PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

NO. SD-93-23

SYSTEM DESCRIPTION: STEAM LINE RUPTURE DETECTION/ISOLATION SYSTEM	PLANT ITEM NO'S.

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ISSUE SUMMARY

ISSUE	PREPARED BY	ENGRG. REVIEW	REVIEW	APPROVED BY	DATE	BASIS FOR REVISION
A	M.C. Annon	GSB	JCS	WE Nichoff	12/27/85	CN-2136B

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 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 atmospheres exceeding 160 degrees Fahrenheit (analysis value), a pre-trip alarm initiates in the Control Room.

b) For Reactor and Turbine Building atmospheres exceeding 210 degrees Fahrenheit (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 a high rate of temperature rise, exceeding 100 degrees Fahrenheit per minute, an alarm is initiated in the Control Room.

e) 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.

f) 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) Eight (8) Temperature Sensors - TE93838 thru 93941 for Zone 1
TE93942 thru 93945 for Zone 2

b) Monitoring and Control Rack (I-93543) 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) to the Circulator Trip Logic Portion of PPS.

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

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

a) Plant Protection 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 Protection 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 four thermistor cables providing for redundant and divisionalized temperature sensing capability. The four signals are routed independently to 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 at 160 degrees Fahrenheit (adjustable between 140 degrees & 350 degrees Fahrenheit).

b) Alarm and trip at 210 degrees fahrenheit (adjustable between 140 degrees & 350 degrees Fahrenheit).

c) Trouble for short or open circuit conditions.

d) Rate of rises greater than 100 degrees Fahrenheit per minute.

Dry contacts are provided, connecting to Control Room annunciators. Specifically, the alarms (pre-trip alarm, alarm, trouble, rate of rise) from the Turbine Building are combined into a Control Room annunciator window. Likewise, the alarms from the Reactor Building are similarly combined into the same Control Room annunciator window. Appropriate "reflash" provisions exist so that subsequent valid alarms are presented to the Control Room operator while a channel is disabled for maintenance, or on test. 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 Protection 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 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 the shutdown logic to initiate, a two-out-of-four tripping scheme is established 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 four (4) 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 the 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.

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 circulators and their associated valves, initiates two Loop Trouble Trips, and eventually 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 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 area temperature remaining under the 210 degrees Fahrenheit set point of the trip. However, it is likely that in either of these conditions, the pre-trip alarm (of 160 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 Protection 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. One annunciator window on the main control board alerts the operator to acknowledge the SLRDIS monitor and control rack (I-93543) if any problem occurs. Annunciators on the monitor and control rack 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 the 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 an instrument rack 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	CT	(2)
SV-2106	2	CIRC 1C SPEED CONT	A&B	CT	"
SV-2109	1	CIRC 1A WATER TURB CONT	A&B	CT	"
SV-2110	2	CIRC 1C WATER TURB CONT	A&B	CT	"
SV-2111	1	CIRC 1B SPEED CONT	A&B	CT	"
SV-2112	2	CIRC 1D SPEED CONT	A&B	CT	"
SV-2115	1	CIRC 1B WATER TURB CONT	A&B	CT	"
SV-2116	2	CIRC 1D WATER TURB CONT	A&B	CT	"
HV-2109-1	1	CIRC 1A WATER TURB SUP	A&B	CT	(2)
HV-2110-1	2	CIRC 1C WATER TURB SUP	A&B	CT	"
HV-2115-1	1	CIRC 1B WATER TURB SUP	A&B	CT	"
HV-2116-1	2	CIRC 1D WATER TURB SUP	A&B	CT	"
HV-2109-2	1	CIRC 1A WATER TURB DISCH	A&B	CT	(2)
HV-2110-2	2	CIRC 1C WATER TURB DISCH	A&B	CT	"
HV-2115-2	1	CIRC 1B WATER TURB DISCH	A&B	CT	"
HV-2116-2	2	CIRC 1D WATER TURB DISCH	A&B	CT	"
HV-2201	1	FW INLET	B	XCR	(2)
HV-2202	2	FW INLET	A	XCR	"
FV-2205	1	FW CONTROL	A	XCR	(2)
FV-2206	2	FW CONTROL	B	XCR	"
HV-2203	1	EMER FW INLET	B	XCR	(2)
HV-2204	2	EMER FW INLET	A	XCR	"
HV-2223	1	SHT STM STOP CHECK	A&B	CT	(2)
HV-2224	2	SHT STM STOP CHECK	A&B	CT	"
PV-2229	1	SHT STM BYPASS	A&B	XCR	(3)
PV-2230	2	SHT STM BYPASS	A&B	XCR	"
HV-2292	1	SHT STM STARTUP BYPASS	A&B	XCR	(3)
HV-2293	2	SHT STM STARTUP BYPASS	A&B	XCR	"
HV-2241	1	RHT STM BYPASS	A&B	XCR	(3)
HV-2242	2	RHT STM BYPASS	A&B	XCR	"
PV-2243	1	RHT STM BYP PRESS RATIO CONT	A&B	XCR	(3)

