	1	CIRC 1A TURB TRIP	A&B	LOOP 1 CT	(2)
HV-2250	2	CIRC 1C TURB TRIP	A&B	LOOP 2 CT	"
HV-2251	1	CIRC 1B TURB TRIP	A&B	LOOP 1 CT	"
HV-2252	2	CIRC 1D TURB TRIP	A&B	LOOP 2 CT	"
HV-2253	1	RHT STOP-CHECK	A&B	LOOP 1 XCR	(3)
HV-2254	2	RHT STOP-CHECK	A&B	LOOP 2 XCR	(4)
PCV-5201	-	AUX STM TO 150 PSIG HDR	A&B	LOOP 2 XCR	(6)
PCV-5213	-	AUX STM TO CRH	A&B	LOOP 1 XCR	(5)
PCV-5214-1	-	CRH TO 150 PSIG HDR	A&B	LOOP 1 XCR	(5)
PCV-5214-2	-	CRH TO 150 PSIG HDR	A&B	LOOP 1 XCR	(5)
PCV-5214-3	-	CRH TO 150 PSIG HDR	A&B	LOOP 2 XCR	(6)
PCV-5305	-	150 PSIG HDR TO DA	A&B	LOOP 2 XCR	(6)

(1) XCR indicates valve is actuated thru an XCR Module in PPS.
CT indicates valve is actuated thru Circulator Trip Logic portion of PPS.

(2) Requires:
a. Return of temperature rate of rise to below setpoint
b. Reset of microprocessor at monitoring and control rack I-93543 (Loop 1) or I-93544 (Loop 2)
c. Reset via existing methods to recover from Circulator Trip (or other existing logic in PPS)

(3) Requires:
a. Return of temperature rate of rise to below setpoint
b. Reset of microprocessor at monitoring and control rack I-93543 (Loop 1)
c. Reset of XCR via HS-93375A and HS-93375B for Loop 1 valves on main control board (I-05).

(4) Requires:
a. Return of temperature rate of rise to below setpoint
b. Reset microprocessor at monitoring and control rack I-93544 (Loop 2)
c. Reset of XCR's via HS-93376A and HS-93376B for Loop 2 valves on main control board (I-05)

(5) Requires:
  a. Return of temperature rate of rise to below setpoint
  b. Reset of microprocessor at monitoring and control rack I-93543 (Loop 1)
  c. Reset of XCR's via HS-93377A and HS-93377B for Loop common valves on main control board (I-06)

(6) Requires:
  a. Return of temperature rate of rise to below setpoint
  b. Reset of microprocessor at monitoring and control rack I-93544 (Loop 2)
  c. Reset of XCR's via HS-93378A and HS-93378B for Loop common valves on main control board (I-06)

