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WYR 78-23

YANKEE ATOMIC ELECTRIC COMPANY

YANKEE

20 Turnpike Road Westborough, Massachusetts 01581

February 28, 1978

United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Office of Nuclear Reactor Regulation

Reference: (a) License No. DPR-3 (Docket No. 50-29)
(b) USNRC letter to YAEC, dated December 1, 1977
(c) USNRC letter to YAEC, dated December 23, 1977
(d) YAEC letter to USNRC, dated February 15, 1978 (WYR 78-14)

Dear Sir:

Subject: Systematic Evaluation Program (SEP)

Your letter, Reference (c), requested information of those plants which are participating in the Systematic Evaluation Program (SEP) pertaining to identification, service environmental conditions and environmental qualification of safety-related electrical equipment.

The attached equipment list identifies the equipment, its class, and location. Attachment A to the equipment list defines the limiting service environmental conditions for this equipment and the requirements for the operation of the equipment under DBE conditions. Attachment B to the list provides a determination of the current status of environmental qualification and identifies supporting documentation. The sections of the Attachments which are appropriate for each item of equipment are identified on the list. Similar items of equipment with similar environmental requirements have been included on the list as one item.

In the determination of the current status of environmental qualification for safety-related electrical equipment, no significant safety concerns have been identified. If you have any questions on this submittal, please contact Mr. David A. Hansen of this office.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

D E Vandenburgh

D. E. Vandenburgh
Senior Vice President

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EQUIPMENT LIST

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV Q
Reactor Protection System						
	Linear Amp RPS	WEST FN	IE	MCR	A1	B1
	Indicator RPS	WEST KX24	--	MCR	A1	B1
	Bistable RPS	WEST FN	IE	MCR	A1	B
	Relay and Control Panel RPS	WEST FN	IE	MCR	A1	B1
MC-FD-	Diff. Pressure Detector MC Loop Flow	BARTN 244	IE	VC	A2	B2
AOCT	Current Xformer MCP Current Phase	WEST ECI	IE	SWGR	A2	B3
	Current Relay MC Flow Scram	WEST 1876-072	IE	SWGR	A2	B3
	Relay MC Flow Scram	COUCH 4C37B	IE	SWGR	A2	B4
[illegible]TD	Time Delay Relay Delay Scram 200 ms	AGAST 2422-PA	IE	SWGR	A2	B4
[illegible]-FD-	Pressure Detector MC & Pressurizer	BAILY KIX	IE	VC	A2	B5
[illegible]-LD-	Level Detector Pressurizer Level	BAILY BR117XX MODEL XNX	IE	VC	A2	B6
[illegible]-1003	Level Xmitter SG	FP 13D2495J-BC-BBB-NS	IE	VC	A2	B7
	Power Supply for Xmitter LT-1003	LAMBD LM262	IE	MCR	A1	B8
[illegible]A-1003	Bistable Reactor Trip	RIS ET-215R	IE	MCR	A1	B9
	Test Switch for Xmitter [illegible]3	ES 28204A-2	--	MCR	A1	B10
[illegible]C-1003	Meter Relay Alarm Unit	SIGMA 9222-20ED-2-VB11M	--	MCR	A1	B11

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
CH-3,4,& 5	Comp Ion Chamber	WEST WL6377	IE	VC	A2	B12
CH-6,7,& 8	Ionization Chamber	WEST WL6937A	IE	VC	A2	B12
	Intermediate Range Panel	WEST TYPE FN	IE	MCR	A1	B1
	Power Range Panel	WEST TYPE FN	IE	MCR	A1	B1
	Bistable Panel	WEST TYPE FN	IE	MCR	A1	B1
62CX	Relay Trip BFP	AGAST ND22-0	--	MCR	A1	B3
BK1	Breaker Rod Scram Bkr	WEST DB25	IE	SWGR	A3	B3
	PB Switch Manual Scram	WEST OT	IE	MCR	A1	B3
TC-420	Thermal Converter/Permissive 15MWE	SANG CW-10	IE	MCR	A1	B3
BS-420	Current Alarm Unit/Permissive 15 MWE	ACRO 871-S-8	--	MCR	A1	[illegible]
	Alarm & Scram Panel	WEST FN	IE	MCR	A1	B1
	Scram Amplifier	WEST FN	IE	MCR	A1	B1
	Current Reference	WEST FN	IE	MCR	A1	B1
	AC-DC Panel Power Supply	WEST FN	IE	MCR	A1	B1

Safety Injection System

SI-MOV-	Motor Oper. SI Loop Fill Hdr Isol	LIMIT SMB-00	IE	VC	A6	B13
SI-PP-LP	Motor Low Press SI Pump	EMMCO TYPE 1C	IE	PAB	A4	B3

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
SI-PP-HP	Motor High Press SI Pump	GE 5K404AK174	IE	PAB	A4	B3
SI-MOV-1	Motor Oper. SI Accumulator Isol	LIMIT SMB-1	IE	PAB	A4	B13
LI-SI-1	Electronic Transmitter Level SI TK	GE 555	--	PAB	A4	B14
	Power Supply Level SI TK	GE 570-04	--	MCR	A1	B15
	Vertical Edgewise Meter Level SI TK	GE 180	--	MCR	A1	B16
SI-LS-	Level Switch SI Accumulator	MAGNT 0-751-X1-SP-SIM3	IE	PAB	A4	B17
SI-WL-	Switch SI Initiation Circuit	WEST WL	IE	MCR	A1	B3
SI-1-X	Relay Multiplier	A/B 200E441Z1	IE	MCR	A1	B3
SI-PS-	Pressure Switch VC Pressure	STAT 12N-S4-04-X2	IE	PAB	A4	B18
SI-PS-X	Relay SI Initiation Circuit	WEST SG	IE	MCR	A1	B3
SI-PS-14	Pressure Switch SI Initiation	BARKS B2T-M3255	IE	VC	A6	B19
SI-FT-1	Transmitter SI Loop Flow	BARTN 386	--	VC	A6	B2
	Power Supply SI Flow	GE 570-04	--	MCR	A1	B15
	Indicator SI Flow	GE 180	--	MCR	A1	B16

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUA
	Switch Auto-Manual Bypass Selector	WEST OT	IE	MCR	A1	B3
LSX-	Relay Vent Accumulator	WEST HFA	IE	MCR	A1	B3
TDC-	Relay Pressurize Accumulator	AGAST 7012FD	IE	MCR	A1	B3
NS-SOV	SOV Pressurize Accumulator	ASCO HV-202-301-3-U-125	IE	PAB	A4	B20
NS-SOV-	SOV Vent Accumulator	ATKOM 31820	IE	PAB	A4	B21
	Switch Test Sw	GE CR2940UT200R	--	MCR	A1	B3
PU-MOV-541	Motor Oper. Recirc	LIMIT SMA-000	--	PAB	A4	B13
PU-MOV-542-8	Motor Oper. Recirc	LIMIT SMB-5000	--	PAB	A4	B13

Charging and Volume Control System

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUA
P-15-	Motor Charging Pump	WEST 19N3044	--	PAB	A4	B3
CH-MOV-521	Motor Oper. CVCS Charging Pump Suction	LIMIT SMA-00	--	PAB	A4	B13
CH-MOV-526	Motor Oper. CVCS Orifice Isolation	LIMIT SMA-000	--	VC	A6	B13

Containment Isolation System

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUA
CIS-SOV-	SOV Cont Isol	ASCO HV-202-303-16	IE	PAB	A4	B20
CIS-WL-	WL Switch Cont Isol Act	WEST 803-A448601	IE	PAB	A4	B3
CIS-K9-	Relay Cont Isol Act	GE HGA11J52	IE	MCR	A1	B3
CIS-5801	Switch/Manual Cont Isol & Valve Test	GE CR294QU207	IE	MCR	A1	B3

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
CIS-PS	Pressure Switch Cont Isol Act	STAT 12NNL4-C	IE	PAB	A4	B18
Component Cooling System						
P-20-	Motor Component Cooling Pump	WEST 19N3369	--	PAB	A4	B3
Chemical Shutdown System						
CS-MOV-529	Motor Oper. Chem Shutdown Mix Tk Dsch	LIMIT SMA-00	--	PAB	A4	B13
CS-MOV-540	Motor Oper. Chem Shutdown	LIMIT SMA-000	--	PAB	A4	B13
DW-MOV-655	Motor Oper. Demineralized Water Line	LIMIT SMA-000	--	PAB	A4	B13
Service Water System						
P-6-	Motor Service Water Pump	WEST 19N3044	--	SCRN	A7	B3
Main Coolant System						
MC-MOV-	Motor Oper. Main Coolant Inlet/Outlet	LIMIT SA-3	--	VC	A6	B13
MC-PI	Press Xmitter LTOP	ROSMT 1152-GP	--	VC	A8	B23
	Power Supply LTOP	LAMBD LCS-A-03	--	MCR	A1	B8
	Recorder LTOP	L&N Speedomax M	--	MCR	A1	B23
RM-	Emerg Gamma Guard/Monitor Gamma Level	NMC GA-2TE MOD 1	--	MCR	A1	B24