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

(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 ambient to below setpoint
b. Reset of micropressor at monitoring and control rack (I-93543)
c. Reset via existing methods to recover from Circulator Trip (or other existing logic in PPS)

(3) Requires:
a. Return of ambient to below setpoint
b. Reset of micropressor at monitoring and control rack (I-93543)
c. Reset of XCR via HS-93375 (HS-93376) on main control board (I-05)

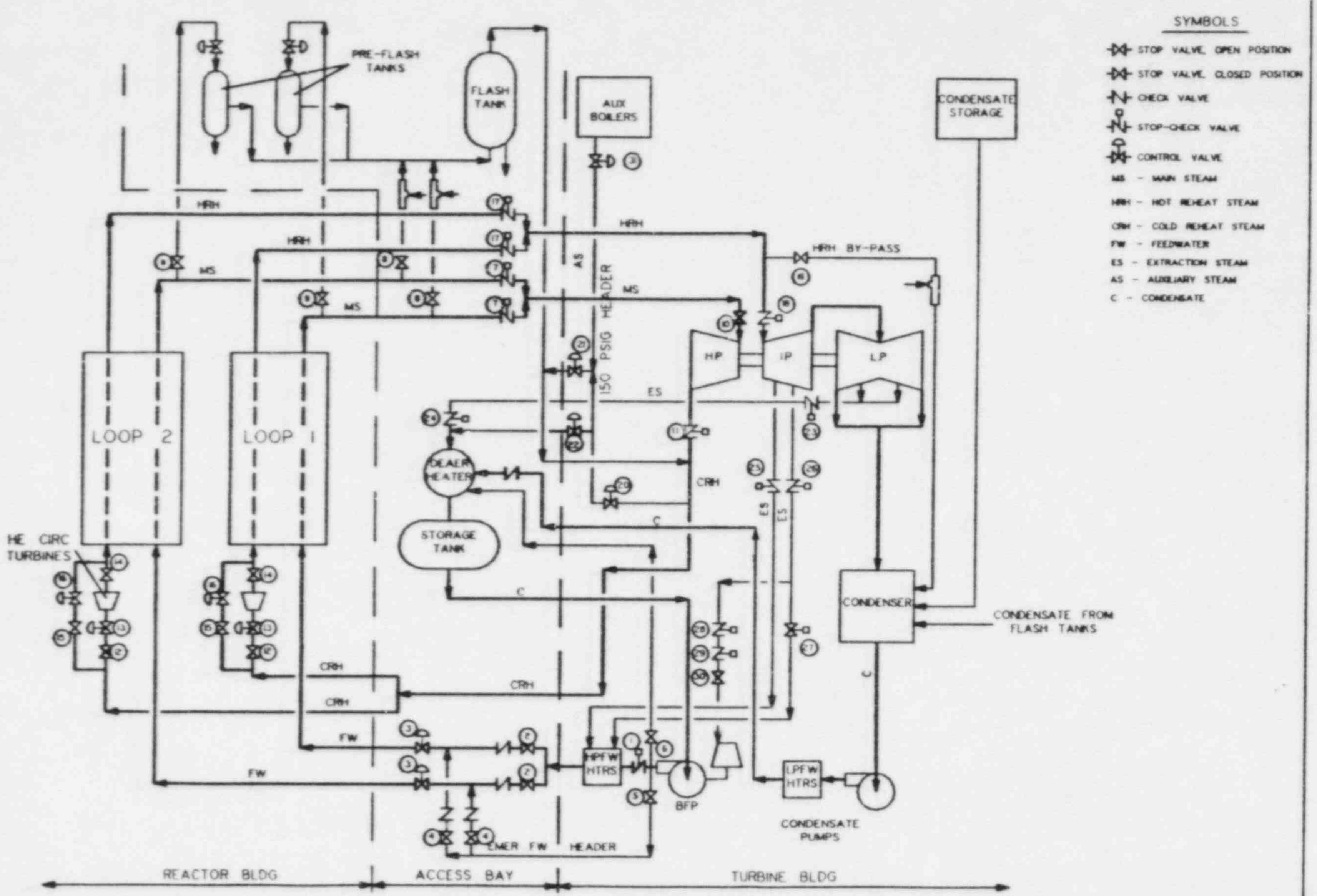


FIGURE 1

FSV SECONDARY COOLANT AND POWER CONVERSION SYSTEM

VALVE LEGEND

- (1) BFP DISCHG STOP-CHECK VALVES HV-3108, HV-3109 & HV-3110
- ✪ (2) FW BLOCK VALVES HV-2201 & HV-2202
- ✪ (3) FW FLOW CONTROL VALVES FV-2205 & FV-2206
- ✪ (4) EMER FW BLOCK VALVES HV-2203 & HV-2204
- (5) EMER FW BLOCK VALVES HV-3118, HV-3119 & HV-3120
- (6) FW BYPASS TO DEAERATOR BLOCK VALVES HV-3101, HV-3102 & HV-3103
- ✪ (7) MS STOP-CHECK VALVES HV-2223 & HV-2224
- ✪ (8) MS BYPASS VALVES PV-2229 & PV-2230
- ✪ (9) STARTUP BYPASS BLOCK VALVES HV-22292 & HV-23293
- (10) HP TURBINE INLET MAIN STOP VALVES
- (11) HP TURBINE EXHAUST STOP-CHECK VALVES HV-5251-1 & HV-5251-2
- (12) CIRC TURBINE INLET BLOCK VALVES HV-2245, HV-2246, HV-2247 & HV-2248