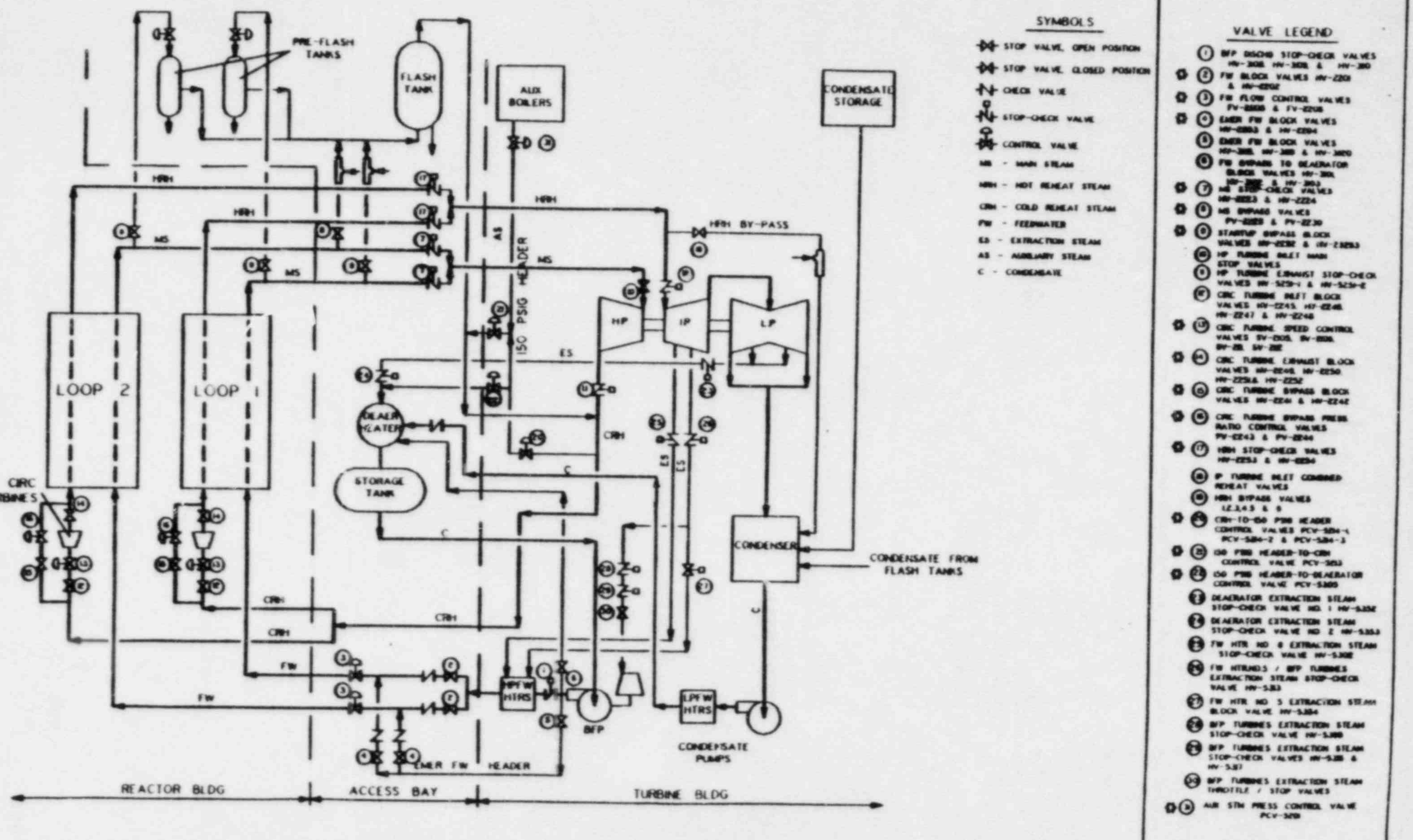

FIGURE I

FSV SECONDARY COOLANT AND POWER CONVERSION SYSTEM

FIGURE 2 SLRDIS, AND PPS RELATIONSHIP

LOOP I A LOGIC SHOWN, B LOGIC SIMILAR)

