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50-270 Oconee Nuclear Station, Unit 2, Duke Power Co. 05000270
~~50-287~~ Oconee Nuclear Station, Unit 3, Duke Power Co. 05000287

AUTH. NAME AUTHOR AFFILIATION
PARKER, W. O. Duke Power Co.
RECIP. NAME RECIPIENT AFFILIATION
REID, R. W. Operating Reactors Branch 4

SUBJECT: Forwards response to NRC 790907 ltr requesting addl info re conceptual safety grade reactor trip design. Discusses conformance w/SRP & IEEE-279-171 design requirements. Oversized drawings encl.

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DUKE POWER COMPANY

POWER BUILDING

422 SOUTH CHURCH STREET, CHARLOTTE, N. C. 28242

WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

TELEPHONE: AREA 704
373-4083

October 5, 1979

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. R. W. Reid, Chief
Operating Reactors Branch #4

Re: Oconee Nuclear Station
Docket Nos 50-269, -270, -287

Dear Sir:

In a letter dated May 21, 1979, a system design description for a safety grade anticipatory reactor trip on turbine trip or loss of main feedwater was submitted for Oconee Nuclear Station. This was provided pursuant to my letter of April 25, 1979, Mr. W. S. Lee's letter of April 26, 1979, the NRC Order of May 7, 1979, and IE Bulletin 79-05B.

Subsequently, in a letter dated September 7, 1979, the NRC staff requested additional information in order to approve the conceptual safety grade design. Attached please find our response to this request.

Of particular concern to the staff was the lengthy lead time for installation. Currently, it is anticipated that material will be available on site for installation within six months of NRC approval of the design. Equipment that can be installed with the unit on-line will be installed as practical following receipt on site. The entire modification will be completed on each unit the first available outage of sufficient duration following receipt of all components.

Very truly yours,

William O. Parker, Jr.

RLG:vr
Attachment

ELECTRICITY FOR A PROGRESSIVE PIEDMONT 75th Anniversary DUKE POWER 1904-1979

A001 S/1

7910120171

DUKE POWER COMPANY
OCONEE NUCLEAR STATION
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
SAFETY GRADE ANTICIPATORY REACTOR TRIP

Question 1. For your proposed design, state the degree of conformance with the acceptance criteria listed in Column 7.2 of Table 7-1 ("ACCEPTANCE CRITERIA FOR CONTROLS") of the Standard Review Plan. Justify any non-conformance.

Question 2. Provide a discussion of the following:

a. Design basis information required by Section 3 of IEEE-279-1971, and

b. Conformance with the design requirements of Section 4 of IEEE-279-1971.

Response to Questions 1 and 2

The proposed design for safety grade anticipatory trips contains four redundant and independent channels which monitor the main feedwater pumps and the turbine. This equipment will initiate an RPS reactor trip on the tripping of both main feedwater pumps or on a turbine trip. The cabinet mounted equipment will be installed in and become an integral part of the existing four channel RPS-I. As such, the additional equipment will be designed in accordance with the design bases of the RPS and will conform with the acceptance criteria and design requirements of the RPS. The acceptance criteria and design requirements of the RPS can be found in Section 7 of the Oconee Nuclear Station FSAR.

Question 3. Provide a description of any changes to and/or interfaces with the existing protection system. Include diagrams (block, location, functional and/or elementary wiring), as necessary, to clearly depict the changes and/or interfaces. In addition, provide an analysis which demonstrates that these changes and/or interfaces will not degrade the existing protection system.

Response

The anticipatory trip equipment will be added to the RPS cabinets and will interface as new trips in the present bistable trip string. Figures 1 and 2 of the Attachment I show the functional interface of the added equipment with the RPS. Drawings 51079DGB-1 and 51079MLG-1 of the attachment describe the inputs, outputs, and logic of the new trip functions. The added modules will consist of contact buffers, bistables, and auxiliary relays, which have been tested and qualified for use in a safety system. Existing RPS power supplies, flux signals, interlock circuits, and indicators will be used as required by the added equipment. The requirements for the RPS, e.g., cooling, power, seismic, environmental, will be the same for the system with anticipatory trips as the requirements prior to addition of the new trips.

A failure analysis of the RPS-I was performed and is contained in Topical Report BAW-10003, "Qualification Testing of Protection System Instrumentation". This failure analysis was predicated on the use of qualified modules and concluded that any single failure in the RPS will not prevent performance of its protection action when required. The added equipment uses qualified modules and the failure analysis of BAW-10003 is still applicable to the RPS containing anticipatory trips.

The anticipatory trips provide additional protection and conservatism beyond that provided by the rest of the RPS. No credit is taken for any of these trips in the FSAR accident analyses. The sensors will be redundant, separated, and designed such that a single failure will not prevent them from performing their intended function. The sensors are anticipatory to other diverse parameters which will cause a reactor trip. Thus, the protection system will not be degraded by these trips since functioning of the anticipatory trips is not required to provide safety action and contact isolation of 500 volts is provided. The sensor contacts are closed during normal operation and open to cause a reactor trip when either the main feedwater pumps trip or the turbine trips. The contacts serve to interrupt power to cause a reactor trip. Loss of power to the trip circuitry will also initiate a reactor trip.

Question 4. Indentify equipment which is identical to equipment utilized in existing safety-grade systems. For the equipment which is not identical, briefly describe the differences.

Response

The equipment to be used are bistables, contact buffers, and auxiliary relays. These modules are updated versions of modules already in use in B&W safety systems of the operating plants. Significant changes are: The bistable output to the RPS trip string has been converted from a relay contact to a solid state output; the contact buffer now uses one transformer with a rectified output to monitor the field contacts instead of two transformers with AC outputs; and transistor buffer amplifiers for driving relay coils from current limited grounded input signals have been added to the auxiliary relay. These changes were made to improve the performance of the modules. The pressure switches used as sensor inputs are the same model as used in other safety applications.

Question 5. For all critical Components, provide an expected delivery date.

Response

Reactor protection system components, contact buffers, bistables and auxiliary relay, are available from existing systems which have been delayed in construction. These components can be made available for installation within 22 weeks. Pressure switches can be available for installation within 14 weeks.

Question 6. In general, the equipment shall be seismically and environmentally qualified. Therefore, provide the following descriptive information for the qualification test program:

a. equipment design specification requirements,
b. test plan,
c. test setup,
d. test procedures, and
e. acceptability goals and requirements.

If the above information is not available at this time, provide a schedule for its submittal.

Response

The modules to be used have been qualified for use in B&W safety systems. Attachment II contains the seismic and environmental summary reports for each module which describe the test programs and report the acceptability of the modules. The detailed test procedures and test data are available for audit. The pressure switches used as sensor inputs into the modules have been used in other safety applications. A summary of the qualification report is attached. The detailed test report is on file and available for audit at the Duke general office.

Question 7. Identify the portion(s) of the design which are within the scope of supply of B&W and/or other contractors.

Response

B&W scope of supply is limited to RPS modules, i.e., contact buffers bistables and auxiliary relays contained within the RSP system cabinets. Input to these modules via pressure switches is by Duke Power Company.

