Commonwealth Edison
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Address Reply to: Post Office Box 767
Chicago, Illinois 60690

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July 3, 1978

Mr. Victor Stello, Director
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Dresden Station Unit 2
Systematic Evaluation Program
NRC Docket No. 50-237

Reference (a): M. S. Turbak letter to V. Stello
dated February 24, 1978

Dear Mr. Stello:

The enclosed information is being transmitted to supplement information included with Reference (a). One page, sheet 12, has been updated to include environmental qualification data (enclosure A) for the Target Rock Valve Solenoid Valves, as committed to in Reference (a).

The other page, sheet 26, is new and includes information for the Main Steam Isolation Valve limit switches which was inadvertently excluded from the previous transmittal. The referenced qualification test (enclosure B) has been performed on limit switches which are identical to those currently installed at Dresden 2, with the exception of gasket and lubricating materials.

The MSIV limit switches initiate a reactor scram under certain conditions when the MSIV's are less than 90% open. The switches on the MSIV's which are inside containment are not required to mitigate a LOCA, the event which causes an adverse environment to exist. These switches, therefore, do not require qualification for that environment. The switches on the MSIV's outside containment (steam tunnel) would be required to terminate a steam line break outside containment. Since the environment caused by this event (See Ref. (a)) is much less severe than the qualification test parameters, it is our

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engineering judgement that the use of unqualified gasket and lubricating materials will not effect switch operability. This judgement is also based on the fact that the switches are required to operate within the first few seconds of the event occurrence, and no deterioration of these components is expected to occur in that time. Additionally, the limit switches on the valves inside containment will not be exposed to this environment and will be able to carry out their required function. Other reactor scram signals will also be present (high pressure and high neutron flux) which serve as backup to the MSIV limit switch initiated scram.

Based on the above, we believe the switches are qualified to perform their intended function.

Three signed originals and forty (40) copies are being submitted for your use.

Very truly yours,

M. S. Turbak

M. S. Turbak
Nuclear Licensing Administrator
Boiling Water Reactors

attachments

DRESDEN 2
SAFETY RELATED ELECTRICAL LIST

COMPONENT	EQUIPMENT NUMBER	MANUFACTURER	MODEL	FUNCTION	LOCATION	TYPE OF DBE & ENVIR. PARAM.	TIME AFTER DBE REQUIRED OPERATION	SPECIFIED OR QUALIFICATION VALUES	DOCUMENTATION REFERENCES	PREVIOUS NRC CORRESPONDENCE
essure itch	2-0261-040A	Static-O-Ring		Main Steam Line Target Rock Valve 2-203-3A	Cont.	A	1	Ambient 32 to 250°F		
mp. lement	2-0261-041A	C.S. Gordon	(TC)	Main Steam Line Target Rock Valve 2-203-3A	Cont.	A	1,2	No Temp Limits		
lenoid	2-0261-042A	Automatic Valve Co.	C5450	Main Steam Line Target Rock Valve 2-203-3A	Cont.	A	4,5	340°F/65psig-2min. 340°F/45psig-3hrs. 320°F/45psig-3hrs. 250°F/25psig-90hrs. *	PED Memo* 126-62	
lenoid	2-0261-043A	↓	↓	Main Steam Line Target Rock Valve 2-203-3A	A	A	4,5	↓	↓	
low witch	2-0262-005A	PEECO	NT	Recirc. Pump "A" Seal #2 Hi-Flow Switch	Line 2-025A.75A	A	1	No Temp Limit	PEECO Catalog #65	
low witch	2-0262-005B	PEECO	NT	Recirc. Pump "B" Seal #2 Hi-Flow Switch	Line 2-0205B .75	A	1	No Temp Limit	PEECO Catalog #65	
ressure ransmitter	2-0262-007A	General Electric	GE/MAC 551	Recirc. Pump "A" Seal #1 Pressure	2202-9 497'-0"	D	1	Ambient Temp -20 to +185°F	GE/HBK 8041	
ressure ransmitter	2-0262-007B	General Electric	GE/MAC 551	Recirc. Pump "B" Seal #1 Pressure	2202-10 497'-0"	D	1	Ambient Temp -20 to +185°F	GE/HBK 8041	