LOOP 2 IDENTICAL

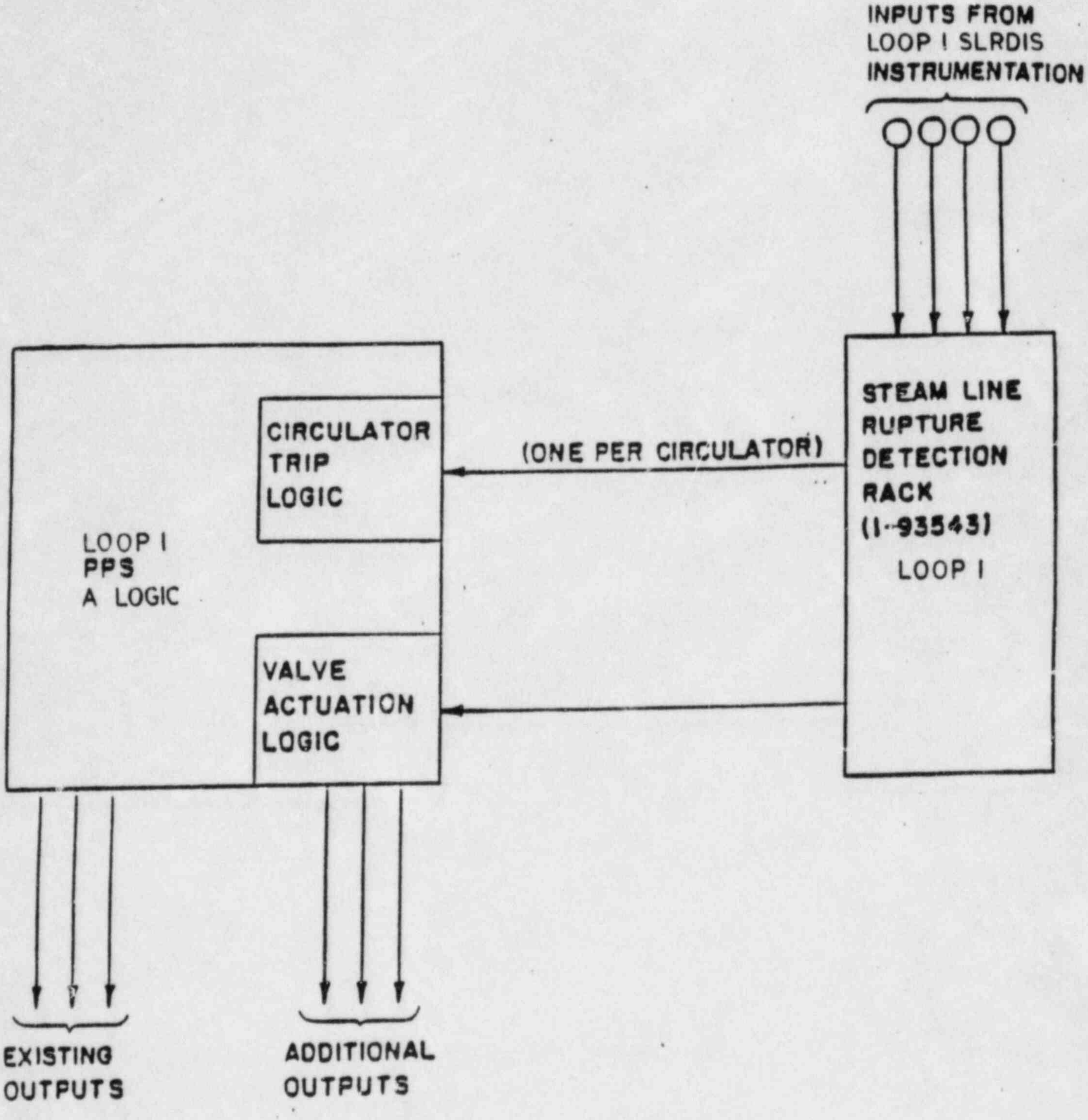

FIGURE 3

SENSOR LOCATIONS