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
Feedwater System						
P-1-	Motor Boiler Feed Pump	WEST 18N6512	--	TB	A9	B3
P-4-	Motor Condensate Pump	WEST 18N8216	--	TB	A9	B3
SG-SEV-	Pneum Cntrl Sta F W Flow	BAILY AM	--	MCR	A1	B22
SG-PIT-	Press Xmitter Stm Gen	BAILY KP-1320A	--	TB	A9	B22
SG-LT-	Level Xmitter Stm Gen	BAILY BR-116X	--	VC	A10	B25
Main Coolant Drain & Sampling Systems						
VD-MOV-	Motor Oper. Loop Drain	LIMIT SMA-000	--	VC	A6	B13
VD-MOV-509	Motor Oper. Pressurizer Drain	LIMIT SMA-000	--	VC	A6	B13
VD-MOV-510	Motor Oper. Drain Header	LIMIT SMA-00	--	VC	A6	B13

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
LPST, Shutdown & Spent Fuel Pit Cooling System						
SC-MOV-	Motor Oper. Shutdown Cooling Inlet/Outlet	LIMIT SMA-1	--	VC	A6	B13
P-23	Motor LPST Cooling Pump	WEST 19N3369	--	PAB	A4	B3
P-21	Motor Spent Fuel Transfer Pump	WEST 19N3370	--	PAB	A4	B3
Pressure Control and Relief System						
PR-MOV-512	Motor Oper. Press Sol Rel Stop Valve	LIMIT SMA-00	--	VC	A6	B13
PR-SOV-90	SOV Press Solenoid Relief Valve	MMM	--	VC	A6	B34
Post Accident Hydrogen Vent System						
FN-18-	Motor Post Accident Recirc Fan	WEST 72Y51238	--	VC	A6	B26
HV-SOV-	SOV Hydrogen Sample	ATKOM URAMIC 30,000 Series	--	VC	A4	B21
Primary Pump Sealwater System						
P-	Motor Seal Tank Makeup Pump	RELIA M484	--	PAB	A4	B3
P-16-	Motor Purification Pump	GE 5K4284A12	--	PAB	A4	B3

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
Electrical Equipment						
DG-	Generator Emergency Diesel Gen	DELCO E-4859VB	IE	PAB	A5	B27
DG-LSC-2	Level Sw Level Cntrl Day Tnk	GEMS LS 800	IE	PAB	A5	B28
DG-SLCV-4	SOV Diesel Gen Day Tnk Fill Valve	ASCO 8211B56	IE	PAB	A5	B20
	Relay Solid State/Level Cntrl Day Tnk	GEMS 28196	IE	PAB	A5	B28
	No 1 Battery	EXIDE FOP-15	IE	SWGR	A3	B3
	No 2 Battery	EXIDE FOP-19	IE	SWGR	A3	B3
	No 3 Battery	C&D KU-15	IE	PAB	A5	B3
	No 1 Battery Charger - MG Set	EPCO 70-D	IE	SWGR	A3	B3
	No 2 Battery Charger - MG Set	EPCO 70-D	IE	SWGR	A3	B3
	No 3 Battery Charger - Static	C&D ARR130H	IE	PAB	A5	B3
	No 1 Battery Switchboard	WEST	IE	SWGR	A3	B3
	No 2 Battery Switchboard	WEST	IE	SWGR	A3	B3
	No 3 Battery Switchboard	WEST CDP	IE	PAB	A5	B3
	No 3A Battery Switchboard	WEST G-10P	IE	PAB	A5	B3
	No 3B Battery Switchboard	WEST WFB-2W	IE	PAB	A5	B3
	480 Volt Emergency bus 1	GE AKD-5	IE	PAB	A5	B3
	480 Volt Emergency Bus 2	GE AKD-5	IE	PAB	A5	B3

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
	480 Volt Emergency Bus 3	GE AKD-5	IE	PAB	A5	B3
	480 Volt Emergency MCC 1	WEST YS-1738	IE	SWGR	A3	B3
	480 Volt Emergency MCC 2	WEST TYPE-W	IE	PAB	A5	B3
	Vital Bus Inverter (M-G Set)	WEST SO-18N7679	IE	SWGR	A3	B3
	Vital Bus Distribution Cubicle	WEST SO-18N7681	IE	SWGR	A3	B3
	Terminal Block 12 Point	MARAT TB-6000 Series	IE	VC*	A11	B29
	Terminal Block 12 Point	WEST 542247	IE	VC	A11	B29
	Penetration Assembly	CBICO	IE	VC	A11	B30
	Control Switch	GE SBM	IE	MCR	A1	3
	Relay Over/Under Voltage (CV-7)	WEST 1875524	IE	MCR	A1	B3
	Relay Voltage (SV)	WEST	IE	MCR	A1	B3
	Relay Aux Self-Reset (HFA)	GE HFA51A (Code 42)	IE	MCR	A1	B3
	Relay Aux Electric-Reset (HFA)	GE HFA54E (Code 60)	IE	MCR	A1	B3
	Relay Aux Self-Reset (HFA)	GE HFA51A (Code 51)	IE	MCR	A1	B3
	Relay Reverse Power (CRM-1)	WEST	IE	MCR	A1	B3
	Relay Time Delay TDPU 2.5-50 Sec.	AGAST 2412 PD	IE	MCR	A1	B3
	Relay	GE HGA11J	IE	MCR	A1	B3

ID #	EQUIPMENT (DESC.-FUNC.)	MFR MODEL, TYPE OR CAT #	CLASS	LOC	ENV REQT	ENV QUAL
	Selector Switch for MOV-1	WEST OT211	IE	MCR	A1	B3
	Relay Aux Hand Reset (40 Stage)	WEST WL	IE	MCR	A1	B3
	Cable Mineral Insulated		IE	VC*	A11	B31
	Cable Polyethylene/PVC		IE	VC*	A11	B31
	Cable Butyl Rubber/PVC		IE	VC*	A11	B31
	Cable Silicone Rubber/Asbestos		IE	VC	A11	B31
	Cable XLP/Neoprene (or Hypalon)		IE	VC*	A11	B31
	Cable PVC Shielded		IE	VC*	A11	B31
	Cable Coaxial		IE	VC*	A11	B12
Instrumentation						
PT-227	Pressure Transmitter VC Press.	ROSMT 1151-GP	--	PAB	A4	B32
	Power Supply	LAMBD LCS	--	MCR	A1	B8
	Indicator	ANALO PI2455	--	MCR	A1	B33

Key to Abbreviations Used on Equipment List

Manufacturers

WEST	Westinghouse
BARTN	Barton
AGAST	Agastat
BAILY	Bailey
FP	Fischer & Porter
LAMBD	Lambda
ES	Electro Switch
RIS	Rochester Instruments
SANG	Sangamo
ACRO	Acromag
LIMIT	Limitorque
EMMCO	Electric Machinery
GE	General Electric
MAGNT	Magnetrol
A/B	Allen Bradley
BARKS	Barksdale
ASCO	Automatic Switch
ATKOM	Atkomatic Valve
ROSMT	Rosemount
NMC	Nuclear Measurements
RELIA	Reliance
C&D	C&D Battery
EPCO	Electronic Products
MARAT	Marathon
CBICO	Chicago Bridge & Iron
MMM	Manning Maxwell and Moore
COUCH	Couch Ordnance
SIGMA	Sigma Instrument
STAT	Static 'O' Ring
EXIDE	Exide Battery
GEMS	GEMS
L&N	Leeds & Northrup

Location

MCR	Main Control Room
VC	Vapor Container
SWGR	Switchgear Room
PAB	Primary Auxiliary Building
SCRN	Screen Well House
TB	Turbine Building
VC*	Equipment, such as cable which is located in the vapor container, but also is used throughout the plant

EQUIPMENT LIST
ATTACHMENT A
ENVIRONMENTAL REQUIREMENTS

A.1 The environment in the main control room is air conditioned with temperatures maintained at 70° ± 10°F. Equipment is mounted in cabinets, on racks within control boards, or mounted on a control board, and there are no adverse vibrational effects. The room has been protected from the environmental effects of piping system breaks.