*Information added 5-26-78

DRESDEN 2
SAFETY RELATED ELECTRICAL LIST

OMPONENT	EQUIPMENT NUMBER	MANUFACTURER	MODEL	FUNCTION	LOCATION	TYPE OF DBE & ENVIR. PARAM.	TIME AFTER DBE REQUIRED OPERATION	SPECIFIED OR QUALIFICATION VALUES	DOCUMENTATION REFERENCES	PREVIOUS NRC CORRESPONDENCE
mit itch	203-1A	NAMCO Controls	EA740 50000 Series	MSIV 2-0203-1A 10% Closure Scram Switch	Containment	A	1	340°F/70psig-6hr. 320°F/40psig-11hr. 250°F/25psig-3½hr. 200°F/10psig-26days 2.04x10[illegible] rads Seismic vibration	Acme-Cleveland Development Co. Test Plan 8-31-77 March 9, 1978 letter R.H. Kantner to R.F. Janecek	
mit itch	203-1B			MSIV 2-0203-1A 10% Closure Scram Switch	Containment	A				
imit itch	203-1C			MSIV-0203-1C etc.	Containment	A				
imit itch	203-1D			MSIV-0203-1D etc.	Containment	A				
imit witch	203-2A			MSIV-0203-2A etc.	Steam Tunnel ("x"-area)	E	3,5,7			
imit itch	203-2B			MSIV-0203-2B etc.	Steam Tunnel ("x"-area)	E				
imit witch	203-2C			MSIV-0203-2C etc.						
imit witch	203-2D			MSIV-0203-2D etc.						

Enclosure A

GENERAL ELECTRIC

INSTALLATION AND SERVICE ENGINEERING DEPARTMENT

GENERAL ELECTRIC COMPANY, 2015 SPRING ROAD, OAK BROOK, ILL. 60521
Phone (312) 986-3000

WRITER'S DIRECT DIAL NUMBER

G-EBO-8-141

May 17, 1978

Mr. W. H. Koester
Commonwealth Edison Company
One First National Plaza
P.O. Box 767
Chicago, Illinois 60690

SUBJECT: QUALIFICATION OF TARGET ROCK SOLENOID VALVE

REFERENCE: CSP Meeting, April 28, 1978

Dear Mr. Koester:

During the referenced meeting CECO requested qualification information on the Target Rock safety/relief valve solenoids. A memo regarding environmental testing by General Electric of the AVC model number C5450 solenoid valve similar to that used for the Dresden 2 Target Rock safety/relief valve is attached. This should satisfy your request for qualification documentation. The test results indicate that the valve will continue to operate satisfactorily during hypothetical LOCA conditions. Note that a caveat is included in the recommendation to use Parker Super O Lube which will not bake at postulated LOCA temperatures.

Very truly yours,

D L Butcher

D. L. Butcher
Service Supervisor
Mechanical & Nuclear Services

RT
DLB:RHT:bjm

cc: Messrs: G. Wagner
J. Abel
B.B. Stephenson-w/a
R. Janecek-w/a

MAIL IO

PLANT EQUIPMENT DESIGN ENGINEERING MEMORANDUM

No. 126-62

To: B. P. Brooks
D. L. Murray

Subject: ENVIRONMENTAL TESTING OF MSS/RV AIR CONTROL VALVES

Record Copy Filed by: B. P. Brooks
Issued by: R. C. Graeser 1/15/75

Introduction

Solenoid valves like those used on Target Rock safety/relief valves were tested under the accident environmental conditions anticipated after a design basis event. The temperature and pressure profiles used in these tests are similar to those required in IEEE Std. 323-1974.