- ✪ (13) CIRC TURBINE SPEED CONTROL VALVES SV-2105, SV-2106, SV-2111, SV-2112
- ✪ (14) CIRC TURBINE EXHAUST BLOCK VALVES HV-2249, HV-2250, HV-2251& HV-2252
- ✪ (15) CIRC TURBINE BYPASS BLOCK VALVES HV-2241 & HV-2242
- ✪ (16) CIRC TURBINE BYPASS PRESS. RATIO CONTROL VALVES PV-2243 & PV-2244
- ✪ (17) HRH STOP-CHECK VALVES HV-2253 & HV-2254
- (18) IP TURBINE INLET COMBINED REHEAT VALVES
- (19) HRH BYPASS VALVES 1,2,3,4,5 & 6
- ✪ (20) CRH-TO-150 PSIG HEADER CONTROL VALVES PCV-5214-1, PCV-5214-2 & PCV-5214-3
- ✪ (21) 150 PSIG HEADER-TO-CRH CONTROL VALVE PCV-5213
- ✪ (22) 150 PSIG HEADER-TO-DEAERATOR CONTROL VALVE PCV-5305
- (23) DEAERATOR EXTRACTION STEAM STOP-CHECK VALVE NO. 1 HV-5352
- (24) DEAERATOR EXTRACTION STEAM STOP-CHECK VALVE NO. 2 HV-5353
- (25) FW HTR. NO. 6 EXTRACTION STEAM STOP-CHECK VALVE HV-5302
- (26) FW HTR.NO.5 / BFP TURBINES EXTRACTION STEAM STOP-CHECK VALVE HV-5313
- (27) FW HTR. NO. 5 EXTRACTION STEAM BLOCK VALVE HV-5354
- (28) BFP TURBINES EXTRACTION STEAM STOP-CHECK VALVE HV-5398
- (29) BFP TURBINES EXTRACTION STEAM STOP-CHECK VALVES HV-5316 & HV-5317
- (30) BFP TURBINES EXTRACTION STEAM THROTTLE / STOP VALVES
- ✪ (31) AUX STM PRESS CONTROL VALVE PCV-5201

✪ INTERLOCKED WITH SLRDIS

CAD-STDFL01 9-88

FIGURE 2 SLRDIS, AND PPS RELATIONSHIP
A LOGIC SHOWN, B LOGIC SIMILAR)