The bounding environmental condition for this equipment is the occurrence of loss of offsite power, wherein the source of power for the air conditioning system is lost. However, in 17 years of plant operation, this event has occurred only once during the great Northeast blackout in 1965, and lasted for only 20 minutes. Therefore, it can reasonably be assumed that power will be restored within this time frame, as each transmission line from the plant is connected directly to a hydro-electric plant.

A.2 The attached Table A.1 presents the transients and the protection provided by the reactor protection system for these transients.

Environmental requirements for each reactor protection detector function are as follows:

a. <u>High Neutron Flux Power Range and High Startup Rate</u>

The neutron detectors for these channels are located in sealed thimbles in the neutron shield tank, which provides a controlled environment at a temperature of 100°F to 110°F. Coaxial cables are run from the detectors to the control room through a sealed drybox (105-115°F) around the top of the reactor vessel, and via conduits and penetrations (75-95°F along the route). Connectors are of the standard coaxial cable type. None of the transients requiring protection from these channels affect the normal environmental conditions of the detectors because of the double seal between the thimble and the containment air space.

b. <u>Reactor Coolant Pump Low Current Flow</u>

The redundant current transformers and equipment for this protection are located in the controlled environment of the switchgear room and the normal environment is unaffected by the loss of flow transient.

Backup protection for the loss of flow transient is provided by four differential pressure detectors, with one connected across the primary side of each steam generator. The signal from the detector is transmitted through mineral insulated cables, and in cables in conduit via penetrations to the control room. The environment of the detectors and cables within the containment or outside the containment is unaffected by the transient.

c. Pressurizer Low Pressure and Low Main Coolant Pressure

These channels provide redundant reactor protection for events which cause low main coolant system pressure. The low main coolant pressure channel also provides one of the initiation signals for the safety injection actuation. The LOCA environmental conditions for these detectors are shown on the attached LOCA pressure and temperature curves (See Figures 1 and 2). See Section A.6 for conditions during the steam line break.

The signals from these detectors are transmitted through mineral insulated cables and cables in conduits via penetrations to the control room. Normal temperatures in the containment vary from 75°F to 95°F.

d. Pressurizer High Water Level (Wide Range)

This detector is located in the pressurizer compartment and the signal is transmitted to the control room through a mineral insulated cable and cable in conduit via a penetration. Normal temperatures in the compartment vary from 90°F to 95°F. For reactor protection functions, the environment at the detector does not change. This detector and the identical narrow range detector are not required during the LOCA DBE, but provide pressurizer level indication during main steam line break conditions, which are discussed in Section A.6.

e. Steam Generator Low Water Level

One of these detectors monitors the water level in each steam generator. With the exception of steam line break within containment, none of the transients requiring protection will affect the normal environment of the detectors or cables. For steam line break inside containment this channel provides a backup trip and provides indication of level over the long term. See Section A.6 for conditions during steam line break.

f. Turbine Trip

This trip is initiated by reactor protection relay circuits located within the main control room, which actuate a turbine trip solenoid coil which is part of the turbine equipment. The loss of load transient does not affect the environment of the protection circuitry. Although this trip provides a backup function, no credit is taken for it in the safety analysis.

g. Manual Reactor Trip

Manual reactor trip is actuated by three pushbutton switches located on the main control board. Since manual trip can be actuated at any time, the limiting environmental conditions occur

during loss of offsite power where air conditioning is lost in the main control room.

A.3 The switchgear room is located on the second floor level of the turbine building and contains the following equipment: 2400V switchgear, 2400/480V transformers, 480V switchgear and motor control centers, main coolant pump current (low flow) trip cabinets, vital a-c motor generator set and vital bus cabinet, 125V d-c No. 1 and No. 2 batteries (enclosed), battery chargers, d-c switchboard buses, reactor scram breakers, and safety injection system valve contactors.

The environment of the area is controlled and is protected against the effects of pipe breaks in the turbine building and LOCA radiation levels. The limiting environmental condition in this area is caused by the loss of offsite power where a loss of ventilation would occur. However, at the same time, the 2400/480V transformers would lose their excitation and cease being a heat source. Since power should be restored within 20 minutes, based on previous experience, and that there are no other significant heat sources, the effect of the event on the environment is not significant. This was demonstrated during the 1965 Northeast blackout in that no equipment operational abnormalities occurred.

A.4 Equipment located in the Primary Auxiliary Building which is associated with the ECCS and containment isolation systems, provides protection for the LOCA and main steam line break DBE's. Since this equipment is outside containment, it is not subjected to the steam and pressure environmental conditions. Being located adjacent to the containment, it is subject to LOCA 30-day accumulated radiation dose of less than 10^5 R, using the source term based on 100% of the noble gases and 50% of the halogens uniformly dispersed in the containment atmosphere, and taking minimal credit for the shielding effects of the PAB Structure. If it is assumed that the safety injection system operates, this radiation dose level will be greatly reduced because fuel damage will be minimized. Therefore, the calculated dose levels have been reduced by a factor of ten throughout Attachments A and B, and still will be conservatively higher than the dose rates expected using realistic assumptions.

In the general areas of the first and second floors of the PAB, including the accumulator, safety injection pumps, component cooling pumps, and instrumentation; the normal radiation level is 0.001R/hr. In the cubicle area where most pumps and valves are located, the normal levels vary from 0.01 to 0.03 R/hr, giving a total integrated exposure to date of less than 5×10^3R for this equipment and cables. The valves, CH-MOV-521 and PU-MOV-541, are located in areas of the PAB where the radiation level is 0.8 R/hr, and the integrated dose to date is approximately 10^5R. The normal temperature variations at this location are from 65°F to 90°F.

Specific operational requirements are as follows:

<u>SI-MOV-1</u> Operation is required during the injection phase of the

LOCA. Valve operation occurs within the first few minutes of the LOCA.

CH-MOV-521 Operation of this valve is required during the recirculation phase of a LOCA and prior to cold shutdown following a steam line break.

CS-MOV-529 & 540 & DW-MOV-655 These valves are part of the Chemical Shutdown System and are used, if required, for emergency boration following main steam line breaks. Operation of these valves may be required at any time prior to cold shutdown.

PU-MOV-542 through 548 These valves are part of the post-LOCA recirculation system and operate approximately twenty minutes into the LOCA. They are not required during a steam line break.

PU-MOV-541 This valve operates on the containment isolation signal within seconds after the LOCA.

P-15-1,2,3 The charging pumps are used for hot leg injection following a LOCA and for emergency boration, if required, following main steam line breaks.

Initial operation of the pumps following a LOCA is after 20 hours, while emergency boration may occur in the first hour. Pump operation could continue for several months.

NS-SOV-45, 46, 47, 56, 57, 539 & 540 These valves are part of the accumulator control system. Operation is required during the first minutes of a LOCA.

SI-PP-LP1, 2, 3 & HP1, 2, 3 The low pressure and high pressure safety injection pumps are required during the injection phase of a LOCA and a rupture of the 24" steam header which is outside the vapor container.

Operation during the LOCA is for the first minutes up to several hours. Operation following a steam line break may be at any time prior to cold shutdown.

SI-LI-1 The safety injection tank level transmitter provides an indication of tank level which is required up to several hours after the LOCA.

P-16-1 & 2 The purification pumps are used for post-LOCA recirculation. Initial operation is from approximately 20 minutes to 3 hours following the LOCA. Operation may continue for several months.

Seal Tank Makeup Pumps These pumps provide seal water for the purification pumps and low pressure surge tank cooling pump.

Initial operation is from approximately 20 minutes to 3 hours

following the LOCA. Operation may continue for several months.

P-23 The low pressure surge tank cooling pump may be required after a steam line break. Operation may continue for several months.

P-21 The spent fuel transfer pump is used to cool the spent fuel pit water, and it operates continuously.

P-22A & B The component cooling water pumps transfer heat from the low pressure surge tank during a steam line break and from the spent fuel pit pool cooling water to the service water.

A.5 Equipment located in the Primary Auxiliary Building which is associated with the emergency power system provides protection for the loss of offsite power event. Since the local ventilation is operated by the diesel generators under this condition, there is no change in environment for this equipment. The normal temperature variations at this general location are from 65°F to 90°F. Within the diesel generator rooms the temperature varies from 55°F to 100 °F. Normal radiation level is 0.001 R/hr. The 30 day integrated LOCA dose is $<10^4$R.