Test Equipment and Procedure

Figure 1 shows a schematic of the test apparatus. Two solenoid valves are shown however one, two or three valves were tested in any one of the tests that were performed. The test vessel used was 30 inches in diameter x 24 inches deep. Each inlet, cylinder and electrical connection to the valves was piped to the outside of the vessel. The exhaust port was left open to the vessel conditions. The following valve was tested:

	Manufacturer	Model No.	Characteristics
T	AVC	C-5450	1/2 inch, Viton seals

The temperature controller automatically maintains a preset temperature in the vessel by turning the 6000 W strip heaters on the sides of the vessel on or off. The bottom heater is on a manual switch. Before testing the temperature controller, recorder, and probes and the cylinder and vessel pressure gauges were checked and calibrated.* During the test the two temperature probes agreed within 5°F. During assembly three inches of water was added to the bottom of the test vessel in order to maintain steam throughout the test. Before turning on the heaters, each valve was cycled 200 times to demonstrate operability and simulate a solenoid valve in service. The temperature controller was adjusted to maintain the following minimum test conditions:

Temperature	Pressure	Time
340°F	65 psig	2 min.
340°F	45 psig	3 hrs.
320°F	45 psig	3 hrs.
250°F	25 psig	90 hrs.

*Calibration records are maintained for traceability.

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The test procedure given in Appendix 1 was used except for the following modifications:

Test	Modification
3	The valves were not operated during the test, only before and after.
4	For 5 consecutive days the valves were subjected to 340°F for 3 hours, 320°F for 3 hours and 250°F overnight. Then an additional 2 days at 250°F. The T valve was operated after day 1, 2, 5, and 7.

The solenoid valves in test 1 were not irradiated. In test 2, 3 the valves were irradiated to a total integrated dose of 4 x 10^6 R. All irradiation was prior to assembling the test apparatus.

Results and Discussion

Table I shows a summary of test results. The following are more details by test number:

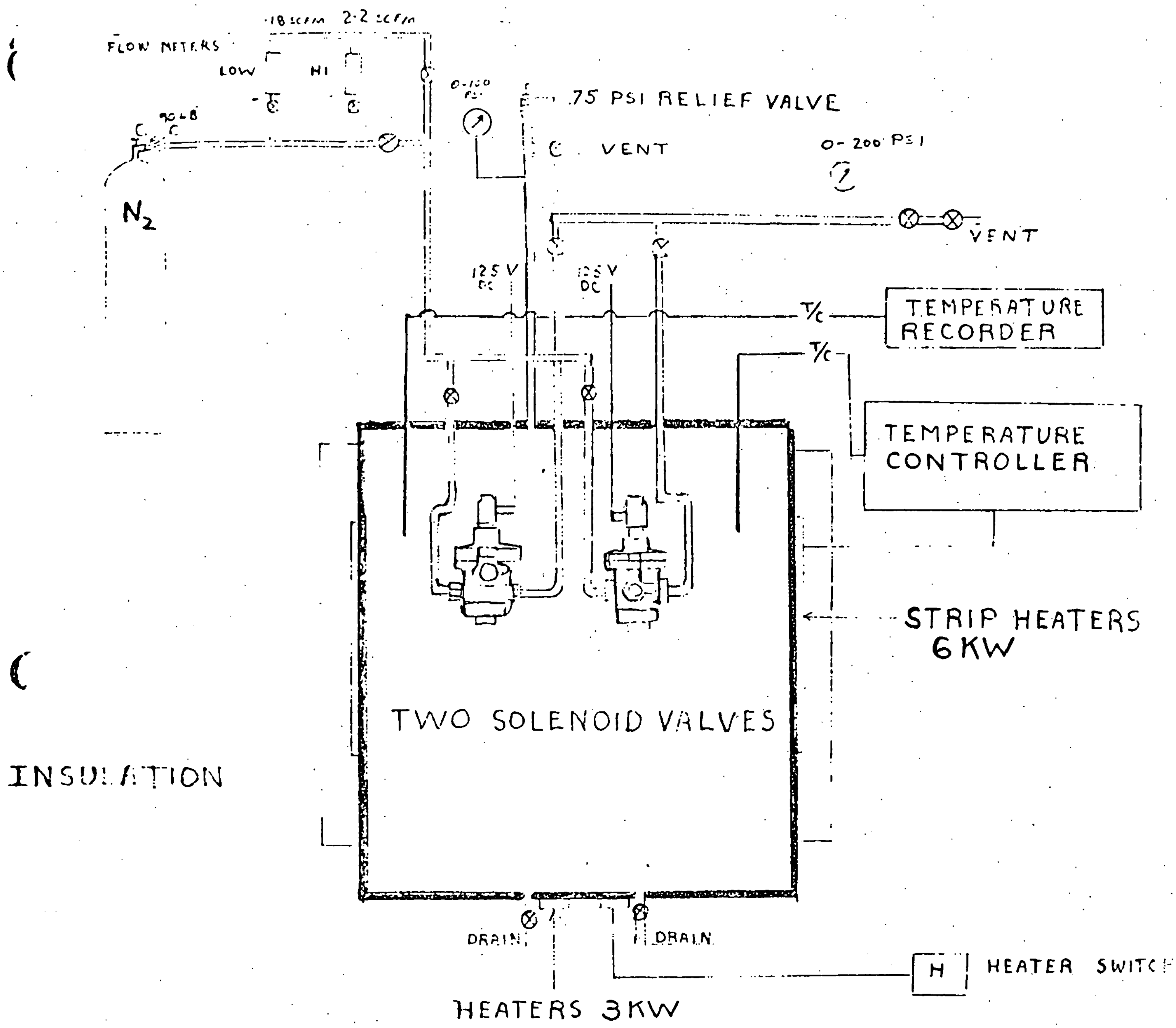
Test 1 Valve operated satisfactorily with no leakage.