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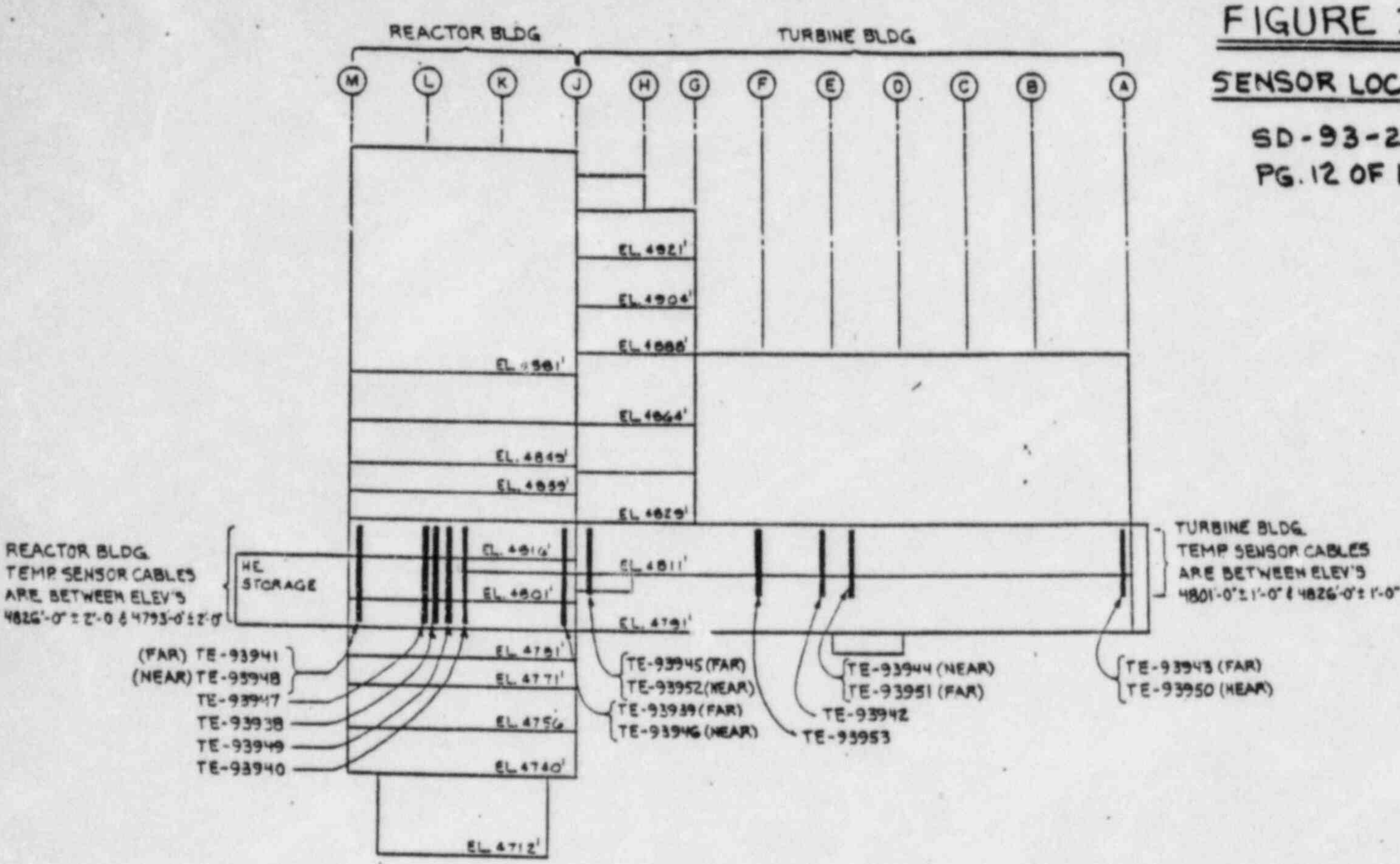
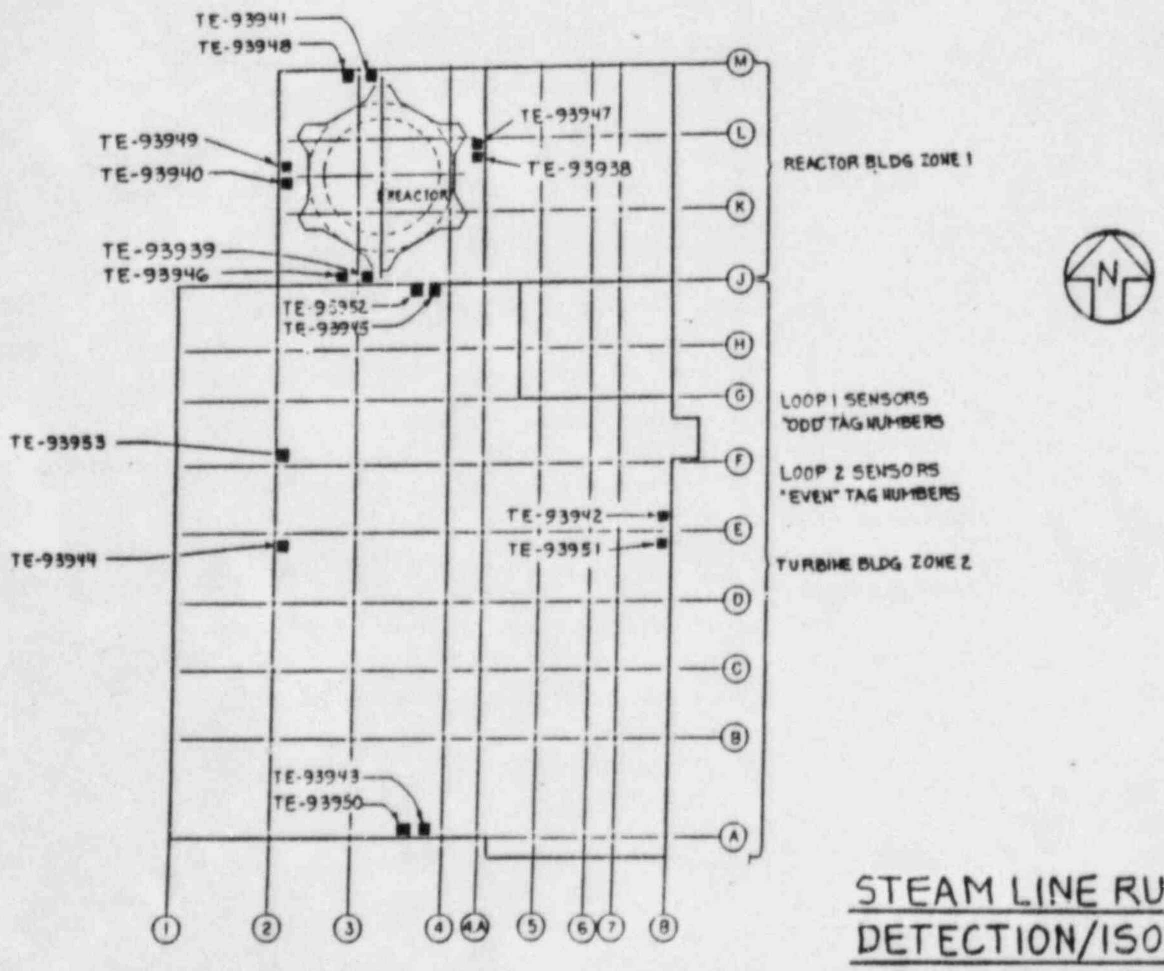