A.6 Equipment located within the containment which is operated during the LOCA DBE is subject to the steam and pressure conditions shown in Figures 1 and 2. No valves or motors have to operate during the injection phase. Those required during the recirculation phase are exposed to the peak conditions of the transient, but do not have to be operated for at least twenty minutes, when conditions are considerably less severe.

Detailed calculations of the containment transient resulting from rupture of a main steam line inside containment have not been completed at this time. Scoping analyses have, however, been performed and indicate that the peak containment pressure will be less than that resulting from the LOCA DBE. These scoping analyses also indicate that although the peak vapor space temperature may exceed that occurring during the LOCA DBE due to superheating of the blowdown fluid, it will decrease below the LOCA DBE values in the long term.

The normal temperature variations are from 70° to 110°F, depending on the location of the equipment in the containment. Radiation levels at power operation are approximately 0.04 to 2R/hr in the general loop areas, 0.25R/hr near the pressurizer, and 0.001R/hr outside the biological shield wall. The loop cutout valves, which are mounted on the loop piping are at 20R/hr which gives them an integrated dose to date of 3×10^5R. The integrated doses to date in general areas are approximately 3×10^5R in the loops, 4×10^4R near the pressurizer, and 2×10^2R outside the shield wall. The 30-day integrated dose from the LOCA is $<2 \times 10^6$R at the center of the containment and $<10^5$R outside the shield wall.

All valves inside the vapor container which are required to operate

during or after a LOCA will not be submerged when the maximum amounts of water are injected.

Specific operational requirements are as follows:

SI-MOV-22, 23, 24 & 25 The loop fill header isolation valves are part of the Safety Injection System and may be required during the recirculation phase of a LOCA. They are operated from approximately thirty minutes to several hours after the LOCA.

PR-MOV-512 & PR-SOV-90 These valves are part of the pressure control and relief system. Operation may be required during the recirculation phase of a LOCA from approximately twenty minutes to several hours after the LOCA.

These valves may also be required following a steam line break. Operation of these valves may be required at any time prior to cold shutdown.

SC-MOV-551, 552 553 & 554 Shutdown Cooling inlet & outlet valves may be required during the recirculation phase of a LOCA. They must operate from approximately twenty minutes to several days after the LOCA.

VD-MOV-509 & 510 The pressurizer drain and drain header valves are operated during the recirculation phase of a LOCA and as a second backup bleed path for main steam line breaks. They are operated from approximately twenty minutes to several days after the LOCA.

FN-18, 1, 2, 3 The post accident recirculation fans may be required to operate during the recirculation phase for months after the LOCA. They will not be started until one hour after the LOCA.

HV-SOV-1 & 2 These are the post-accident hydrogen sample valves. Periodic operation of these valves is required from several days to several months following a LOCA.

CH-MOV-526 This valve is in the bleed line and may be required as a backup bleed path during main steam line breaks inside containment.

MC-MOV-301, 302, 309, 310, 318, 319, 325 & 326 The main coolant loop cutout valves are required for a steam line break outside the vapor container to isolate the affected steam generator. Valve operation is not required for a steam line break inside the vapor container therefore, the environmental conditions do not change when operation is required.

VD-MOV- 505, 506, 507 & 508 Although not required, any one of the loop drain valves can provide a backup for VD-MOV-509, which in conjunction with VD-MOV-510, provides a second backup bleed path following main steam line breaks.

SI-FT-1, 2, 3, & 4 The safety injection loop flow transmitter provides indication as to the broken loop in a LOCA. The transmitters are located outside the biological shield wall and have to operate long enough (up to one hour) into the DBE to allow determination of differences between the four loop flows. Normal temperatures at the transmitters are 75 to 85°F.

SI-PS-14 The pressure switch monitors pressurizer pressure and initiates one of the redundant safety injection actuation signals within seconds after the LOCA DBE. It is located outside the biological shield wall.

Table A.2 summarizes the operational requirements of the equipment within containment.

A.7 The service water pumps are located in the screen well house where normal temperatures vary from 50-100°F. The pumps provide cooling water for purification pumps during the recirculation phase of LOCA, for component cooling during the steam line break, and spent fuel pit cooling. The limiting conditions for these pump motors occur during the loss of offsite power when ventilation is lost. As shown in Section A.1, power should be restored within approximately 20 minutes, and for this amount of time, there are no significant environmental changes.

A.8 The low temperature overpressurization (LTOP) pressure transmitter is connected at the same location as the main coolant pressure detector. It normally functions under normal operating conditions for LTOP, but provides backup pressure indication to the main coolant pressure channel during LOCA conditions. This channel was installed in 1977, so the integrated radiation dose to date is less than 2 x 10^4R.

A.9 The steam driven emergency boiler feed pump provides secondary side makeup in event of a loss of offsite power occurring simultaneously with any steam line break. If power is not lost, the boiler feed pumps and/or condensate pumps may be used following a steam line break. In event of loss of offsite power, the condensate pumps are capable of being operated by the diesel generators as a backup to the steam driven pump. A further backup is provided by manual connection of spool pieces to provide charging pump discharge flow to the feedwater header.

These pumps are in the turbine building and have been protected against the effects of a steam line break. Normal temperatures in this area vary from 70° to 90°F. Operation of the pumps may be required for several days following the DBE.

Also located in this general area are the pneumatic steam generator pressure transmitters which provide pressure indication during the DBE.

Reference: See References B.1.2 and B.1.3 in Section B.1.

A.10 The steam generator level transmitters are located in the main coolant loops and are required during the initial stages of the main steam line break to determine initial steam generator feed requirements. If the break is outside containment, there are no changes in transmitter environment. If the break is inside containment, the bounding environmental conditions are as described in Section A.6.

A.11 For cables, terminal blocks and penetrations in the containment, the bounding environmental conditions are determined by the requirements of the equipment to which they are connected. Since the cables outside of containment are generally the same types that are used inside containment, the bounding environmental conditions are much less severe. Except for mineral insulated cables, all cables and terminal blocks in containment are installed in conduits or protective boxes.

TABLE A.1

RPS TRIPS POTENTIALLY ACTIVATED

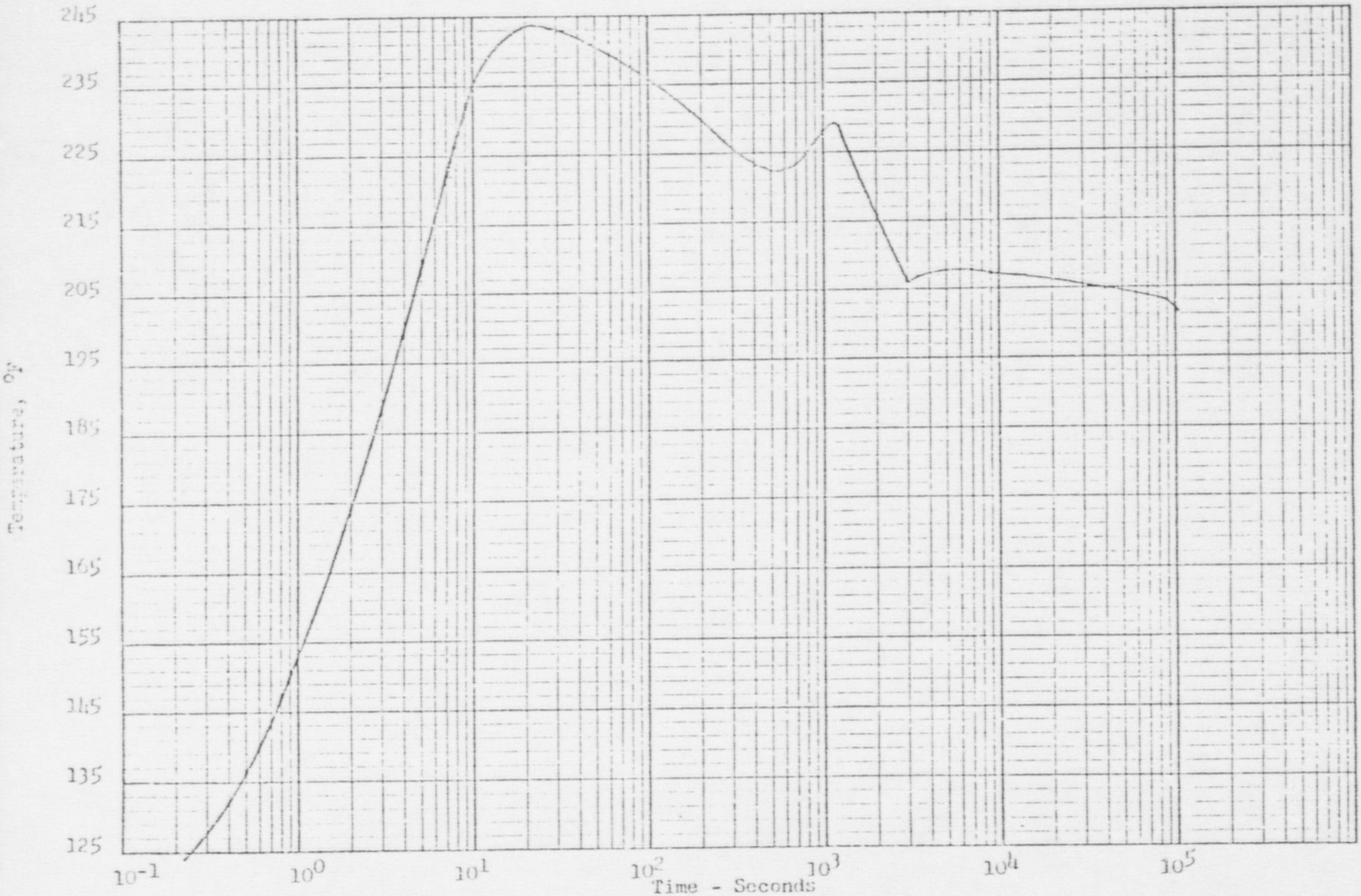
TRANSIENT		*RPS TRIPS POTENTIALLY ACTIVATED								
		1	2	3	4	5	6	7	8	9
1	Loss of Feedwater Flow				X	X			X	
2	Rod Group Withdrawal	X			X	X			X	X
3	Loss of Load				X	X	X		X	
4	Loss of Main Coolant Flow		X						X	
5	Loss of Offsite Power		X		X	X	X		X	
6	Main Coolant System Depressurization			X				X	X	
7	Excessive Load Increase	X				X			X	X
8	Boron Dilution	X			X	X			X	X
9	Control Rod Drop	X		X				X	X	
10	Isolated Loop Startup	X			X	X			X	X
11	Steam Generator Tube Rupture			X				X	X	
12	Rod Ejection	X		X				X	X	X
13	Steamline Rupture	X		X		X		X	X	X
14	LOCA			X				X	X	