Test 2 Operated satisfactorily with no leakage, however when checking for the minimum shift ΔP it stuck twice, once at a ΔP of 20 psi and another time at ΔP of 45 psi. Increasing the pressure caused it to operate satisfactorily.

Test 3 The valve operated satisfactorily with no leakage, however after it cooled down it failed to shift on the first attempt. After that it operated satisfactorily every time. The teflon insulation on the electrical loads cracked and broke away due to the irradiation.

Test 4 Valve operated satisfactorily. The valve leaked 2.2 SCFM in the energized condition. No leakage deenergized.

Subsequent testing of the lubricant used in these valves, Parker O Lube, showed that when baked in a dry oven for 24 hours, it turns black and gummy at about 250°F. At temperatures lower than 200°F it does not turn gummy. Another lubricant, Parker Super O Lube, continued to maintain its lubricant quality with no apparent bad effects at temperatures up to 350°F.



SOLENOID VALVE TEST APPARATUS

FIGURE 1

The conclusion drawn is that these valves can continue to operate satisfactorily during emergency operating conditions similar to those shown on page 2 provided the air supply can handle the small amount of leakage that can develop. This leakage has been primarily when the valve is in the energized condition. Deenergized leakage has been very minimal. The lubricant used should be Parker Super O Lube and not Parker O Lube since the Parker O Lube has a tendency to bake at a temperature of 250°F or higher. Some of the valves had critical dimensions that are not within drawing tolerance, however, since those valves were manufactured AVC has initiated an improved quality control programs.

Test	Test Sample	Test Parameters*	Results
1	T	2,3,4,6	no malfunctions
2	T	1a,2,3,4,6,7	stuck twice, jogged into operability after subsequent attempts
3	T	1a,2,3,5,6,9, 10	stuck once when cold
4	T	1b,2,4,6,8,10	some leakage when energized, no malfunction

*Test Parameters:

1a. Radiation - 4 x 10^6 R
1b. Radiation - 3 x 10^7 R
2. 200 cycles - normal operation
3. emergency temperature/pressure conditions
4. valve operation after each step
5. valve operation only at end of test cycle
6. leakage check
7. additional temperature spike to 350°F
8. 4-test cycles of emergency test condition
9. cool down to 80° after high temp. portion
10. modified test sequence as shown on page 3