Question 8. Provide the criteria for the overall reactor protection system installation testing which will demonstrate that the new trip has been installed properly. If this information is not available at this time, provide a schedule for its submittal.

Response

Detailed installation instructions and test procedures will be provided to ensure that the anticipatory trip equipment is properly installed and performs the functions described. In addition, the cabinet mounted equipment to be supplied by B&W will be fully testable from the RPS cabinets. The equipment will have provisions for simulating input signals and verifying the proper response of the RPS channel. This testing will be similar to that presently performed on the RPS and will be integrated into the periodic testing of the cabinets.

Overall reactor protection system installation testing will be performed by actuation of the new sensors and verification of proper response at the CRDCS cabinets.

Question 9. The safety evaluations for the anticipatory trips are either missing or are incomplete. Submit supporting analysis to justify the proposed trip signals by addressing the following items:

a. Provide an analysis that quantifies the improvement in the time-to-reactor-trip for both the turbine trip and and loss of main feedwater signals;

b. Address the need to bypass these trips at 20% power versus bypass at a lower power (approximately 10%);

c. Discuss the adequacy of the proposed trip signals for loss of main feedwater for a variety of failure scenarios (such as feedwater valve closures), i.e., see the Oconee 1 transients of June 11, 1979; and

d. Provide an evaluation of why a reactor trip on low steam generator level is not a viable anticipatory trip signal when the other signals are bypassed, i.e., see the Crystal River 3 transient of August 2, 1979.

Response

a. The primary purpose of anticipatory reactor trips (ARTs) is to reduce the challenges to the PORV for loss of secondary heat sink conditions. For a reactor high pressure trip setpoint of 2300 psig, it was shown in References 1 and 2 that the PORV would not lift with a setpoint of >2400 psig. The margin to the PORV setpoint can be increased, however, by use of ARTs. Figure 9a-1 shows the pressure increase from nominal operating pressure as a function of time to trip for the loss of main feedwater event. From this figure, it can be seen that an ART that detects and trips the plant at 4 seconds results in a peak pressure increase of 60 psi; whereas the high RC pressure trip which would occur at 8 seconds results in a peak pressure increase of 184 psi. The anticipatory trip signals which have been selected will initiate a reactor trip in less than one second. As seen on Figure 9a-1, a one second time to trip results in a 12 psi pressure increase, compared to a 184 psi pressure increase for the high pressure trip at 8 seconds.

The analyses presented above are for a loss of main feedwater event which produces higher peak pressures than turbine trips produce. The time to reactor trip after a turbine trip from full power is, however, approximately the same as that for a loss of main feedwater.

b. Sensitivity studies on time to reach the PORV setpoint vs. power level for a loss of feedwater event have been performed. Table 9b-1 displays the results of these analyses. The results are for a trip on high RC pressure since that gives the shortest time to steam generator dryout assuming no auxiliary feedwater. For power levels <25% FP, it can be seen that sufficient time for operator action exists to initiate feedwater and any bypass setpoint below this value should be a matter of providing sufficient operational flexibility.

For the turbine trip event, the system has sufficient responsiveness such that, at lower power levels (≤25%), a reactor trip is not anticipated if the turbine trips.

c. This case was a reactor startup situation with 1 MFWP reset and not operating. When the operating feedwater pump tripped, the reactor did not automatically trip on loss of feedwater because the low discharge pressure trip on the reset MFWP was not reached prior to the operator manually tripping the plant. For reactor operation above 20% power a reactor trip based on feed pump operation, such as the proposed safety grade trips will be, would have detected this loss of feedwater event. Since this particular transient occurred at a startup condition the ARTs would have been bypassed. However, as discussed in response to b, above, there is sufficient time for operator action available.

Again it is noted that the purpose of ARTs is to decrease the challenges to the PORV on loss of secondary heat sink conditions. Since it has been demonstrated [1,2] that with a reactor trip of 2300 psig and PORV setpoint >2400 psig, no lifting of the PORV will occur, the addition of ARTs only increase the margin to PORV setpoint pressure.

d. The purpose of our proposed anticipatory reactor trip is to sense a loss of secondary heat sink conditions promptly and to reduce challenges to the PORV. It is not considered that the low steam generator level trip is a viable anticipatory trip, because at low power levels, a low steam generator level trip would result in unnecessary reactor trips when loading or unloading the main turbine. If a loss of heat sink condition had occurred in the case referred to, either the loss of main feed pump reactor trip or the high RCS pressure trip would have occurred prior to actuation of the PORV. At high power levels, the low steam generator level trip is not anticipatory with the main feed pump and main turbine trips operable.

REFERENCES:

1. B&W Report to the NRC, May 7, 1979, "Evaluation of Transient Behavior and Small Reactor Coolant System Breaks in the 177 Fuel Assembly Plant."

2. Toledo Edison Report to the NRC, May 16, 1979, "Evaluation of Transient Behavior and Small Reactor Coolant System Breaks in the 177 Fuel Assembly Plant, Volume 3."

TABLE 9b-1

POWER LEVEL SENSITIVITY UPON LOSS OF MAIN FEEDWATER

POWER LEVEL	TIME TO REACH PORV SETPOINT	TIME TO FILL PRESSURIZER
100%	3 min.	10 min.
75%	6 min.	11 min.
50%	12.3 min.	13 min.
25%	>>15 min.	16.6 min.

NOTE 1: RESULTS ARE FOR THE CASE OF NO AUXILIARY FEEDWATER INITIATION WHICH RESULTS IN THE SHORTEST ACTUATION TIMES. REACTOR TRIPS ON HIGH RC PRESSURE TRIP (2300 psig).