* RPS Trip Functions

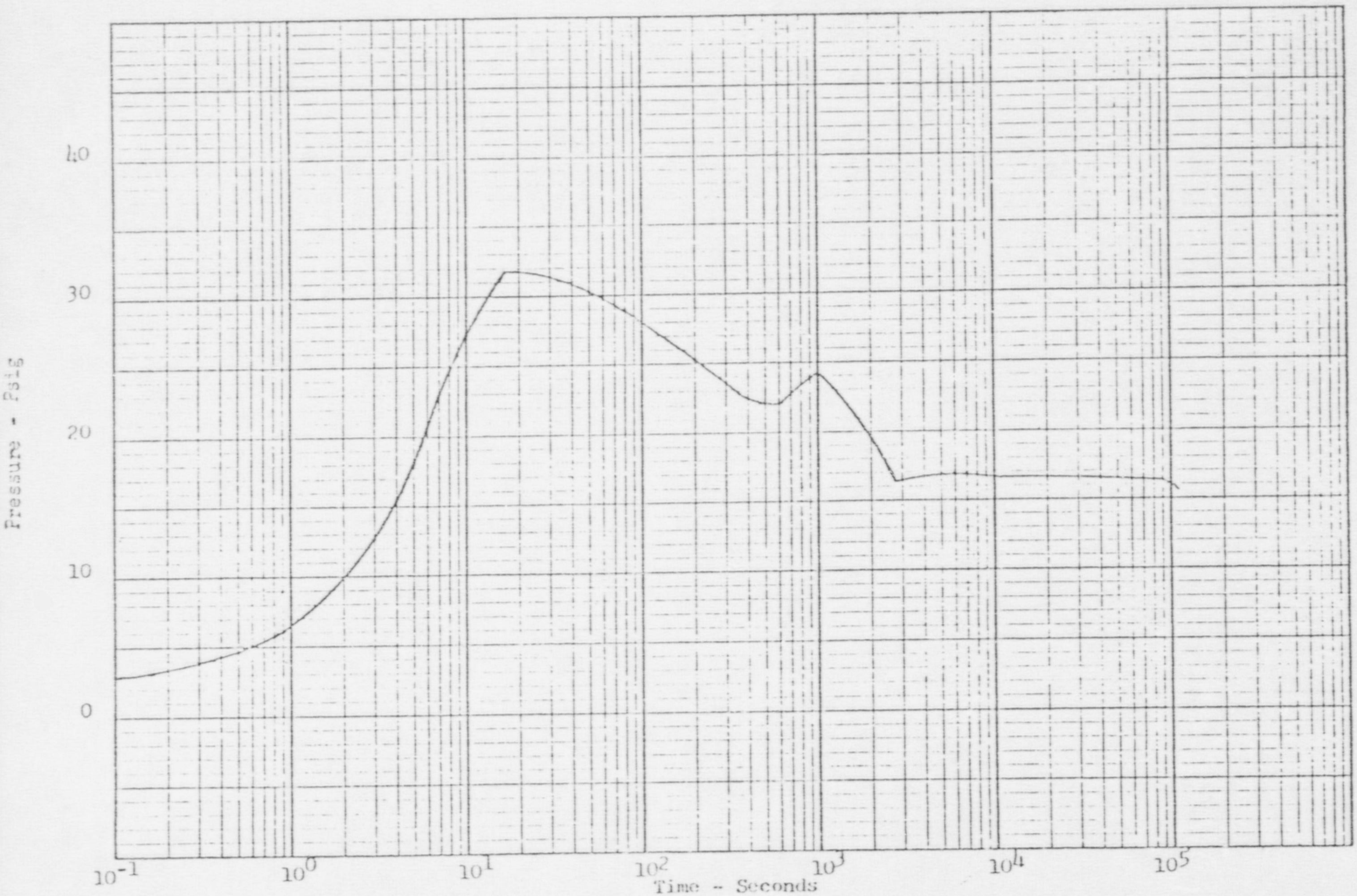
1. High Neutron Flux Power Range
2. Reactor Coolant Pump Low Current Flow (2/4)
3. Pressurizer Low Pressure
4. Pressurizer High Water Level
5. Steam Generator Low Water Level
6. Turbine Trip
7. Low Main Coolant Pressure
8. Manual Reactor Trip
9. High Startup Rate

TABLE A.2
EQUIPMENT IN CONTAINMENT

Function/Equipment	Operational Requirements: LOCA – Inj. Phase	LOCA – Recirc. Phase	LOCA – H_2 Control	Steam Line Break – Inside VC	Steam Line Break – Outside VC
Loop Fill Header Isolation SI-MOV-22, 23, 24, 25		X			
Pressure Control & Relief PR-MOV-512, PR-SOV-90		X		X	X
Shutdown Cooling Inlet/Outlet SC-MOV-551,552,553,554		X			
Pressurizer Drain & Header VD-MOV-509,510		X		X	X
Recirculation of H_2 FN-18-1,2,3			X		
Hydrogen Sample HV-SOV-1,2			X		
Main Coolant Loop Cutout MC-MOV-301,302,309,310,318, 319,325,326					X
Bleed Line CH-MOV-526				X	X
Safety Injection Actuation MC-PD-9, SI-PS-14	X				X
Indication					
Pressure MC-PD-9	X	X		X	X
MC-PI-LTOP	X	X		X	X
Pzr Level PR-LD-(WR)				X	X
PR-LD-(NR)				X	X
SG Level LT-1003 (each SG)				X	X
SG-LT-(WR, each SG)				X	X
SI Flow SI-FT-1,2,3,4	X				



YANKEE NUCLEAR POWER STATION	HYPOTHETICAL ACCIDENT CONTAINMENT TEMPERATURE VS. TIME	FIGURE 1



YANKEE NUCLEAR POWER STATION	HYPOTHETICAL ACCIDENT CONTAINMENT PRESSURE VS. TIME	FIGURE 2

EQUIPMENT LIST
ATTACHMENT B
ENVIRONMENTAL QUALIFICATION

B.1 Components of the reactor protection system located in the control room are the same type of components that were used in contemporary U.S. Navy nuclear submarines and are qualified for military usage. Although no qualification test data is available; the equipment is of rugged military type construction, uses simple and straightforward magnetic amplifier circuits, and has been tested for compatibility and overall system performance. The equipment is located in a controlled air conditioned environment protected from the environmental effects of a steam line break and LOCA radiation levels. The accuracies specified for the basic circuit units are based on an ambient temperature variation of 80° F $\pm$ 40°F. The bounding environmental conditions for the equipment result from the loss of offsite power wherein the air conditioning equipment loses its power source. The original plant design did not include control room air conditioning, so the equipment did operate for about 10 years under the conditions which would result from this transient and has operated satisfactorily during and since these conditions. The air conditioning was installed for operator comfort, rather than for equipment performance. The protection system equipment is under a periodic maintenance and testing program wherein equipment is calibrated and operationally tested during each refueling outage to verify continued satisfactory operation.