SOLENOID VALVE

TEST PROCEDURE

1.0 Assembly and Preliminary Testing

1.1 Assemble as shown in the schematic, adding 3 inches of water in the bottom of the test vessel.

1.2 Leak check the entire piping system using a soap solution and recheck using the flow meter. There shall be no leaks.

1.3 Close all of the valves on the cylinder side of the solenoid valves, and the vent valve.

1.4 Energize each solenoid valve 200 times with 106 VDC using the following procedure.

a. Open the valve on the cylinder side of the solenoid valve for the valve being tested only.

b. Each time after energizing the solenoid, check the pressure gage to see that the cylinder pressure increases to the inlet pressure showing satisfactory operation. Inlet pressure is set to 90 psig.

c. Before starting, and after every 50 times, check and record seat leakage of the solenoid valve in both the energized and de-energized condition. Leak check by noting the flow through either the high or low flow meter after equilibrium is reached. Check min. shift pressure.

1.5 If all solenoid valves continue to operate satisfactorily with less than .05 SCFH seat leakage, assemble and leak check the vessel including the lid and all vessel penetrations. There shall be no leakage.

2.0 Environmental Test

2.1 Adjust the over pressure trip to 75 psig and the over temperature trip to 375°F. Start the temperature recording chart and adjust it for the proper time on the scale.

2.2 Turn both heaters on (side and bottom) and adjust the temperature controller to 350°F. Open the vent if the vessel pressure exceeds 70 psig.

2.3 Turn on the N_2 supply and adjust to 90 psig. Check and record leakage in the de-energized condition while waiting for 340°F.

3.0 First Step

3.1 When the vessel temperature reaches 350°F ±10, turn the bottom heater off. Hold 65 $^{+5}_{-0}$ psig for 60 seconds, then reduce to 45 ± 5 psig by carefully cracking open the vent valve.

3.2 Energize the solenoid 4 times, checking to see that the cylinder pressure increases to inlet pressure (90 psig) each time. Hold the solenoid in the energized condition for 10 sec. each time.

3.3 Check and record seat leakage in the energized and de-energized condition. Check minimum shift pressure.

4.0 Second Step

4.1 Maintain 350°F ±10 and 45 ±5 psig for 3 hrs.

4.2 Repeat steps 3.2 and 3.3.

5.0 Third Step

5.1 Adjust the temperature controller to 330°F. Continue to maintain 45 ±5 psig.

5.2 Maintain 330 ±10°F and 45 ±5 psig for 3 hours.

5.3 Repeat steps 3.2 and 3.3

6.0 Fourth Step

6.1 Adjust the temperature controller to 260°F. Reduce the vessel pressure to 30 ±5 psig. Adjust the over pressure trip to 40 psig and the over temperature trip to 300°F.

6.2 Maintain 260 ±10°F and 30 ±5 psig for 24 hours.

6.3 Repeat 3.2 and 3.3

7.0 Fifth Step

7.1 Reduce the vessel pressure to 25 ±5 psig. Keep the temperature at 260 ±10°F.

7.2 Maintain these conditions until the total length of test time is 96 hours (an additional 66 hrs.).

7.3 Repeat 3.2 and 3.3 after a total test time of 48 hours and again at the end of test.

Enclosure B

NAMCO CONTROLS

170 EAST 131st STREET • CLEVELAND, OHIO 44108 • (216) 268-4200 • TELEX 98-5499

March 9, 1978

Mr. Bob Janecek, 34 FN East
Commonwealth Edison Company
P.O.Box 767
Chicago, Illinois 60690

Subject: Series EA740 Switches for Use in a Nuclear Environment

Dear Mr. Janacek:

As we discussed with you on the telephone recently we have your purchase order number 207587 which calls for a quantity of 20 EA740-50100 switches which are to be qualified to IEEE-344, 323 and 382.

We expect to be able to ship these switches shortly since we have qualified our EA740 switch to the applicable specifications on February 20th.

As you requested during our telephone conversation, we are enclosing a copy of our test plan which outlines the procedure that we followed in our qualification testing.

If you have any questions about this test plan, or need any additional information, please contact me at any time.