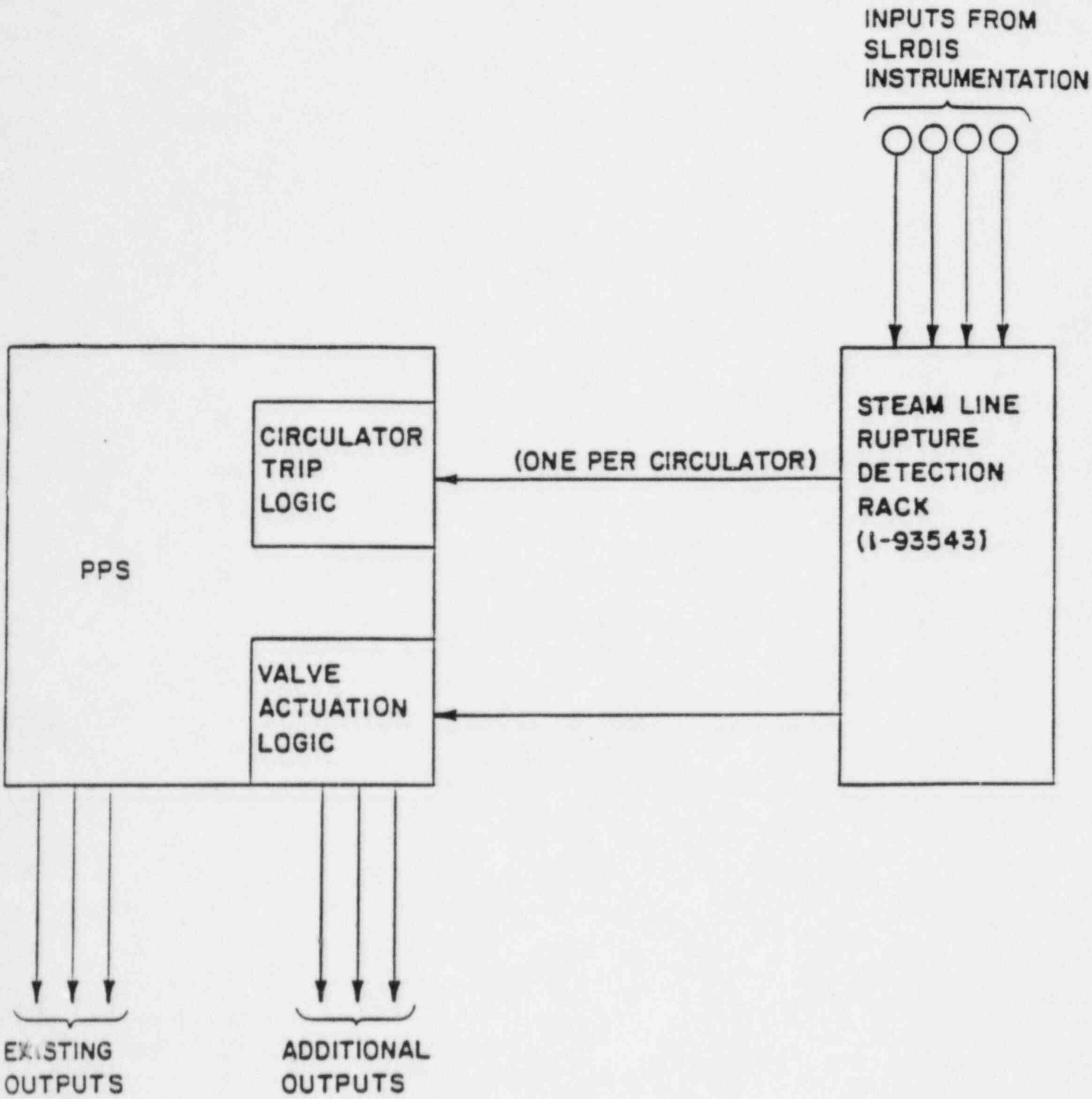
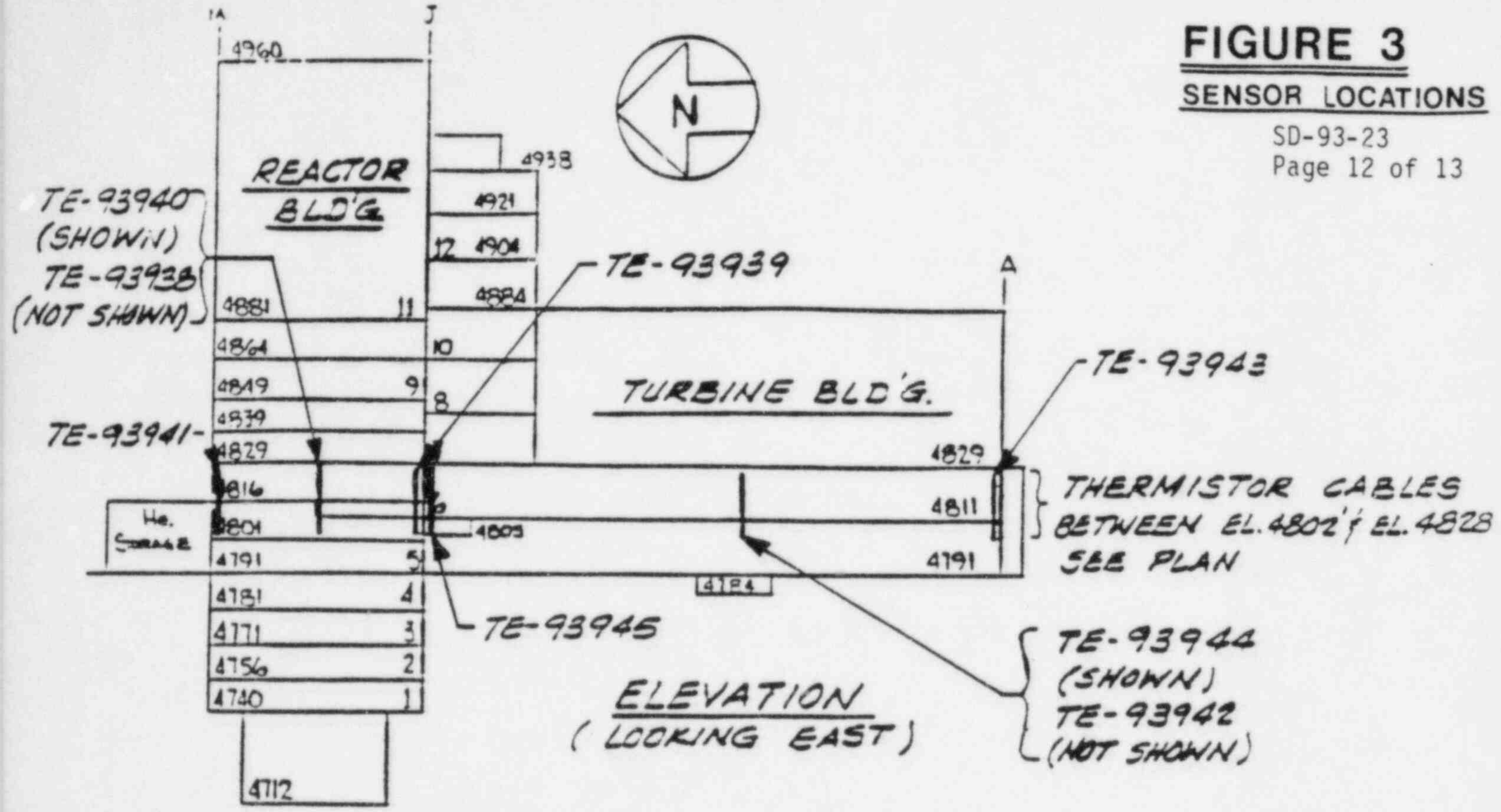