References: B.1.1 Westinghouse, Descriptive Bulletin 57-452, "Type FN Reactor Coolant Control and Instrumentation."

B.1.2 "Report on Effects of a Piping System Break Outside Containment at Yankee Nuclear Power Station, Rowe, Massachusetts" July 1973.

B.1.3 "Report on Effects of a Piping System Break Outside Containment, Supplemental Information, at Yankee Nuclear Power Station, Rowe, Massachusetts" September 1973.

B.2 The Model 386 differential pressure transmitter has been tested under post-accident steam environments. These tests are documented by References B.2.1 and B.2.2 which are on file at the Barton Co. In addition, the transmitters were successfully tested to a total dose of 2×10^{8}R, per Reference B.2.3.

The main coolant flow transmitters are specified for operation from 60°F to 200°F but they only have to operate under their normal environmental conditions. In 17 years of operation with maintenance, calibration and testing performed at each refueling, these transmitters have continued to perform reliably.

Reference: B.2.1 Final Report F-C2667, "Performance Test of Three

Differential Pressure Transmitters in a Simulated Reactor Containment, Post-Accident Steam Environment: FIRL.

B.2.2 Final Report F-C3076, "Performance Test of Two Static Pressure Transmitters in a Simulated Reactor Containment, Post-Accident Steam Environment" FIRL.

B.2.3 Letter, ITT Barton to YAEC, dated 3/12/76.

B.2.4 Barton Product Bulletin 199-2-1

B.3 Certain electrical equipment was included in the original Yankee plant design because of its previously proven reliability in utility applications. These components are in the general areas of protective relays, timers and auxiliary relays, transformers, circuit breakers, motors, batteries, control switches, and other power circuit controlling equipment. This equipment had to have a demonstrated reliability because of the large economic penalties which are incurred when failures occur in the switching large blocks of energy in power generating stations, substations, and switchyards. Components with this background of reliability were deemed satisfactory for safety applications, installed in environments suitable to their application, provided with appropriate periodic and preventive maintenance, and have continued to perform reliably through 17 years of continuous operation. When reliability has been demonstrated in this manner, similar equipment has been specified for use in design changes and new installations.

As noted in Section A.4, some motors are installed in the PAB in cubicles in an area where radiation levels are higher than normal because of the fluids in the systems. The integrated dose to date for these motors after 17 years of operation is 5×10^3R. When the LOCA 30-day integrated dose of $<10^4$R is superimposed on this, the total dose is approximately 10^4R which will not damage the motors or their cables. Motors associated with motor operated valves are discussed in Section B.13.

Breakers, motors, transformers, switchgear, batteries, motor control centers, M-G sets, and protective relaying are provided with continuing periodic maintenance and testing programs to assure continuing proper operation and to detect any conditions which would indicate potential wear and other types of incipient failures. Any components which have known failure rates, such as M-G set brushes and bearings, are replaced on periodic intervals in advance of anticipated failure. Vibration readings are taken monthly on the diesel generators, motor generator sets, and all major motors outside of the vapor container, and readings are analyzed and plotted to provide continuous trends which will indicate potential failure.

The capacities of the station batteries have demonstrated by discharge test and are equal to or greater than the capacities required to

supply their maximum loads. Periodic battery service tests on a refueling interval have demonstrated that the batteries will supply their anticipated loads after a loss of offsite power.

B.4 The reactor coolant pump low current trip cabinets are located in the controlled environment of the switchgear room and use components similar to those previously discussed in Section B.1 and B.3.

B.5 The pressurizer pressure and main coolant pressure transmitters provide reactor protection for events which cause main coolant system depressurization. In addition, the main coolant pressure detector provides actuation of one of the safety injection trains at a pressure below the reactor protection system pressure setpoint.

The bounding environmental conditions for these detectors and their cables during the LOCA DBE is shown in Figures 1 and 2 of Attachment A. The safety injection low pressure setpoint is reached within 10 seconds; therefore, the reactor protection scram point is reached in a shorter time period.

The ambient temperature at the transmitter location varies from 75° to 95°F and the maximum specification allowable continuous ambient temperature of the transmitter is 158°F. Because of the large mass of the steel detector housing, 170 $\pm$ 5 pounds, and the very short time that the temperature is above 158°F, the internal temperature of the housing should not exceed the 158°F ambient temperature allowable for normal operation. Therefore, there will be no effect on the transmitter internal components before the reactor protection and safety injection actuation functions are initiated.

The containment pressure will have no effect on transmitter operation because the housing has been tested to an internal test pressure of 4500 psig.

These detectors are part of the Westinghouse Type FN equipment, and, similar to the remaining circuit components in the control room (see Section B.1), are constructed to military specifications. Although no qualification test data is available, shock and vibration tests to military standards were approved by BUSHIPS letters. The transformer winding is encapsulated and the electrical housing is explosion proof and qualified watertight in accordance with MIL-STD-108 and MIL-E-2036.

From the detector to a junction box outside the concrete shield wall, the signal is carried in mineral insulated cable. From the junction box to the penetration, cable with polyethylene insulation and a polyvinylchloride jacket is run in steel conduit. For discussion of the environmental qualification of the cables, see Section B.31.

Redundant indication of pressure through the DBE is also provided by the independent low temperature overpressurization channel which is qualified for LOCA conditions (See Section B.23).

These channels and the pressurizer wide range level channel (Section B.6) have been maintained, calibrated, and tested at each refueling since initial plant operation. In addition, operators perform a check of each channel at least twice per day to verify continued proper operation.

Reference: B.5.1 Bailey Meter Co., Drawing No. H6610184, Rev. A, Title "Electrical Pressure Transmitter"

B.6 For all of the transients for which the pressurizer wide range level detector provides a reactor protection signal, there is no change in detector environment. The wide range and narrow range detectors provide pressurizer level indication after the steam line break.

The level detectors (wide range and narrow range) are constructed to the same military specifications as the pressure detectors discussed in Section B.5. The only difference is that the level detectors are of the differential pressure type. The cable arrangement is the same from detector to penetration.

As discussed in Section B.5, the large mass of the detector should allow the initial transient temperature to pass without affecting operation of the internal components, and for the long term indication function, the pressure tight and waterproof construction should provide adequate protection from the environment. Radiation levels should not change significantly after the steam line break.

Reference: B.6.1 Bailey Meter Co., Drawing No. H6610183, Rev. A, Title "Electrical Diff. Pressure Trans. Low Hd."

B.7 The narrow range steam generator level transmitter is designed for post accident operation with high temperature specifications, epoxy paint, special seals, and radiation hardened transistors, and specified to be tested to Combustion Engineering Test Procedure, ICE-TP-1. Test conditions were one hour at 302°F and 70 psia, ramp down for two hours to, and then for five hours at, 228°F and 20 psia. Since these tests were of a generic nature, the documentation of test results is probably on file at the Fischer and Porter Company. Yankee is presently trying to verify this.

Separate radiation testing was performed to qualify the transmitter to at least ten megarads of gamma exposure. Documentation of these tests is available at the Yankee Westboro office.

The sequence in which these tests were performed is not pertinent because the accumulated radiation dose during the steam line break is insignificant compared to the tested level.

The cable used to connect the transmitter to the penetration has crosslinked polyethylene insulation, shielded, with a Hypalon jacket, and is in conduit.

Reference: B.7.1 Test Procedure, ICE-TP-1, Combustion Engineering.

B.7.2 Engineering Report, "Nuclear Radiation Investigation," Fischer and Porter Company, September 14, 1970.

B.8 Lambda power supplies are designed to meet military environmental specifications and for continuous operation from -20°C to +71°C ambient temperature. These requirements far exceed the environmental requirements of actual usage.

Specific specifications are as follows:

LC Series: MIL-STD-810B, MIL-E-5272C, MIL-1-6181D

LM Series: MIL-STD-810B, MIL-1-16910, MIL-E-5272C, MIL-T-4807A, MIL-E-4970A

Since the power supplies are connected to instruments which provide continuous indication in the main control room, any deviations in performance are readily detected.