Yours very truly,

Robert H. Kantner

Robert H. Kantner
Staff Sales Engineer
NAMCO CONTROLS

RHK/kg
Enc.

cc: W. Fullen

QUALIFICATION OF SERIES EA-180 AND EA-740 SWITCHES FOR CLASS IE USE IN NUCLEAR POWER PLANTS IN COMPLIANCE WITH IEEE STANDARD 382-1972

Copy #

Research Center of Acme-Cleveland Corporation

(1) Number of Units to be Tested

One unit of each switch type to be qualified will be tested for purposes of qualifying to IEEE standard 382-1972.

(2) Mounting and Connection Requirements

Each switch is mounted in a pressure chamber for design basis event testing by the taper pipe threads provided at the base of the switch housing for the connection of electrical conduit. As the pressure applied during design basis event testing is essentially hydrostatic, no great stress will be placed on the mounting mechanism. All switch poles are connected in order to test continuity during design basis event testing with the wires leaving the switch through the above mentioned mounting.

During seismic testing the switch is mounted by the standard mounting holes on the side of the housing.

(3) Aging Simulation Procedure

Thermal aging is accomplished by holding each unit at 200°F for 200 hours with 100% R.H. These are the conditions specified in Fig. 2 of Draft American National Standard N278.2.1, Draft 3, Rev. 1, June 1977.

Simulation of aging due to service use is made by actuating each unit a minimum of 100,000 times under electrical load.

(4) The Service Conditions to be Simulated

Service conditions of 140°F and 50% humidity are to be simulated. These service conditions are taken from IEEE standard 323 of 1972.

(5) Performance and Environmental Variables to be Measured

The performance variable is electrical resistance across each pair of contacts in both the open and closed position. The environmental variables are temperature and pressure in the chamber and the temperature, flow rate and chemical composition of the chemical spray.

(6) Test Equipment Requirements and Accuracies

A megohm tester and a test circuit are required. The test circuit includes a typical voltage source, electrical load and an ammeter, all in series. As only open versus closed circuits are being tested a $\pm$10% accuracy may be tolerated. The electrical load in the test circuit is .09 amps at 100 V.D.C. in all portions of the test except seismic, where the load is .5 amps at 125 V.D.C. The wear cycling portion of the test uses a load of .5 amps at 125 V.D.C. for conservative simulation of working conditions.

(7) Environmental, Operating and Measurement Sequence in Step by Step Detail

The environmental profile to be used is that specified in IEEE standard 382-1972; Figure 1 (see page 4) for qualification for both PWRs and BWRs.

The sequencing of the test is taken largely from section 5.5.2 of draft 2, revision 0, of Draft American National Standard N278.2.1 and is as follows:

Inspect the switch to assure that it has not been damaged by handling subsequent to manufacture. This inspection shall not be directed to select a unit for type testing.

Operate the switch to provide a baseline for comparison with performance at other stages of the test.

Perform environmental and mechanical wear aging simulation.

Perform radiation aging simulation by exposing the actuator to a source of gamma radiation simulating the normal background integrated dose expected over the installed life of the equipment. The radiation due to the LOCA is added at this same point. The total radiation used is 204 megarads of gamma rays from a cobalt 60 source.

Perform seismic safe shut down simulation as follows: Test the actuator as a complete unit. Mount the switch to the shake table fixture in the same manner as it would be attached to a valve. Attach electrical connections to the switch. Accelerometers located at the mounting surface of the switch shall be used to determine the actual input motion. Operate the switch under load before, during and after the tests with sufficient monitoring equipment to verify functional operability. Apply vibratory motion which simulates normal operation.