FIGURE 3

SENSOR LOCATIONS



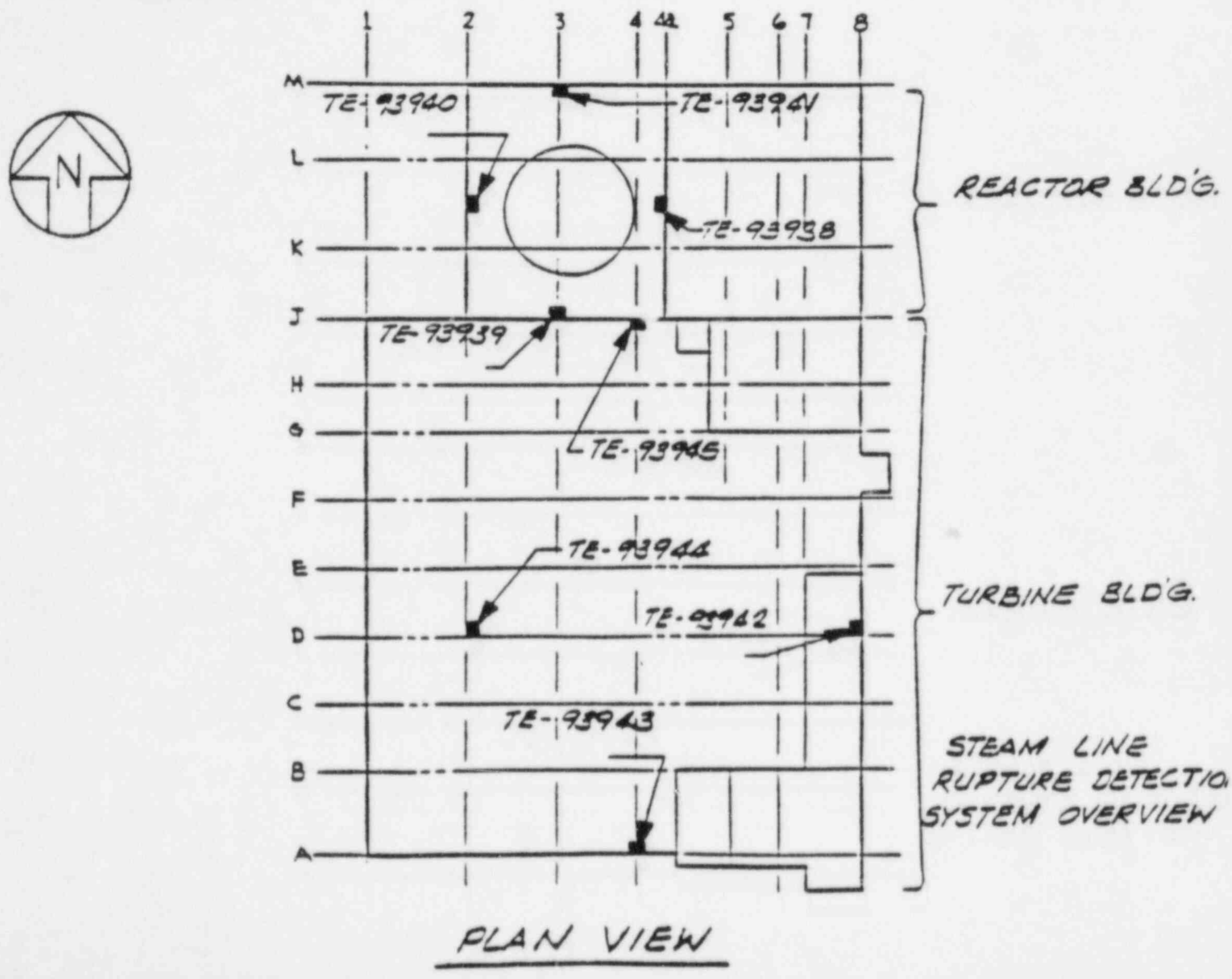