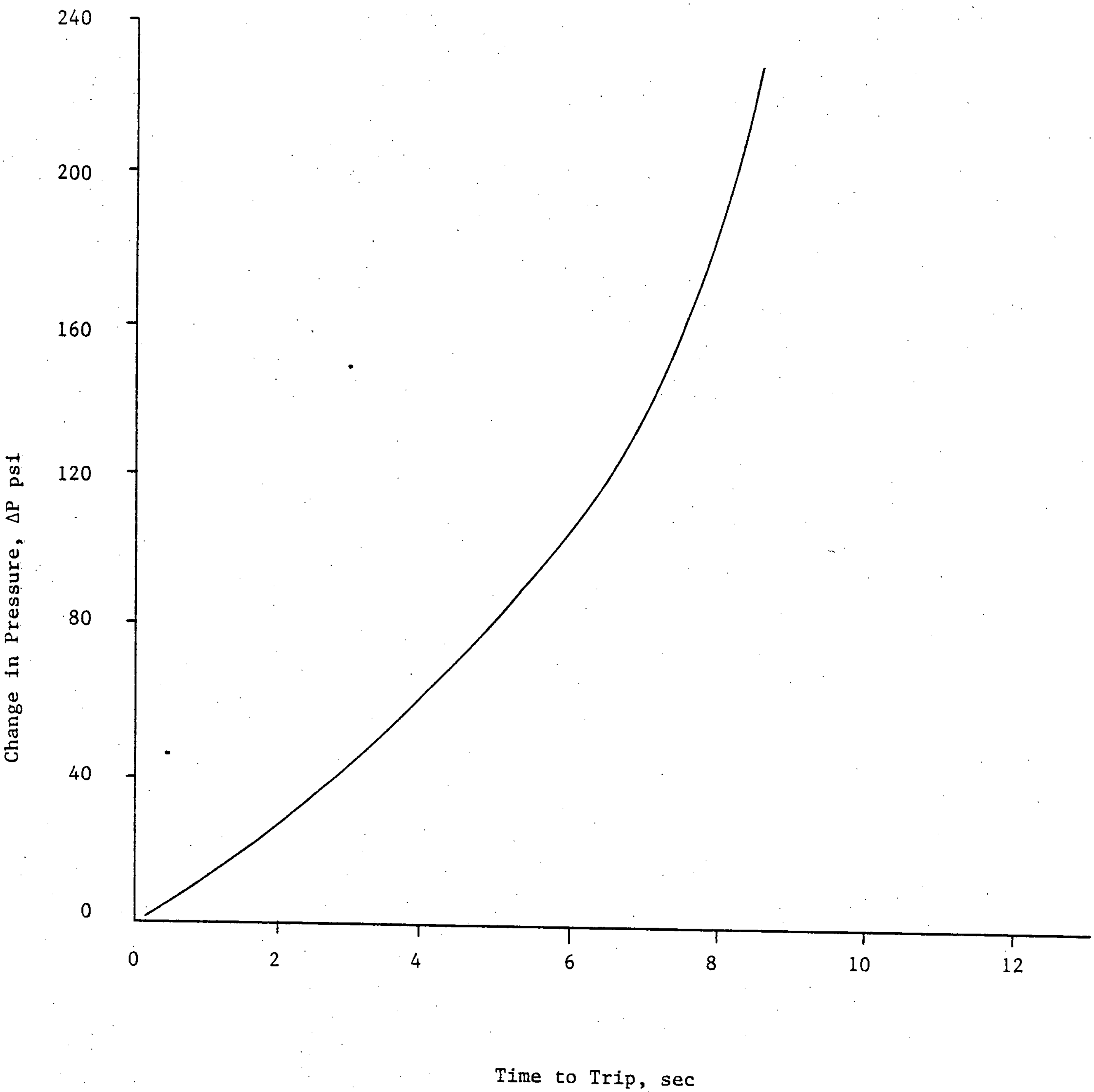
2. AS DISCUSSED IN 9a A LOSS OF MAIN FEEDWATER WITHOUT A LOSS OF AUXILIARY FEEDWATER WILL NOT RESULT IN OPENING THE PORV.

CHANGE IN REACTOR COOLANT SYSTEM

PRESSURE VS TIME TO TRIP FOR

A LOSS OF MAIN FEEDWATER

FROM 100% POWER



ATTACHMENT I

NEW SAFETY-GRADE REACTOR
TRIPS FOR RPS-I

This report describes the implementation of safety-grade reactor trips into the RPS-I for loss of main feedwater and turbine trip.

Loss of Main Feedwater Trip - Control oil pressure switches or Feedwater header discharge pressure switches for each feedwater pump will input an open indication to the RPS on feedwater pump trip. Contact buffers in the RPS will sense the contact inputs and initiate an RPS trip when both pumps have tripped. This trip will be bypassed below a predetermined flux level, typically 20% FP. Reference Figure 1.

Turbine Trip - Pressure switches monitoring the hydraulic fluid pressure in the turbine "Emergency Trip System" header will input an open indication to the RPS on turbine trip. Contact buffers in the RPS will sense the contact inputs and initiate an RPS trip when a turbine trip is indicated. This trip will be bypassed below a predetermined flux level, typically 20% FP. Reference Figure 2.

Pressure switches for both trips will be supplied by the customer. B&W will supply all RPS cabinet mounted equipment. Attachment 1 lists the cabinet mounted equipment and gives the trip response time. Attachment 1 also gives the contact buffer isolation voltage and the customer requirements for the contact inputs.

Figure 1 is a simplified drawing of the main feedwater pump trip.

Figure 2 is a simplified drawing of the turbine trip.

Drawing 51079DGB-1 shows the generic logic for the new trips.

Drawing 51079MLG-1 is a legend for the generic logic drawing.

CABINET MOUNTED EQUIPMENT FOR ADDITION OF RPS
TRIPS ON LOSS OF MAIN FEEDWATER AND TURBINE TRIP

3 Contact Buffers	
2 Bistables	Per Channel
2 Auxiliary Relays	

Modules will be installed in a pre-wired mounting case and tested as a unit prior to shipment. The mounting case is to be installed in an empty row of each RPS channel and connections made to the RPS wiring.

Trip response time of the RPS cabinet mounted equipment will be $\leq$ 150 ms.

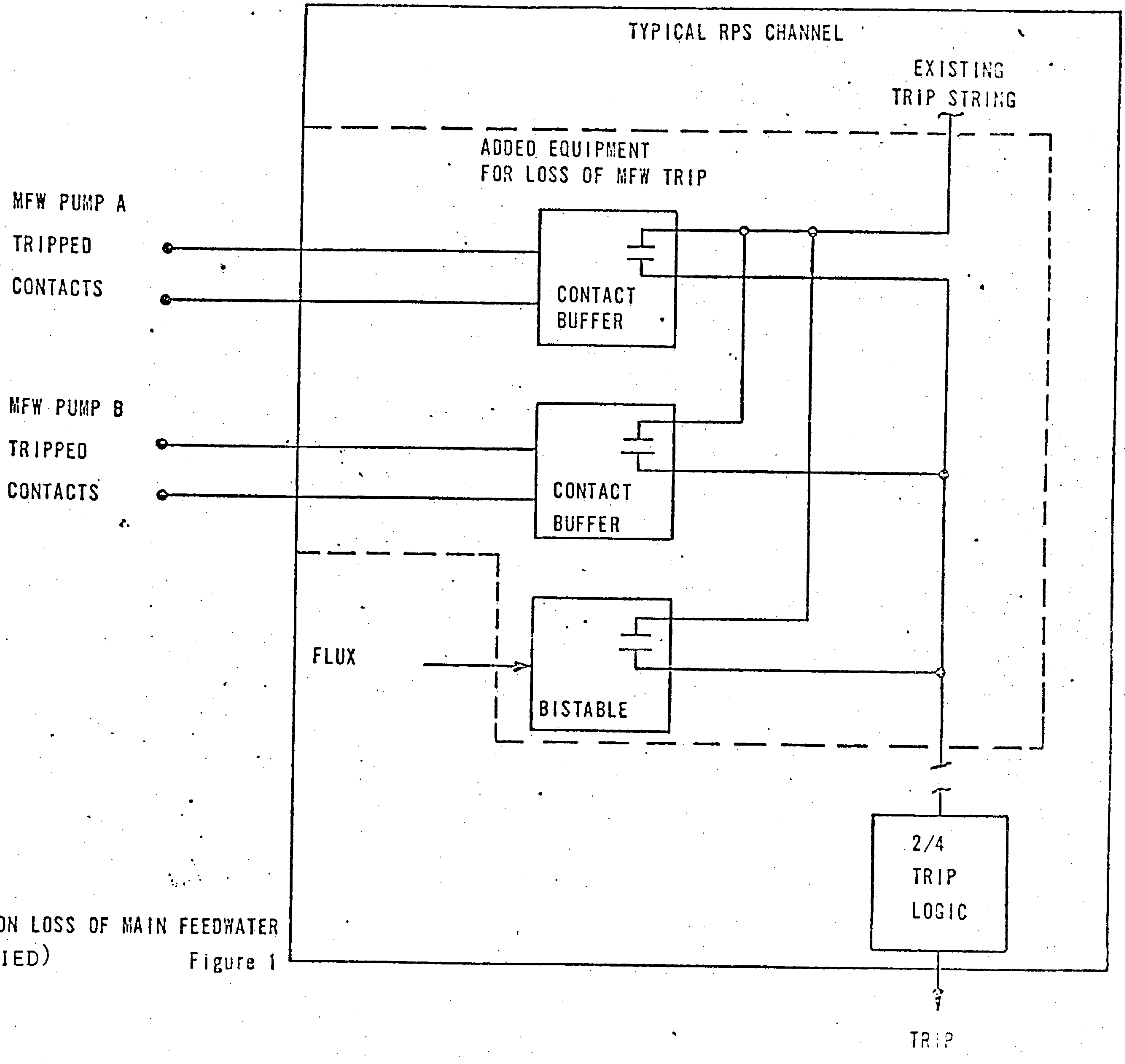
Isolation of the contact buffer module is 600 volts with the contact input lines not grounded.