Reference: B.8.1 Lambda Specification Sheets for LC and LM Series Power Supplies

B.9 These bistables are specified for operation in ambient temperatures ranging from -30° to 150°F which allows adequate margin over the actual conditions in the control room. A periodic testing program is in effect on a monthly basis to allow detection of any deviations in performance. Since installation in 1972, no abnormalities in performance have been detected.

Reference: B.9.1 Rochester Instrument Systems, Bulletin No. 214

B.9.2 Rochester Instrument Systems, Bulletin No. 401

B.10 This switch was installed in 1972 when the steam generator low level trip channels were added, and is of the same rugged construction as equipment discussed in Section B.3. Although designed for heavy duty application on power switching circuits, it is used only for switching signals in the milliampere range, and only during channel test. Therefore, it does not have to function during the time when protection is required.

B.11 These meter relays are not required for the reactor protective function, but provide an alarm to indicate power supply or channel failure and provide long term indication of steam generator level after a steam line break. Indicators similar to this have been used extensively at both Connecticut Yankee and Maine Yankee plants for protective functions and have a demonstrated reliability for providing a continuous indication function. They are specified for operation from 60° to 130°F.

Reference: B.11.1 Sigma Specification Sheet, Series 9220

B.12 Neutron detectors used for power range applications are designed to operate in high neutron and gamma fields for a specified period of exposure. In the first few years of operation, the symptoms of initial radiation damage to the detector, coaxial connectors, and coaxial cables located within the detector thimbles and dry box were evidenced by the occurrence of a few instantaneous "pips" on the normally stable power range level indications. With relative in-thimble radiation exposure thus determined, a program of periodic replacement of in-thimble and dry box components was established to preclude failure due to radiation damage.

The controlled temperature of the neutron shield tank keeps the in-thimble components well within their specified temperature ratings of at least 80°C (176°F)

The coaxial cables between the loop area and the penetrations are subject to comparatively insignificant radiation levels, so routine replacement is not required.

Reference: B.12.1 Westinghouse, Descriptive Bulletin 57-451, "Type FN Reactor Nuclear Control Equipment."

B.13 All original motor operators installed in the vapor container and referenced in Section A.6 were specified to have totally enclosed motors with Class H insulation, suitable for operation in an area with 50-75 R/hr continuous radiation dose rate. Two motor operators, PU-MOV-541 and CH-MOV-521, which are installed in the PAB in areas with high radiation levels (see Section A.4) are also specified to these requirements. (Reference B.13.1) The four additional motor operators (SI-MOV-22, 23, 24, 25), which were installed in the vapor container in 1972, are also totally enclosed and have Class H insulation. Similar motor operators having Class H insulation have been successfully tested under post accident steam conditions (Reference B.13.2). The test conditions for these motor operators exceed expected DBE conditions in the vapor container.

The remaining motor operators outside the vapor container are located in the PAB (Section A.4) and are not subject to the severe environmental conditions which result from the LOCA or main steam line break. These motor operators have Class B insulation as a minimum. Similar motor operators have been successfully tested under steam temperature and pressure conditions (Reference B.13.3). Motor operators with Class B insulation have also been successfully operated after irradiation to 2 x 10^6R. (Reference B.13.4) Since there are no steam conditions in the PAB and the LOCA radiation dose plus integrated operational dose is less than 10^5R, these motor operators are adequately qualified for their environmental conditions.

Reference: B.13.1 Specification #YS-621, Stainless Steel Stem Leakoff Manual and Motor Operated Valves in Radioactive Service.

B.13.2 Qualification Test of Limitorque Valve Operators in Simulated Reactor Containment Post Accident Steam Environment, FIRL Report #F-C3441, Sept., 1972

B.13.3 "Performance Qualification Tests of Four Valve Motor Operators", FIRL Report #F-C 4124, April, 1975

B.13.4 WCAP-7410-L, Volume I of II, "Environmental Testing of Engineered Safety Features Related Equipment", December, 1970.

B.14 The safety injection tank level transmitter is specified with a pressure rating of 1500 psig, an operating temperature range of -20° to 200°F, and meets MIL-E-5272 humidity test (24 hour cycle 68 ° to 158°F at 100% relative humidity), which far exceeds its application and environmental conditions. The 30-day integrated LOCA radiation dose of $<10^4$ R will have no effect on the transmitter within the operational period of several hours.

Reference: B.14.1 General Electric Measurement & Control Handbook, Section 8042A

B.15 The GE power supply was selected for this application because of extensive reliable use at the Vermont Yankee plant in similar applications and for its compatibility with the safety injection tank level transmitter. It is rated for ambient temperature ranges of 40° to 120°F.

Reference: B.15.1 General Electric Measurement and Control Handbook, Section 8063-2C.

B.16 This indicator is used extensively at the Vermont Yankee plant for indication on protective channels and has provided reliable service. It is specified for operation in an ambient temperature range of -4° to 150°F, allowing adequate margin for its environment.

Reference: B.16.1 General Electric Apparatus Handbook, Section 8075, page 104.

B.17 The Magnetrol level switch assembly is made primarily of 304 stainless steel and is rated for 100°F at 500 psig. The switch element mounted in the assembly is rated for 250°F. The PAB temperature and pressure are unaffected by the LOCA environment, allowing adequate margin for assured operation. Since this operates within seconds after a LOCA, radiation dose is not a factor.

These switches have been tested at each refueling for five years without a failure.

Reference: B.17.1 Magnetrol Product Data, Model 751 Series Liquid Level Controls

B.18 Being located in the PAB, these vapor container pressure switches are not subject to a change in temperature or pressure conditions during the LOCA or steam line break events. The switching element is specified for operation between - 65°F and 180°F, allowing considerable margin over the normal (or accident) environmental temperature variation of 65 to 90°F.

Radiation level will increase during the LOCA event, but the switch operates at 5 psig containment pressure and will have completed its function before any increase in radiation in the PAB. These switches are similar to those qualified by GE for use in the Vermont Yankee plant protection systems. Information on qualification and operational experience at Vermont Yankee has been submitted in the referenced letter.

Reference: B.18.1 Letter, YAEC to USAEC, subject: Additional Information for Proposed Change No. 111, dated January 16, 1974.

B.18.2 Static 'O' Ring Product Data

B.19 The Barksdale pressurizer low pressure switch is designed with a weather-sealed housing and a proof pressure of 4000 psig with a temperature rating of -45° to 165°F. The pressure switch operates within ten seconds after the LOCA DBE. Because the pressure switch is located outside the biological shield wall and the switch operates in such a short time period, the switch internals should not be adversely affected by the temperature increase. There will be no increase in radiation level in that short a time after the initiation of the transient.

This pressure switch is redundant to the main coolant pressure channel signal and diverse to the two vapor container high pressure actuation signals which are discussed in Sections B.5 and B.18.

Reference: B.19.1 Barksdale Product Data

B.20 The ASCO Solenoid valves have Class H coils and are designed to operate in a temperature environment from o°C to 180°C. Since these valves are all in the PAB, the design far exceeds the environmental conditions.

Reference: B.20.1 ASCO Product Bulletin 8211

B.20.2 ASCO Product Bulletin 8302

B.21 The Atkomatic valves are of an explosion proof construction with Class H insulated coil. The valves are specified to operate satisfactorily from minus 420°F to plus 500°F. These specifications surpass the environmental requirements and therefore the valves are considered qualified for their application.

In addition, the valves have been operationally tested monthly for a period of three years without a failure to operate.

B.22 The Bailey pneumatic control stations for the feedwater system can be manually adjusted to position the main feedwater valves or the bypass valves if required after a steam line break. This pneumatic equipment consists of a regulating valve which adjusts the air pressure on copper tubing which is terminated at a bellows or similar air-tight device. It is non-electrical, almost all metallic and not subject to the failure modes of electrical equipment. For 17 years of continuous operation, the equipment has been given routine maintenance, and has provided essentially trouble-free, reliable service.

The steam generator pressure transmitters monitor the pressure of the steam lines and transmit a pneumatic signal from the turbine building to a pressure gage in the control room. The transmitter also provides direct local readout, which can be used for backup indication.

B.23 The low temperature overpressurization (LTOP) pressure transmitter was installed in 1977, and is specified to maintain $\pm$ 0.75% accuracy after sequential exposure to steam pressure of 70 psig, 316°F for one hour; 55.4 psig, 303°F for seven hours; and 6 psig, 230°F for 42 hours. Radiation performance is $\pm$ 2% after 5 megarads total integrated gamma dose. Documentation reports are on file at Rosemount. Crosslinked polyethylene cables are run from the detector to a penetration in conduit.