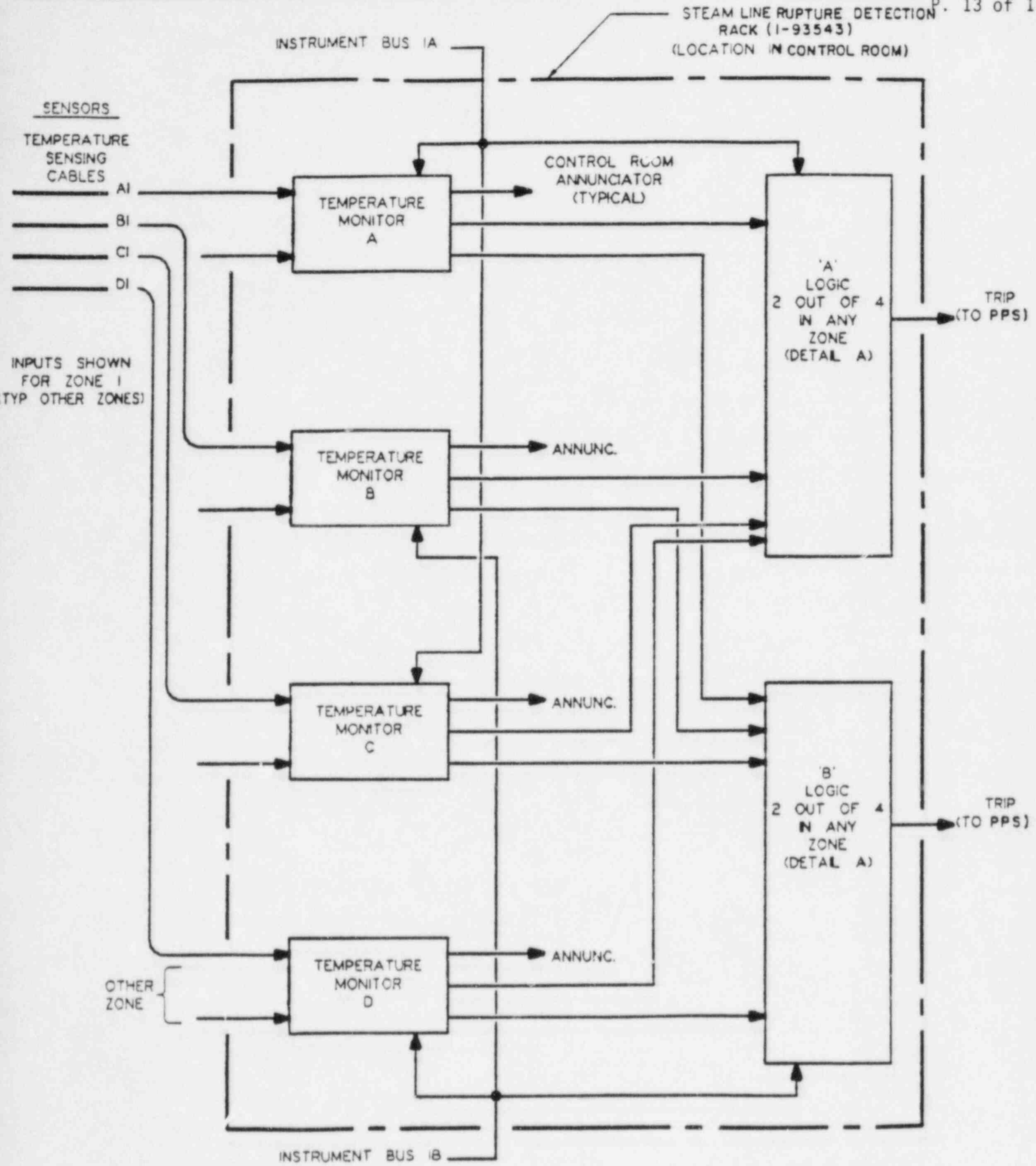
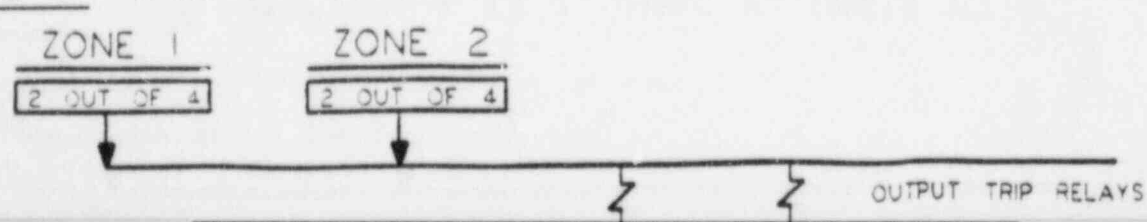