ELEVATION LOOKING EAST

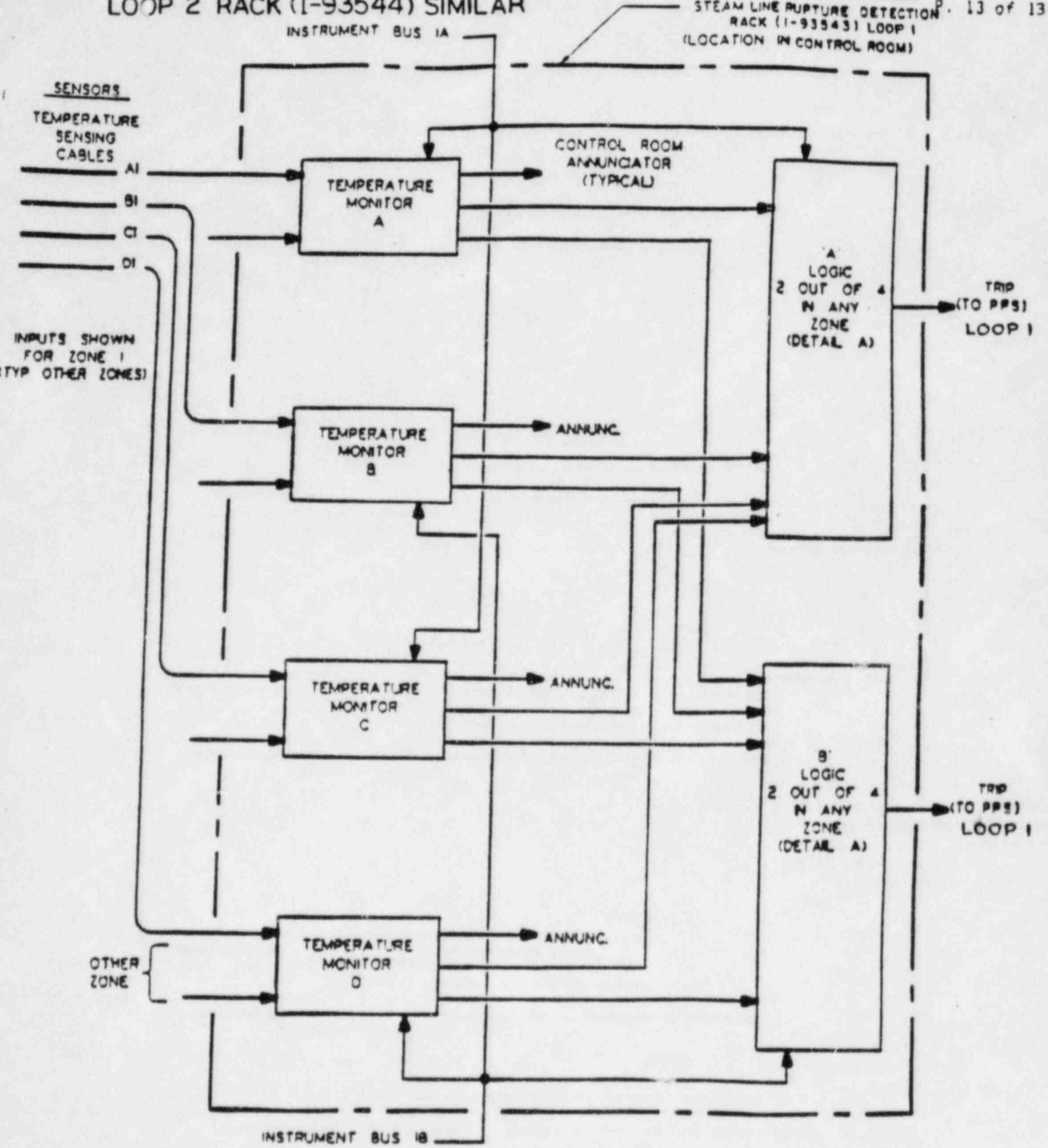


PLAN VIEW

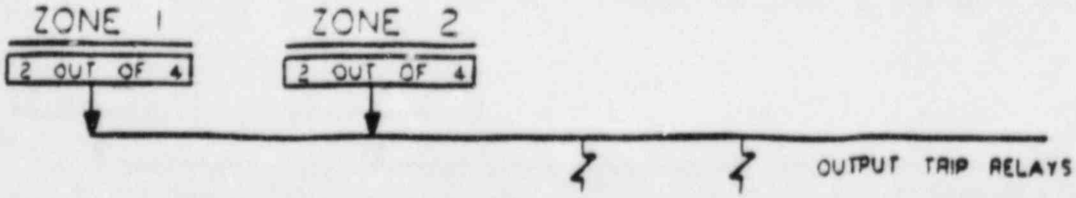
STEAM LINE RUPTURE DETECTION/ISOLATION SYSTEM OVERVIEW

FIGURE 4 STEAM LINE RUPTURE DETECTION ISOLATION INSTRUMENTATION

LOOP 2 RACK (I-93544) SIMILAR



DETAIL A 2 OUT OF 4 LOGIC 'A' BUS 1A (TYPICAL FOR LOGIC "B" BUS 1B)



ATTACHMENT 3

to P-86208

Temperature Profile Summary

Introduction

This attachment summarizes the development of temperature profiles for the FSV EQ Program. These profiles have been developed by GA Technologies (GAT) using two computer programs. The FLASH/GA program was used to obtain pipe break blowdown rates and the CONTEMPT-G program was used to obtain building temperature profiles.

As PSC presented to the NRC staff in the meeting on October 29, 1985 in Bethesda, GAT developed numerous scenarios to consider breaks in virtually all high energy lines. Full offset breaks were evaluated in the following lines: Feedwater, Condensate, Extraction Steam, Auxiliary Boiler Steam, Main Steam, Cold Reheat Steam, and Hot Reheat Steam. Subsequent to the October 29 meeting, the line break scenarios have been expanded to include a spectrum of break sizes, in addition to offset ruptures. Representative small crack sizes were input to the FLASH program to yield initial blowdown rates which were a percentage of the initial blowdown rates resulting from offset ruptures. Scenarios with the following associated blowdown rate percentages have been analyzed: 100%, 75%, 50%, 25%, and 10%, 3%, 2%, 1% and smaller. By evaluating the numerous systems and break sizes, PSC is confident that the final temperature profiles are representative of the most limiting environments.

Ground Rules

The following are the major ground rules used for all scenarios.