The recorder, which was also installed in 1977, allows trending of main coolant pressure throughout the transient with a range of 0-3000 psig. It is of the latest L&N recorder design, continually monitored to allow detection of any deterioration in performance and suitable for operation in ambient temperatures from 16° to 122°F.

Reference: B.23.1 Rosemount Product Data Sheet 2235.

B.23.2 Leeds & Northrup Co. Manual, 177823

B.24 The high range emergency gamma-guard provides an indication of the radiation level in containment after the LOCA DBE. The detector is mounted high on the turbine room wall, above the control room roof elevation, and the circuitry and readout is in the control room. Monitors of this type have been used for area monitoring purposes since initial plant operation, and the scintillator tubes used for detection are periodically replaced every three years. The readout circuitry is under continuous surveillance by the control room operator and the detector and cables are tested monthly to assure proper operation. The only change in environment during the DBE is at the detector and the coaxial cable in the turbine building. The 120-day integrated dose is less than 1R which will have no adverse effect.

B.25 These transmitters are similar in style to the pressurizer level transmitters discussed in Section B.6, except that they are rated for 1500 psia, rather than 3000 psia, and are of weatherproof construction, rather than explosion proof. The Buna-N O-rings which provide the housing seals are rated for operation up to 212°F. Since there is no radiation dose increase associated with the steam line break and continued operation is required for less than one hour, there is reasonable assurance that the transmitters will provide a signal adequate to allow the operators to obtain a comparison of steam generator levels.

When levels have been restored to the narrow range level of operation, the level detectors discussed in Section B.7 provide indication. These detectors are qualified for LOCA conditions.

Reference: B.25.1 Bailey Product Specification E21-7.

B.26 The recirculation fan motors have been designed to operate in an atmosphere of steam and dissolved boric acid at a temperature of 275°F and a pressure of 50 psig to an integrated dose of 10^{8} R. A prototype motor has been qualification tested at the Franklin Institute Research Laboratory and documentation is on file at YAEC.

Reference: B.26.1 Specification YA-719-Y (rev. 4), Specification for Fan Motors for Hydrogen Control System.

B.26.2 Letter, Westinghouse to YAEC, dated 3/9/72

B.26.3 Letter, Westinghouse to YAEC, dated 3/27/73

B.27 The referenced letter contains a complete description of the standby diesel generators as well as information regarding their satisfactory performance to date in their periodic testing and maintenance programs.

Reference: B.27.1 Letter, WYR 78-5, YAEC to NSNRC, dated January 20, 1978, Subject: Standby Diesel Generator Questionnaire

B.28 The Gems level switch is designed for fuel oil day tank applications. In the fuel oil environment, the switch assembly will function between 0°F and 230°F, up to a pressure of 150 psi. The solid state relay that is used in conjunction with the level switch is a completely encapsulated unit, free from the affects of oil, dust, humidity and vibration. In addition, the system has been tested at each refueling interval for five years with no failures.

Reference: B.28.1 Gems Technical Bulletin, Series LS-800

B.28.2 Gems Product Data, Model 28196

B.29 Terminal blocks used inside containment are enclosed in protective boxes and their environmental qualification has been discussed with

NRC and addressed in the referenced letter.

The same terminal blocks are used throughout the plant outside containment and are exposed to much less severe environmental conditions.

Reference: B.29.1 Letter, YAEC to USNRC, Subject: IE Bulletin #78-02, Terminal Block Qualification, dated February 14, 1978

B.30 The references contain qualification information for the penetration assemblies at Yankee Rowe.

Reference: B.30.1 YAEC letter to USNRC dated November 30, 1977, WYR 77-116

B.30.2 YAEC letter to USNRC dated December 1, 1977, WYR 77-118

B.30.3 Test Report: Associated Nucleonics, Inc., AN-115, dated May 15, 1959

B.31 The equipment within the containment to which cables are connected consists of valve motors, recirculation fan motors, and instruments. Equipment which was originally installed in the plant was wired in a consistent manner. Instrumentation wiring within the loop compartments and the pressurizer compartment consists of mineral insulated cable to a junction box outside the biological shield wall; and from there, polyethylene insulated cable with a PVC jacket in conduit to the penetration. Similarly, the power and control wiring for valve motors consists of mineral insulated cable within the biological shield wall; and from there, either polyethylene or butyl rubber insulated cable with a PVC jacket in conduit to the penetration.

Instrumentation and motors which were installed later in plant life were connected by cables in conduit from the equipment via enclosed junction boxes to the penetrations. This equipment is specifically the recirculation fan motors, the LTOP transmitter, the steam generator narrow range level transmitters for reactor protection, the pressurizer pressure switch for safety injection initiation, the safety injection loop flow transmitters, and the solenoid valves for hydrogen sampling. PVC shielded cables were specified for these installations, unless otherwise noted in the discussion of the environmental qualifications of the equipment to which it is connected. Otherwise, it may be assumed that the cables connected to equipment are those of the initial installation mentioned above.

The mineral insulated cable used within the biological shield wall is specified to meet or exceed the National Electric Code requirements for MI cable. It is generally rated for operation at temperatures in excess of 300°F and is not susceptible to radiation damage for doses exceeding 10^{9}R. After some problems during initial power

operation due to moisture at the fittings, the MI cables have operated essentially trouble-free for 17 years and have shown no evidence of radiation effects.

The polyethylene insulated cable with PVC jacket has been successfully tested in a steam environment at 260°F and 21.5 psig for a period of 45 minutes. This allows margin over the momentary peak anticipated LOCA temperature of 245°F. Test results are on file at YAEC (Reference B.31.4). Butyl rubber insulation is generically rated for service up to 250°F which equals or exceeds the service rating of the polyethylene and PVC insulation material. Since the polyethylene and PVC have been satisfactorily tested and shown to have at least a 15°F margin over the anticipated momentary peak LOCA temperature, this provides reasonable assurance that the butyl rubber insulation will also operate satisfactorily under these conditions. The tests were performed in an open steam environment; whereas the cables are actually installed in steel conduits and junction boxes, which provide protection from the steam environment. The threshold of radiation damage for butyl rubber is 2×10^{6} R and for polyethylene and PVC, the threshold is 2×10^{7} R. These cables are located outside the biological shield wall, so the integrated dose after 17 years is only 2×10^{2} R. The 120-day integrated LOCA dose outside the shield wall is less than 10^{6} R, so there is adequate margin for these cables to perform their function before radiation damage even begins to take effect. Operating experience for 17 years has shown these cables to be satisfactory for their application.

Cables with silicone rubber insulation and asbestos braid overall and cables with crosslinked polyethylene (XLP) insulation have been tested in accordance with IEEE-383 to environmental conditions which far exceed the conditions expected within the containment. Documentation of test results is on file at YAEC. (Reference B.31.2)

Reference: B.31.1 U.S. Department of Commerce Report #APEX-261, "Radiation Damage to Elastomers, Organic Liquids, and Plastics".

B.31.2 FIRL Test Report #F-C3798, "Qualification of Class IE Electric Cables for Nuclear Power Generating Stations per IEEE 383", 1974

B.31.3 Standard Handbook for Electrical Engineers, 1957.

B.31.4 Collyer Technical Report #67-2, "Study of 1000V Control Cable in Steam Environment", 1967.

B.32 The Rosemount 1151GP transmitter is the same basic unit as the 1152GP model discussed in Section B.23. Amplifier operation is designed for a temperature range of 20°F to 200°F, which far exceeds the conditions in the PAB. The transmitter is rated for 100 psig and is calibrated to a span of 60 psig. This allows considerable margin over the LOCA peak pressure of 32 psig.

Reference: B.32.1 Rosemount Product Data Sheet 2260

B.33 The Analogic PI2455 indicator has solid-state circuitry and an LED digital display. The operating temperature range is 14°F to 140° F, which exceeds the environmental conditions in the control room.

Reference: B.33.1 Analogic Bulletin No. 16-100056 Rev. 2

B.34 The solenoid relief valve is designed for a normal operating temperature of 635°F as the inlet side of the valve is continually exposed to pressurizer saturated steam conditions. It has operated satisfactorily at this elevated temperature for 17 years. This valve is to be replaced at the next refueling. Environmental conditions will be considered in the specification of the replacement valve solenoid.

Reference: B.34.1 Westinghouse Specification, E-567128-A

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