Contact input characteristics:

Continuous	90 ma, P-P
Surge	250 ma, P-P
Voltage	118 VAC

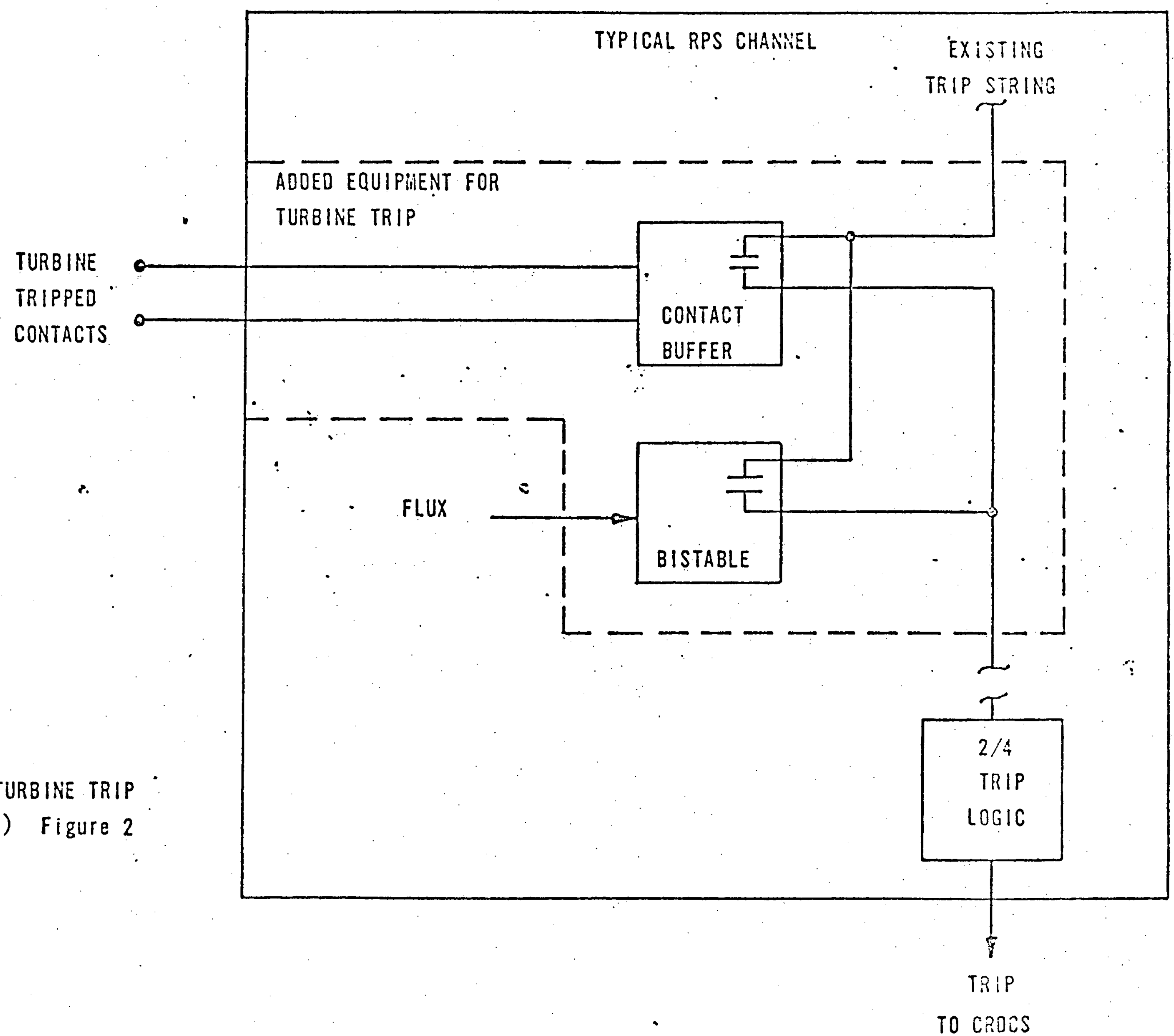
Closed contact indicates pump running

Open contact indicates pump tripped



RPS TRIP ON LOSS OF MAIN FEEDWATER (SIMPLIFIED)