1) The SLRDIS will be installed to detect and isolate breaks which reach the sensor temperature rate of rise setpoint. See Attachment 2 of this letter for a description of the SLRDIS.

2) The analysis value trip setpoint is 55 degrees Fahrenheit per minute and a fixed temperature pre-trip alarm of 135 degrees Fahrenheit (analysis value) will be functional.

3) The CONTEMPT-G program calculates a bulk building temperature, and the SLRDIS relies on the same bulk temperature for detection/isolation.

4) Following each rupture, an experienced team of GAT personnel determined the worst case single active failure by engineering judgement and used this in the analysis.

5) Existing plant protection and control systems will function (except for the existing Steam Pipe Rupture Detection System).

6) All environmentally qualified equipment will function unless it is the object of the single active failure.

7) All non-qualified equipment will function if it performs its function prior to experiencing the harsh environment (approximately 20 seconds) and if it is not the object of the single active failure.

8) Various plant power levels (100%, 59%, 29%) were evaluated in different scenarios to assure that the most limiting environment would be evaluated.

Temperature Profile Development

A scenario is developed by assuming a certain size line rupture based on a percent of full offset rupture flow. The rupture is assumed in any of the piping systems previously identified and a worst case single active failure is assumed coincident with the rupture. The FLASH/GA computer program is then used to determine the unterminated blowdown rate due to the rupture. This energy and mass leak rate is then input into the CONTEMPT-G program to determine the resulting atmospheric temperature. Using this unterminated temperature profile the SLRDIS setpoint could be applied to determine the method of termination.

When considering the entire spectrum of breaks, the detection and isolation of the breaks can be separated into several categories.

1) Large breaks (those with blowdown rates equal to approximately 2% to 100% of offset rupture blowdown rates) in the steam lines are automatically detected and isolated by SLRDIS, using an analysis value setpoint of 55 degrees Fahrenheit per minute.

2) Large breaks in the lower enthalpy lines (condensate, feedwater) can be detected by SLRDIS pre-trip alarm, noise, plant personnel, or other plant instrumentation. Manual actions can be taken 10 minutes following detection to manually isolate the break.

3) Some steam line breaks yielding blowdown rates less than approximately 2% of offset rupture blowdown rates will trip the SLRDIS 135 degrees Fahrenheit pre-trip alarm (analysis value). Manual actions can be taken 10 minutes following the alarm to isolate the break.

4) If the alarm setpoint is not reached within an hour, termination is assumed to take place at 1 hour.

These air temperature profiles are used along with the sensor response time test results to determine tne time in which the sensor cables reach the alarm or trip temperature. After the termination time is determined, the valves that SLRDIS activates are modeled to close at normal speed. This information is input into FLASH and the terminated blowdown rate is rerun. With the terminated leak energy and mass rates, the CONTEMPT-G program is used to determine the final air temperature profiles.

Results

Attached are representative composite profiles for the reactor building and the turbine building. These result from large and small breaks, and they include profiles with the highest peaks and representative profiles with high temperatures at one hour after the LOFC. Subsequent to the October 29 meeting, no scenarios with smaller than offset rupture breaks have yielded profiles with peak temperatures higher than those presented on October 29. The peak temperatures for the Reactor and Turbine Buildings are 371 degrees Fahrenheit and 360 degrees Fahrenheit, respectively. These values have increased slightly due to a computational error that was found. The scenarios have been corrected and updated temperature profiles are attached.

Many of these small breaks may not cause a Loss of Forced Circulation (LOFC) and access would not be required. However, if an LOFC occurred, 1 1/2 hours would be available to restart forced circulation. If an LOFC occurred before the operator received the 135 degrees Fahrenheit temperature alarm, he would be aware that a problem had occurred and could isolate the break within 10 minutes. However, at worst case, it is assumed that the LOFC occurred when the break is detected. Based on this, the worst case ambient temperature 1 hour after break detection is 134 degrees Fahrenheit.

This temperature is considered acceptable to perform manual actions in utilizing cool suits. However, PSC is currently pursuing plant modifications that would eliminate all manual actions from the harsh environment. Manual actions would still be required outside of the control room, which is consistent with the current FSV licensing basis for many accidents, but none of them would be located in a harsh environment.

As described above, PSC has considered a wide range of break scenarios and break sizes. We are confident that the composite profiles which will be included in the FSV EQ Program will be representative of the most limiting environmental conditions for equipment qualification and human access. The attached summary table and composite profiles are representative of those that will be the final basis of the FSV EQ Program.