FIGURE 4 STEAM LINE RUPTURE DETECTION ISOLATION INSTRUMENTATION



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



ATTACHMENT 3

to P-85499

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 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 are being 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 will be 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 setpoint. See Attachment 2 of this letter for a description of the SLRDIS.

2) The analysis value trip setpoint is 210 degrees Fahrenheit (which has been lowered since the October 29 meeting to detect smaller breaks), and a pre-trip alarm of 160 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.

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. Subsequent to the October 29 meeting, no scenarios with smaller than offset rupture breaks have yielded profiles with peaks 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. The smaller breaks did produce higher temperatures at one hour than the offset ruptures. Maximum temperatures for both buildings are in the 180 degrees Fahrenheit range at one hour following the steam line rupture.

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 2-100% of offset rupture blowdown rates) in the steam lines are automatically detected and isolated by SLRDIS, using an analysis value setpoint of 210 degrees Fahrenheit.

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

3) Steam line breaks yielding blowdown rates approximately equal to 1% of offset rupture blowdown rates will trip the SLRDIS 160 degrees Fahrenheit pre-trip alarm (analysis value). Manual actions can be taken 10 minutes following the alarm to isolate the break.

4) Steam line breaks with much smaller than 1% of offset rupture blowdown rates and do not trip the 160 degrees Fahrenheit alarm are conservatively assumed to be isolated at one hour.

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. The profiles presented are currently being independently reviewed. However, we are confident the curves correctly represent the environmental conditions resulting from the many scenarios analyzed. The NRC staff will be notified if any major changes are uncovered during the review.

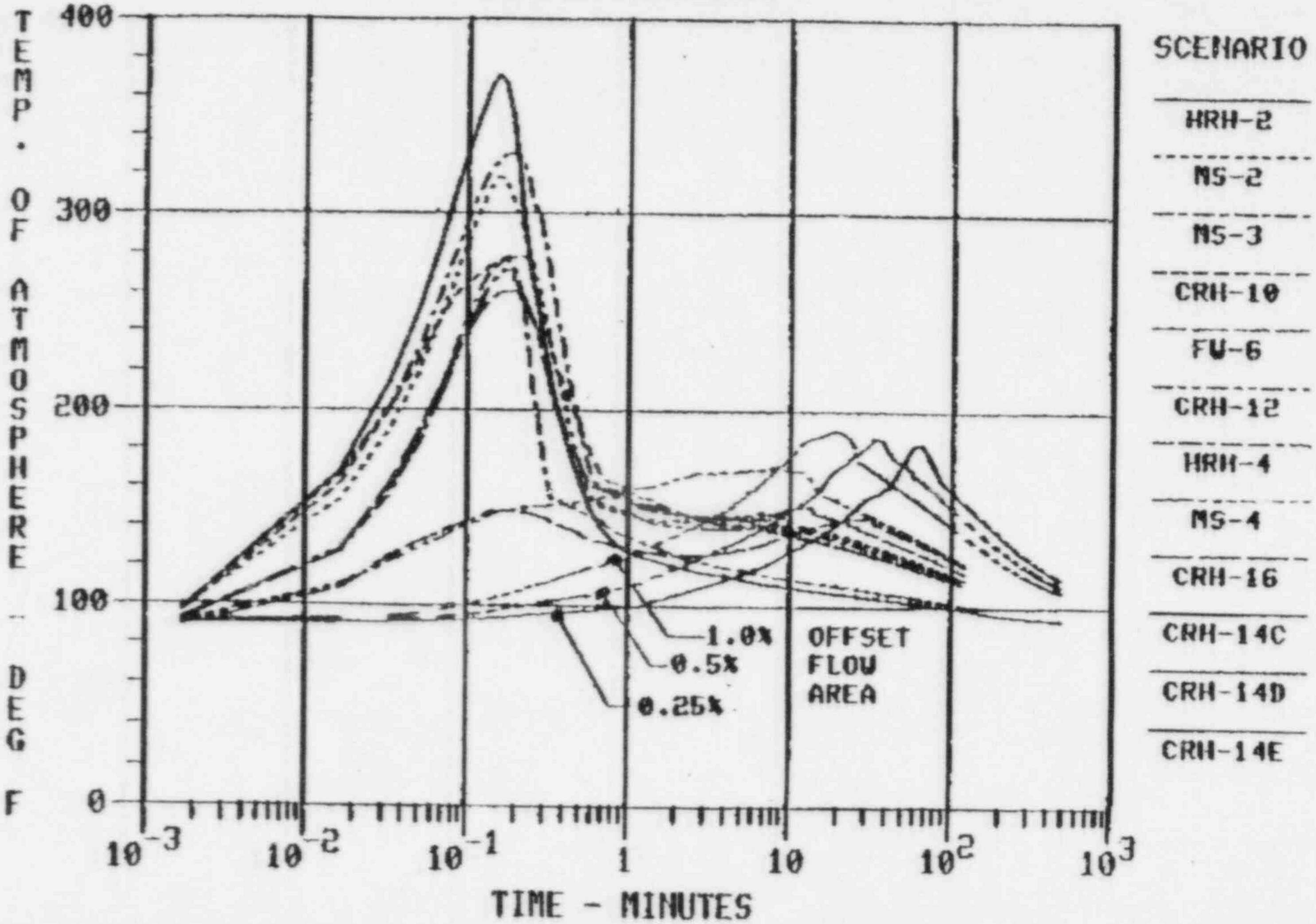
Summary of Results - Spectrum of Break Sizes