Figure 1



RPS TRIP ON TURBINE TRIP
(SIMPLIFIED) Figure 2

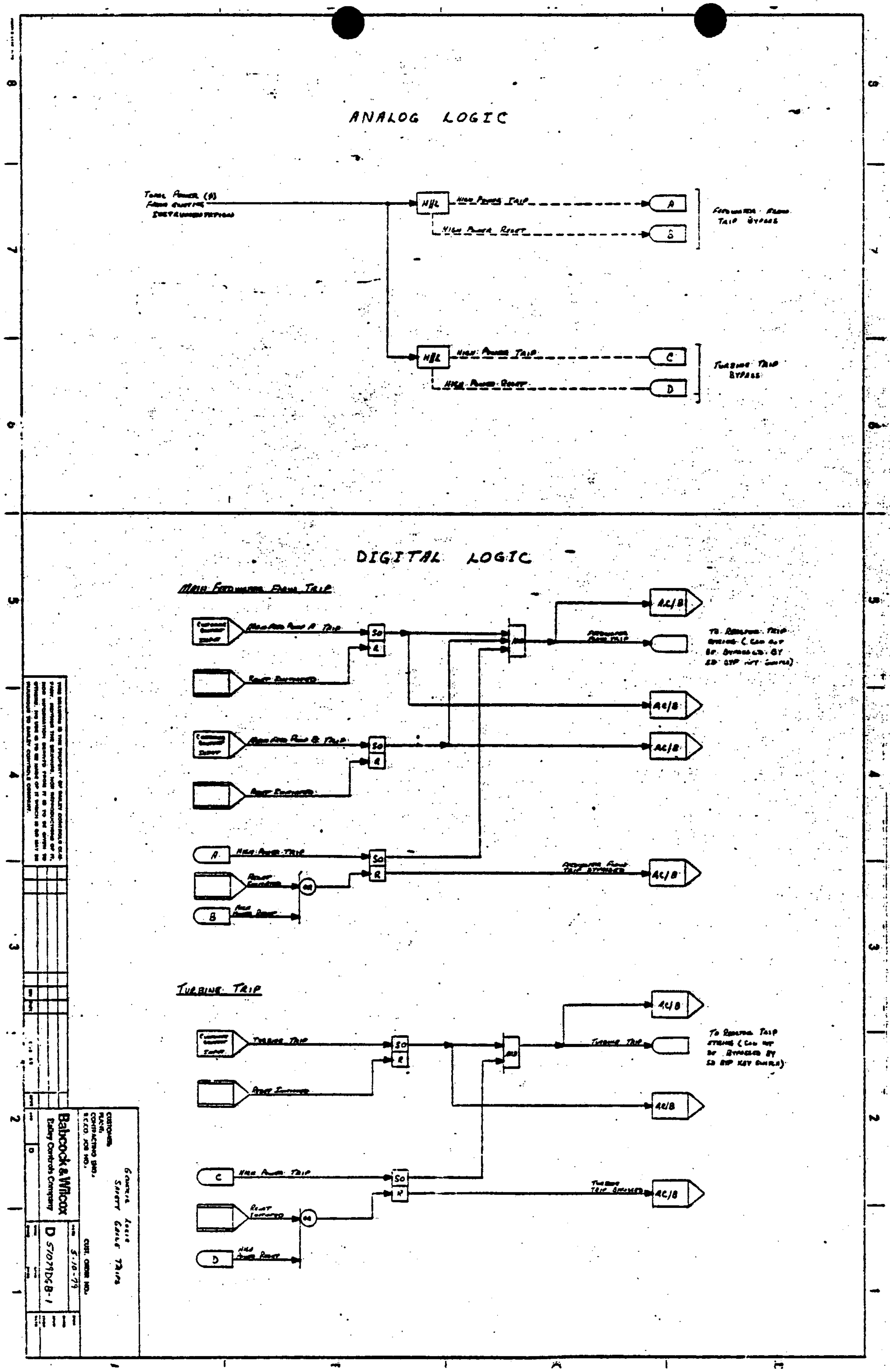

ANALOG LOGIC
H/L
A
B
C
D
DIGITAL LOGIC
SO
R
AC/B
A
B
C
D
TURBINE TRIP
Babcock & Wilcox
Bailey Controls Company

TABLE 1

EXCLUSIVE AND DIAGRAMMING SYMBOLS

MEASURING OR LOCAL READOUT	
MANUAL SIGNAL PROCESSING	
AUTOMATIC SIGNAL PROCESSING	
SYSTEM OUTPUT (PROCESS/OTHER SYSTEM TYPE)	THE SYMBOL REPRESENTS ACTUAL INPUTS FROM OR ACTUAL OUTPUTS TO A PROCESS OR ANOTHER SYSTEM.
SYSTEM INPUT (PROCESS/OTHER SYSTEM TYPE)	
SYSTEM OUTPUT (HUMAN COMMUNICATION TYPE)	THE SYMBOL REPRESENTS ACTUAL INPUTS FROM OR ACTUAL OUTPUTS TO THE OPERATOR.
SYSTEM INPUT (HUMAN COMMUNICATION TYPE)	
BREAK POINT	THE SYMBOL DENOTES BREAKS AND RESUMPTIONS OF SIGNAL LINES ON A SINGLE PAGE OF LOGIC AND/OR BETWEEN PAGES OF LOGIC. (DIGITAL LOGIC TO DIGITAL LOGIC DRAWINGS.)
RESUMPTION POINT	
BREAK POINT	THE SYMBOL DENOTES BREAKS AND RESUMPTIONS OF SIGNAL LINES ON A SINGLE PAGE OF LOGIC AND/OR BETWEEN PAGES OF LOGIC. (ANALOG LOGIC TO DIGITAL LOGIC DRAWINGS.)
RESUMPTION POINT	
ARROWHEAD	THE ARROWHEAD SYMBOL SHOWS DIRECTION OF FLOW OF A SIGNAL LINE.
DASHED LINE	THE DASHED LINE SYMBOL SHOWS ANALOG SIGNAL LINES ON A DIGITAL LOGIC DRAWING OR DIGITAL SIGNAL LINES ON AN ANALOG LOGIC DRAWING.
AND	THE OUTPUT IS A LOGIC ONE IF ALL OF THE INPUT SIGNALS ARE LOGIC ONE.
OR (INCLUSIVE)	THE OUTPUT IS A LOGIC ONE IF THERE IS ONE OR MORE LOGIC ONE INPUTS.
OR (QUALIFIED)	THE OUTPUT IS A LOGIC ONE IF THE NUMBER OF LOGIC ONE INPUTS IS __ N, WHERE N IS 0,1,2... AND __ REPRESENTS ONE OF THE FOLLOWING: GT = GREATER THAN; LE = LESS THAN OR EQUAL TO; LT = LESS THAN; GE = GREATER THAN OR EQUAL TO; EQ = EQUAL TO
NOT	THE OUTPUT IS A LOGIC ONE IF THE INPUT IS A LOGIC ZERO.
MAINTAINED MEMORY	WHEN AN INPUT TO A SQUARE IS LOGIC ONE, THE OUTPUT FROM THAT SQUARE IS LOGIC ONE. WHEN ONLY ONE INPUT TO THE SYMBOL IS LOGIC ONE AND THAT INPUT IS SUBSEQUENTLY LOST (I.E., LOGIC 0), THE OUTPUT ASSOCIATED WITH THAT INPUT IS MEMORIZED (RETAINED AT LOGIC ONE). WHEN AN OVERRIDE DESIGNATION (O) IS IN ONE OF THE SQUARES AND INPUTS TO BOTH SQUARES ARE LOGIC ONE, ONLY THE OUTPUT FROM THE SQUARE WITH THE OVERRIDE DESIGNATION IS LOGIC ONE.

ULTIMATE DESTINATION LEGEND

SYSTEM OUTPUTS ARE IDENTIFIED BY THE FOLLOWING LETTER CODES. THE FIRST LETTER DESCRIBES THE DESTINATION AND THE SECOND LETTER DESCRIBES THE PURPOSE OF USE (EG, A/B MEANS UNIT ANNUNCIATOR FOR ALARM USE).