Summary of Results and Composite Profiles

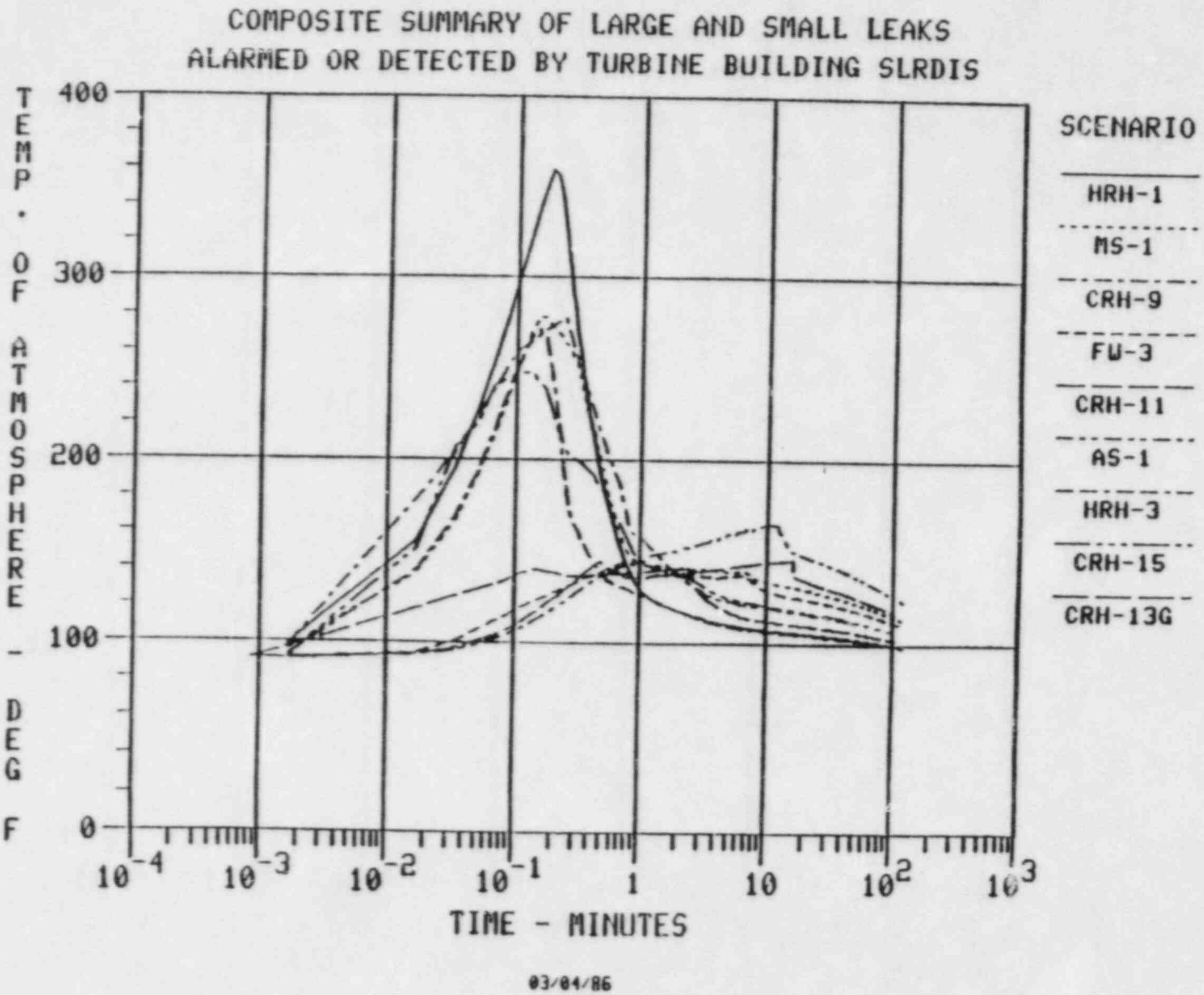
for Turbine and Reactor Buildings

Scenario	Pipe Rupture	Building	Blowdown Rate	Termination
HRH-1	Hot Reheat	Turbine	100%	SLRDIS
MS-1	Main Steam	Turbine	100%	SLRDIS
CRH-9	Cold Reheat	Turbine	100%	SLRDIS
FW-3	Feedwater	Turbine	100%	Manual*
CRH-11	Cold Reheat	Turbine	100%	SLRDIS
AS-1	Aux. Boiler Stm.	Turbine	100%	Manual*
HRH-3	Hot Reheat	Turbine	25%	SLRDIS
CRH-15	Cold Reheat	Turbine	25%	SLRDIS
CRH-13G	Cold Reheat	Turbine	1%	Manual*
HRH-2	Hot Reheat	Reactor	100%	SLRDIS
MS-2	Main Steam	Reactor	100%	SLRDIS
MS-3	Main Steam	Reactor	100%	SLRDIS
CRH-10	Cold Reheat	Reactor	100%	SLRDIS
CRH-12	Cold Reheat	Reactor	100%	SLRDIS
FW-6	Feedwater	Reactor	100%	Manual*
CRH-16	Cold Reheat	Reactor	25%	SLRDIS