Scenario	Pipe Rupture	Building	Break Size (% of Offset Rupture 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%	Manual
AS-1	Aux. Boiler Stm.	Turbine	100%	Manual
HRH-3	Hot Reheat	Turbine	25%	SLRDIS
CRH-15	Cold Reheat	Turbine	25%	SLRDIS
CRH-13C	Cold Reheat	Turbine	0.74%	Manual*
CRH-13F	Cold Reheat	Turbine	0.093%	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%	Manual
FW-6	Feedwater	Reactor	100%	Manual
CRH-16	Cold Reheat	Reactor	25%	SLRDIS
MS-4	Main Steam	Reactor	25%	SLRDIS
HRH-4	Hot Reheat	Reactor	25%	SLRDIS
CRH-14F**	Cold Reheat	Reactor	3%	SLRDIS
CRH-14G**	Cold Reheat	Reactor	2%	SLRDIS
CRH-14C	Cold Reheat	Reactor	1%	Manual*
CRH-14D	Cold Reheat	Reactor	0.5%	Manual*
CRH-14E	Cold Reheat	Reactor	0.25%	Manual*

*12 minutes after 160 degrees F SLRDIS pre-trip alarm

**These scenarios are not included in the graphes but are enveloped by the profiles presented

COMPOSITE SUMMARY OF LARGE AND SMALL LEAKS
REACTOR BUILDING



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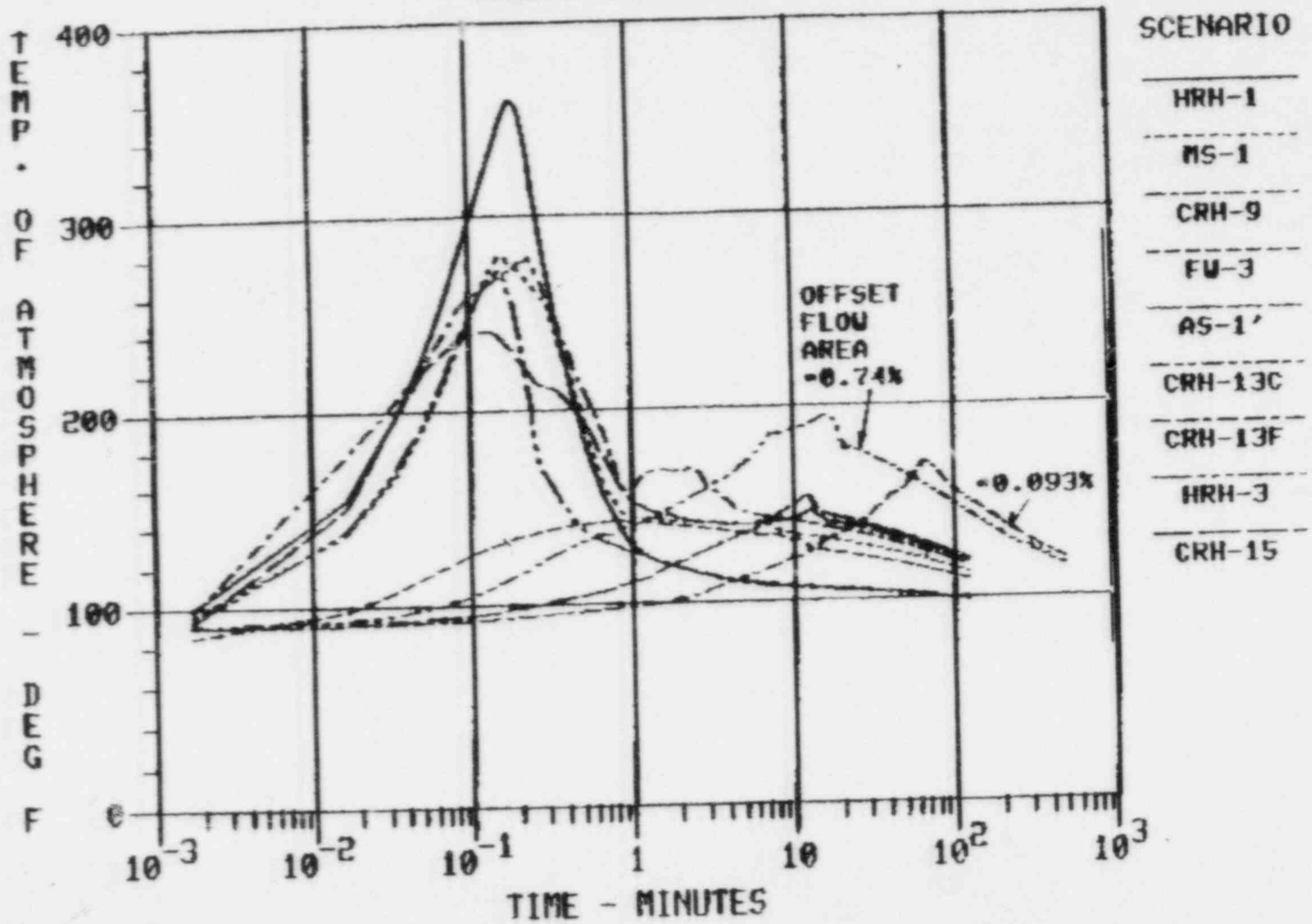
COMPOSITE SUMMARY OF LARGE AND SMALL LEAKS
TURBINE BUILDING



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