DESTINATION

- A = UNIT ANNUNCIATOR
- C = UNIT COMPUTER
- CR = CONTROL ROOM
- CRD = CONTROL ROD DRIVE CONTROL SYSTEM
- DI = DIGITAL INDICATOR
- I = CONTROL ROOM INDICATOR
- ICS = INTEGRATED CONTROL SYSTEM
- R = CONTROL ROOM RECORDER

PURPOSE

- A = REQUIRED FOR HEAT BALANCE CALCULATION
- B = HIGH OR LOW LEVEL ALARM (ANALOG); ALARM (DIGITAL)
- C = ALARM ON ERRATIC DEVIATION FROM NORM OF OTHER INPUTS MONITORING SAME PARAMETER
- D = HOURLY LOG
- E = CONTROL
- F = FUTURE
- I = OPERATOR INFORMATION

TABLE 2

MEASURING/READOUT LETTERS

BIC	BOTTOM ION CHAMBER
BII	BOTTOM ION CHAMBER INDICATOR
CIC	COMPENSATED ION CHAMBER
CRI	COUNT RATE INDICATOR
DAP	DIVISION ALARM PANEL
DPS	DETECTOR POWER SUPPLY
dPT	DIFFERENTIAL PRESSURE TRANSMITTER
FFD	FAN FAILURE DETECTOR
FLI	FLOW LOOP INDICATOR
[illegible]	[illegible]
[illegible]	LOG N INDICATOR
MI	MODULE INTERLOCK
ODI	OFFSET DIGITAL INDICATOR
PC	PROPORTIONAL COUNTER
PII	POWER IMBALANCE INDICATOR
PIP	PNC INDICATING PANEL
PLI	PRESSURIZER LEVEL INDICATOR
PT	PRESSURE TRANSMITTER
RCI	RATE OF CHANGE INDICATOR
RPI	REACTOR COOLANT PRESSURE INDICATOR
RTI	REACTOR COOLANT TEMPERATURE INDICATOR
SPS	SYSTEM POWER SUPPLY
TFI	TOTAL FLOW INDICATOR
TIC	TOP ION CHAMBER
TII	TOP ION CHAMBER INDICATOR
TPI	TOTAL POWER INDICATOR
TT	TEMPERATURE TRANSMITTER

TABLE 3

SIGNAL PROCESSING SYMBOLS

Σ	SUMMING	THE OUTPUT EQUALS THE ALGEBRAIC SUM OF THE INPUTS.
Δ	DIFFERENCE	THE OUTPUT EQUALS THE ALGEBRAIC DIFFERENCE BETWEEN THE TWO INPUTS.
K	PROPORTIONAL	THE OUTPUT IS DIRECTLY PROPORTIONAL TO THE INPUT.
d/dt	DERIVATIVE	THE OUTPUT IS PROPORTIONAL TO THE RATE OF CHANGE (DERIVATIVE) OF THE INPUT.
√	ROOT EXTRACTION	THE OUTPUT EQUALS THE ROOT (I.E., SQUARE ROOT, FOURTH ROOT, 3/2 ROOT, ETC.) OF THE INPUT.
>	HIGH SELECTING	THE OUTPUT IS EQUAL TO THAT INPUT WHICH IS THE GREATEST OF THE INPUTS.
A	ANALOG SIGNAL GENERATOR	THE OUTPUT IS AN ANALOG SIGNAL DEVELOPED WITHIN THE GENERATOR.
T	TRANSFER	THE OUTPUT EQUALS THE INPUT WHICH HAS BEEN SELECTED BY TRANSFER. THIS IS A MULTIPOSITION MANUAL SELECTOR TEST SWITCH FOR TESTING OF ASSOCIATED UNTRIPPED STRING. EACH STRING HAS A SEPARATE TEST SWITCH. THE STATE OF THE TRANSFER IS ESTABLISHED BY EXTERNAL MEANS.
H/	BISTABLE	THE OUTPUT WILL BE TRIPPED WHEN THE INPUT IS ≥ SET POINT.
/L	BISTABLE	THE OUTPUT WILL BE TRIPPED WHEN THE INPUT IS ≤ SET POINT.
H/L	BISTABLE	THE OUTPUT WILL BE TRIPPED WHEN THE INPUT IS ≥ SET POINT AND WILL RESET WHEN THE INPUT IS ≤ DEADBAND (I.E., RESET = TRIP − DB).
∫	INTEGRAL	THE OUTPUT VARIES IN ACCORDANCE WITH BOTH MAGNITUDE AND DURATION OF THE INPUT. THE OUTPUT IS PROPORTIONAL TO THE TIME INTEGRAL OF THE INPUT.
LOG	LOGARITHMIC	THE OUTPUT EQUALS THE LOGARITHM (I.E., $Y = \log_{10} X$) OF THE INPUT.

NOTES:

1) A COMPLETE SYMBOL CONSISTS OF AN ENCLOSURE OR DIAGRAMMING SYMBOL (TABLE 1) WITHIN WHICH IS CONTAINED A MEASURING OR READOUT LETTER (TABLE 2) OR A SIGNAL PROCESSING SYMBOL (TABLE 3). COMPLEX FUNCTIONS ARE REPRESENTED BY THE COMBINATIONS OF THESE BASIC SYMBOLS.

2) NI/RPS CHANNEL INPUT/OUTPUT DEVICE IDENTIFICATION

PARAMETER	NI/RPS DIVISION A	B	C	D
LOOP A dP FLOW	RC-FT-[illegible]	RC-FT-[illegible]	RC-FT-[illegible]	RC-FT-[illegible]
LOOP B dP FLOW	RC-FT-[illegible]	RC-FT-[illegible]	RC-FT-[illegible]	RC-FT-[illegible]
NI DETECTOR	5	6	7	8
RC PUMP MONITORS	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
LOOP A TH	RC-TE-[illegible]	RC-TE-[illegible]	RC-TE-[illegible]	RC-TE-[illegible]
LOOP B TH	RC-TE-[illegible]	RC-TE-[illegible]	RC-TE-[illegible]	RC-TE-[illegible]
LOOP TC	RC-TE-[illegible]	RC-TE-[illegible]	RC-TE-[illegible]	RC-TE-[illegible]
	(LOOP A)	(LOOP A)	(LOOP B)	(LOOP B)
RC PRESS	RC-PT-[illegible]	RC-PT-[illegible]	RC-PT-[illegible]	RC-PT-[illegible]
PRZR LEVEL	RC-LT-[illegible]	RC-LT-[illegible]	RC-LT-[illegible]	RC-LT-[illegible]
VITAL POWER	A	B	C	D
TRIP DEVICE	A	B	C	D

3) PNC INPUT/OUTPUT DEVICE IDENTIFICATION

PARAMETER	PNC-A	PNC-B
SOURCE RANGE	NI-1	NI-2
INTERMEDIATE RANGE	NI-3	NI-4
LOG N RECORDER	NI-3	NONE
OTHER SIGNALS FROM NI/RPS	[illegible]	CRD
UNFILTERED TOTAL POWER RECORDER	NONE	NI-[illegible]

NI/RPS & PNC - LOGIC-LEGEND AND REFERENCE

CUSTOMER:
PLANT:
CONTRACTING ENG.:
B&W CO. JOB NO.:
CUST. ORDER NO.:

DATE 5-10-77

Babcock & Wilcox
Bailey Meter Company U.S.A.