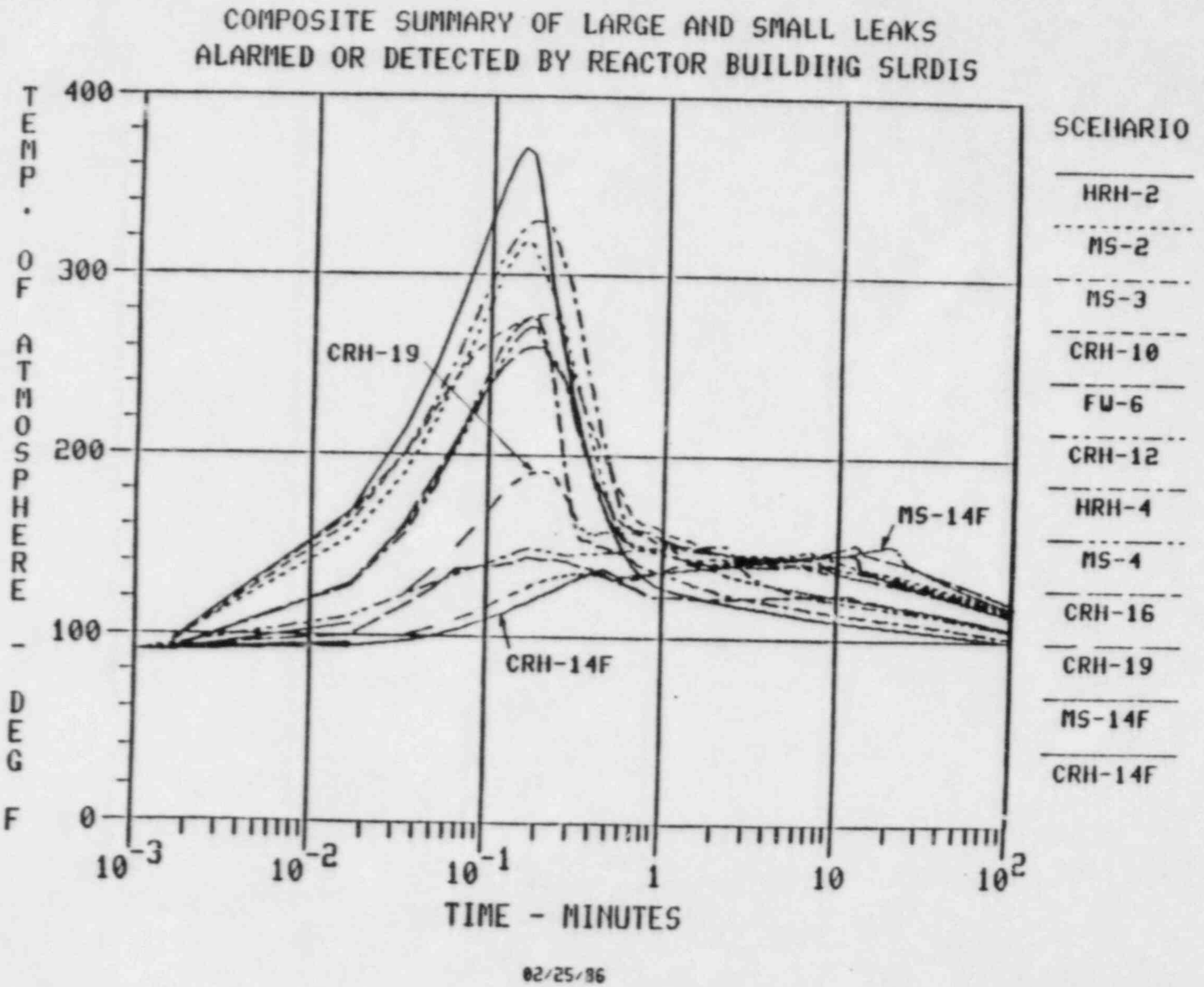
Attachment 3
to P-86208

Scenario	Pipe Rupture	Building	Blowdown Rate	Termination
MS-4	Main Steam	Reactor	25%	SLRDIS
HRH-4	Hot Steam	Reactor	25%	SLRDIS
CRH-19	Cold Reheat	Reactor	10%	SLRDIS
MS-14F	Main Steam	Reactor	2.5%	Manual*
CRH-14F	Cold Reheat	Reactor	2%	Manual*

*12 minutes after receipt of 135 degrees F SLRDIS alarm



COMPOSITE SUMMARY OF LARGE AND SMALL LEAKS
ALARMED OR DETECTED BY TURBINE BUILDING SLRDIS
TEMP. OF ATMOSPHERE - DEG F
400
300
200
100
0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
10^{3}
TIME - MINUTES
SCENARIO
HRH-1
MS-1
CRH-9
FW-3
CRH-11
AS-1
HRH-3
CRH-15
CRH-13G
03/04/86


COMPOSITE SUMMARY OF LARGE AND SMALL LEAKS
ALARMED OR DETECTED BY REACTOR BUILDING SLRDIS
TEMP. OF ATMOSPHERE - DEG F
400
300
200
100
0
CRH-19
CRH-14F
MS-14F
SCENARIO
HRH-2
MS-2
MS-3
CRH-10
FW-6
CRH-12
HRH-4
MS-4
CRH-16
CRH-19
MS-14F
CRH-14F
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
TIME - MINUTES
02/25/86