D 5101911G-1

ATTACHMENT II

SEISMIC AND ENVIRONMENTAL
SUMMARY REPORTS

Equipment: The Bailey Controls Company Solid State Bistable module P/N 6628492A1 was environmentally tested providing type test data. The Solid State Bistable is a standard 2-unit-wide module designed for plug-in mounting.

Brief Summary of Test Results: Tests were performed to verify that the performance characteristics of the Solid State Bistable Module qualify it for use in a Nuclear Power Generating Facility. The test unit failed to meet the acceptance criteria for output load voltages during humidity effect testing. Engineering replaced a reference amplifier. Upon retest, the module met specified acceptance criteria. Based on the test data, the Solid State Bistable meeting all the design range requirements.

Test title sequence	Set up conditions	Environment conditions	Acceptance criteria	Units tested	Units acceptable
Solid State Bistable					
1. Repeatability of set point trip conditions	a. Normal input/output configuration b. Power supplies ±15V dc, ±5% c. Load: 3K ohms	Standard test conditions Temperature: 75^{O}F ± .5% Humidity: 50% ± 20% RH	<0.02% set point span	2	2
2. Power supply effect	Same as test No. 1 except power supplies: ±15 dc with ±1% variation from references repeated using ±5% variations	Standard test conditions	For ±1% variation ≤0.02% set point span For ±5% variation ≤0.1% set point span	2	2
3. Ambient temperature effect	Same as test No. 1 except set internal set point to 8.00 V dc and apply external set point voltage	Temperature: 40^{O}F to 140^{O}F Humidity: RH ≤50%	For 40^{O}F to 140^{O}F Trip point accuracy ≤0.1% set point span shift Response Time: >32 ms-low lvl contact volt. <0.5V dc High lvl contact volt. ≤2.0V dc	2	2
4. Ambient relative humidity effect	Same as temperature tests	Temperature: 110^{O}F Humidity: 80% RH for 96 h 90% RH for 24 h	Trip point accy: <0.1% set point span chge in internal set point <0.1% low lvl contact <0.5V dc-hi lvl contact <2.0V dc Response Time: ≤32 ms	2	2
5. Drift, long term (30 day)	Same as test No. 1 except setpoint adjusted to 9.00V dc	Standard test conditions	Change in trip accuracy ≤0.07% setpoint span	2	2

Equipment: The Bailey Controls Company Solid State Bistable Module, P/N 6628492A1, was seismically tested providing type test data.

Test Mounting: The Solid State Bistable Module was mounted in a standard Module Mounting Case with backplate. A standard 32-blue ribbon connector was utilized to interface the module with the signal source. The standard Module Mounting Case was then securely attached to the Seismic Test Mounting Box. The Seismic Test Mounting Box was attached to the Qualification Test Lab 45° Biaxial Test Table. The use of the 45° Biaxial Table results in equal horizontal and vertical components. Electrical interface, hardware, and mounting were equivalent to field installation.

Seismic Testing:

Exploratory Testing: The resonant survey consisted of a sinusoidal vibration input of 0.2 g's vertical peak acceleration at frequencies from 1 to 35 Hz and back to 1 Hz. The resonant survey was conducted at a sweep rate of 1 octave/minute. The constant input was applied to the 45° Biaxial Table and continuously monitored.

Proof Testing: A biaxial multifrequency excitation was applied to the Solid State Bistable for a period of 30 seconds. Each 30-second event consisted of dependent biaxial pseudorandum excitation. The random input frequencies were adjusted in 1/3-octave bandwidths until the Test Response Spectrum (TRS) enveloped the Required Response Spectrum (RRS) within the limits of the biaxial table displacement. A damping of 5 percent (Q of 10) was utilized for the control accelerometer in testing. The TRS did not envelope the RRS (below 6.0 Hz worst case) in the low-frequency range. No resonant frequencies exist in the range not enveloped during test; therefore, this is an acceptable deviation.

Test Monitoring:

Seismic: The Solid State Bistable Module was monitored with accelerometers through appropriate signal conditioning to determine its mechanical response. The location of the monitoring accelerometers is delineated in the seismic report. The control accelerometer was mounted directly to the biaxial test table for controlled input.

Electrical: The unit's outputs were monitored and documented on a strip chart recorder during these events.

Brief Summary of Test Results: The Solid State Bistable Module was within the specifications cited in the module test procedure acceptance criteria section during and after the SSE tests. Consequently, the Solid State Bistable Modules are considered qualified for nuclear applications.

Specified Features Demonstrated by Test: The purpose of this test was to satisfy seismic level testing requirements before, during, and after test of the Solid State Bistable.

Module functional operability and solid-state relay state were maintained throughout the exploratory and seismic events.

Structural integrity of enclosures was maintained.

Equipment: The Bailey Controls Company Contact Buffer, P/N 6628908A1 was environmentally tested providing type test data.

The Contact Buffer module is a 2-unit-wide module designed for plug-in mounting. Electrical connections are made through a standard 32-pin Blue Ribbon connector at the rear of the module. The vital bus uses a separate plug-in connector.

Brief Summary of Test Results: Tests were performed to verify that the performance characteristics of the Contact Buffer module qualify it for use in a Nuclear Power Generating Facility.

Based on the test data, the Contact Buffer module meets all the design range requirements.

Type Test Justification: Because of the nature of application, this product consists of various types, versions, or ranges. A worst case representative sampling has been tested by BCCo Qualification Test Laboratory to verify that this product performs the required functions within the required operating and environmental conditions.

Part Number	Nature of Difference
6628908A2	Variation of Frontplate Silkscreening

Contact Buffer

Test title sequence	Set up conditions	Environment conditions	Acceptance criteria	Units Tested	Units acceptable
1. Functional test	a. Normal input/output configuration b. Power supply: 118 V ac c. Load	Standard test conditions Temperature: $75^{\circ}F \pm 5^{\circ}F$ Humidity: 50% ± 20% RH	No faulty operation	2	2
2. Power supply effect	Same as test No. 1 except power supplies: Minimum: 105 V ac Maximum: 130 V ac	Standard test conditions	Same as test No. 1	2	2
3. Ambient temperature	Same as test No. 1 for function test Vac = 106 for response time test	Temperature: $40^{\circ}F$ to $140^{\circ}F$ Humidity: RH $\leq 50\%$	No fault operation for function test. ≤ 12 ms. for response time test	2	2
4. Ambient relative humidity effect	Same as test No. 3	Temperature: $110^{\circ}F$ Humidity: 80% RH for 96 h 90% RH for 24 h	Same as test No. 3	2	2
5. Drift, long term (30 day)	Same as test No. 1 with both relays energized during drift test	Standard test conditions	Relays do not change state during drift period	2	2

Equipment: The Bailey Controls Company Contact Buffer Module, P/N 6628908A1, was seismically tested providing type test data.

Test Mounting: The Contact Buffer Module was mounted in a standard Module Mounting Case with backplate. A standard 32-pin blue ribbon connector and a separate standard 2-prong connector for the vital bus were utilized to interface the module with the signal source. The standard Module Mounting Case was then securely attached to the Seismic Test Mounting Box. The Seismic Test Mounting Box was attached to the Qualification Test Lab 45° Biaxial Test Table. The use of the 45° Biaxial Table results in equal horizontal and vertical components. Electrical interface, hardware, and mounting were equivalent to field installation.

Seismic Testing:

Exploratory Testing: The resonant survey consisted of a sinusoidal vibration input of 0.2 g's vertical peak acceleration at frequencies from 1 to 35 Hz and back to 1 Hz. The resonant survey was conducted at a sweep rate of 1 octave/minute. The constant input was applied to the 45° Biaxial Table and continuously monitored.

Proof Testing: A biaxial multifrequency excitation was applied to the Contact Buffer Module for a period of 30 seconds. Each 30-second event consisted of dependent biaxial pseudorandom excitation. The random input frequencies were adjusted in 1/3-octave bandwidths until the Test Response Spectrum (TRS) enveloped the Required Response Spectrum (RRS) within the limits of the biaxial table displacement. A damping of 5 percent (Q of 10) was utilized for the control accelerometer in testing. The TRS did not envelope the RRS (below 5.0 Hz worst case) in the low-frequency range. No resonant frequencies exist in the range not enveloped during test; therefore, this is an acceptable deviation.

Test Monitoring:

Seismic: The Contact Buffer was monitored with accelerometers through appropriate signal conditioning to determine its mechanical response. The location of the monitoring accelerometers is delineated in the seismic report. The control accelerometer was mounted directly to the biaxial test table for controlled input.

Electrical: The unit's outputs were monitored by chatter detectors per MIL-STD-202D, Method 310.

Results: The Contact Buffer was within the specifications cited in the module test procedure acceptance criteria section during and after the SSE tests. Consequently, the Contact Buffer Modules are considered qualified for nuclear applications.

Specified Features Demonstrated by Test: The purpose of this test was to satisfy seismic level testing requirements before, during, and after test of the Contact Buffer. Module functional operability and predetermined relay state were maintained throughout the exploratory and seismic events. Structural integrity of enclosures was maintained.

Equipment: The Bailey Controls Company Auxiliary Relay, P/N 6628807 B1 was environmentally tested providing type test data. The Auxiliary Relay Module is a 2-unit-wide module designed for plug-in mounting.

Brief Summary of Test Results: Tests were performed to verify that the performance characteristics of the Auxiliary Relay qualify it for use in a Nuclear Power Generating Facility. Based on the test data, the Auxiliary Relay meets all the design range requirements.

Auxiliary Relay P/N 6628807 B1

Test title sequence	Set up conditions	Environment conditions	Acceptance criteria	Unit tested	Units acceptable
1. Functional verification	a. Normal input/output configuration b. Power supplies -15 V dc c. Load: none	Standard test conditions Temperature: 75°F ± 5°F Humidity: 50% ± 20% RH	Proper operation of relays	1	1
2. Power supply effect (DC)	Same as test No. 1 except power supplies: from -13.5 V dc to -16.5 V dc	Standard test conditions	Same as test 1	1	1
3. Ambient temperature effect	Same as test No. 1	Temperature: 40°F to 140° F Humidity: RH $\leq$ 50%	Same as test 1	1	1
4. Ambient relative humidity effect	Same as test No. 1	Temperature: 110°F Humidity: 80% RH for 96 h, 90% RH for 24 h	Same as test 1	1	1
5. Drift, long term (30 day)	Same as test No. 1	Standard test conditions	Same as test 1	1	1

Equipment: The Bailey Controls Company Auxiliary Relay, P/N 6628807B1, was seismically tested providing type test data.

Test Mounting: The Auxiliary Relay Module was mounted in a standard Module Mounting Case with backplate. Two standard 32-pin blue ribbon connectors were utilized to interface the module with the voltage source. The standard Module Mounting Case was then securely attached to the Seismic Test Mounting Box. The Seismic Test Mounting Box was attached to the Qualification Test Lab 45^o Biaxial Test Table. The use of the 45^o Biaxial Table results in equal horizontal and vertical components. Electrical interface, hardware, and mounting were equivalent to field installtion.

Seismic Test:

Exploratory Testing: The resonant survey consisted of a sinusoidal vibration input of 0.2 g's vertical peak acceleration at frequencies from 1 to 35 Hz and back to 1 Hz. The resonant survey was conducted at a sweep rate of 1 octave/minute. The constant input was applied to the 45^o Biaxial Table and continuously monitored.

Proof Testing: A biaxial multifrequency excitation was applied to the Auxiliary Relay Module for a period of 30 seconds. Each 30-second event consisted of dependent biaxial pseudorandom excitation. The random input frequencies were adjusted in 1/3 octave bandwidths until the Test Response Spectrum (TRS) enveloped the Required Response Spectrum (RRS) within the limits of the biaxial table displacement. A damping of 5 percent (Q of 10) was utilized for the control accelerometer in testing. The TRS did not envelope the RRS (below 7.0 Hz worst case) in the lowfrequency range. No resonant frequencies exist in the range not enveloped during test; therefore, this is an acceptable deviation.

Test Monitoring:

Seismic: The Auxiliary Relay Module was monitored with accelerometers through appropriate signal conditioning to determine its mechanical response. The location of the monitoring accelerometers is delineated in the seismic report. The control accelerometer was mounted directly to the biaxial test table for controlled input.

Electrical: The unit's outputs were monitored with chatter detectors per MIL-STD-202D, Method 310 during these events.

Brief Summary of Test Results: The Auxiliary Relay Module was within the specifications cited in the module test procedure acceptance criteria section during and after the SSE tests. Consequently, the Auxiliary Relays are considered qualified for nuclear applications.

Specified Features Demonstrated by Test: The purpose of this test was to satisfy seismic level testing requirements before, during, and after test of the Auxiliary Relay Module.

Module functional operability and predetermined relay state were maintained throughout the exploratory and seismic events.

EQUIPMENT

Custom Components Pressure Switch Model 604 6R6-3565 was seismically tested.

TEST FIXTURE

The test fixture was designed in a manner such that the test unit was canted 33 degrees from the direction of the sinusoidial input in all three mutually perpendicular axes.

EXPLORATORY TESTING

Two continuous sweeps from 2 to 200 Hz back to 2 Hz were performed with the following amplitudes: Horizonal 2.0g peak, Vertical 1.34g peak. This was repeated for each of the three mutually perpendicular axes. The resonant survey was conducted at a rate of 10 Hz per minute from 2 to 60 Hz, and a higher rate above 60 Hz.

PROOF TESTING

No resonant frequencies were detected during the exploratory phase. The pressure switches were then subjected to a 2 to 35 Hz endurance in 1 Hz increments. The excitation was held at each increment for not less than 20 seconds.

TEST RESULTS

The pressure switches produced proper electrical output signal at their designated pressure setpoint during and after the proof test.