Perform the remaining design basis event environmental simulation by exposing the actuator to an environment that simulates the design basis event conditions other than those related to radiation or seismic. This includes exposure to appropriate fluids while the temperature and pressure of the environment are controlled in accordance with profiles that simulate accident conditions. The switch shall be mounted in a test chamber prior to initiating the exposure to temperature pressure

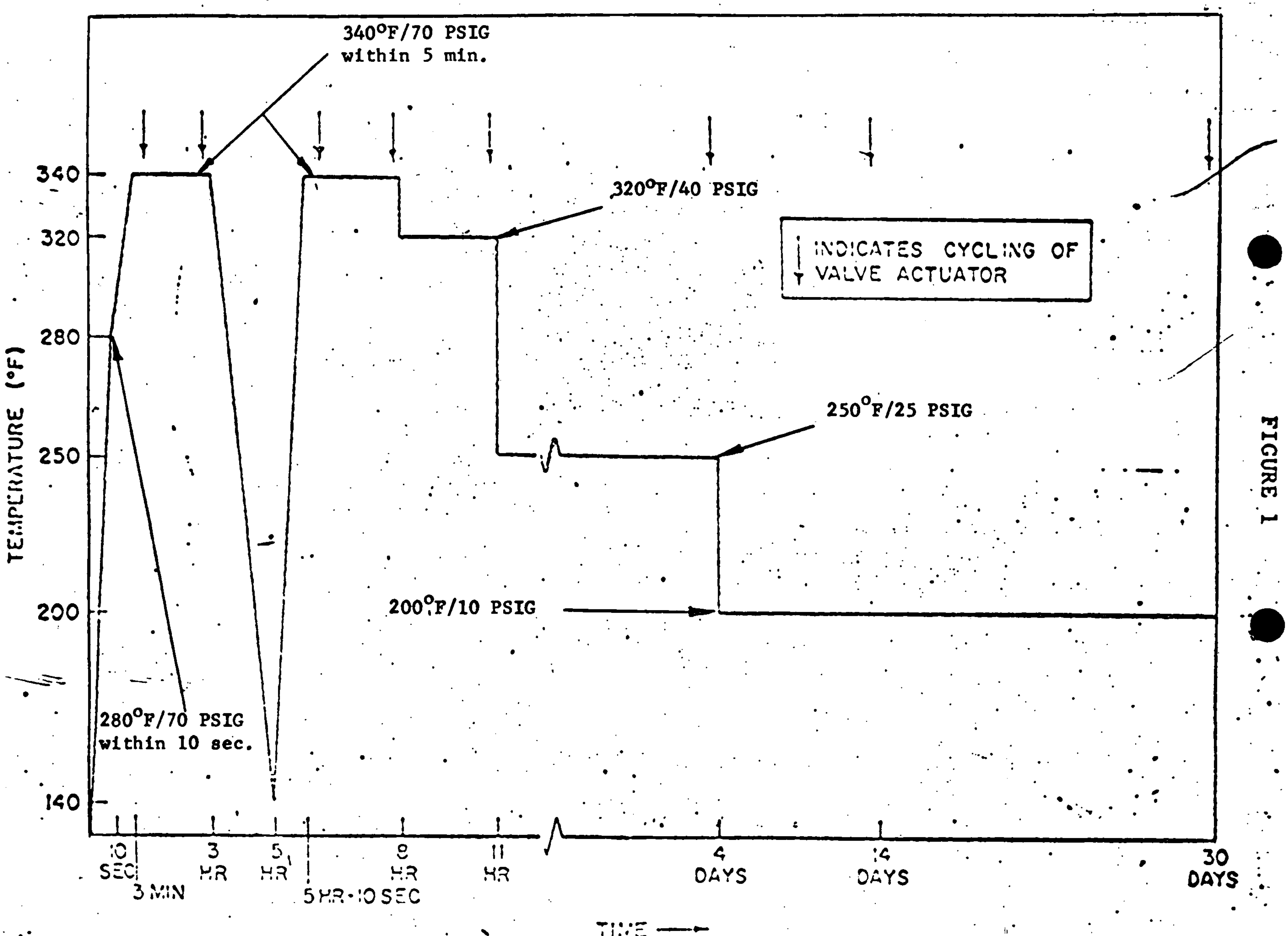


FIGURE 1

Fig 1
Test Chamber Temperature Profile for Accident Environment Simulation

transients. The normal environmental conditions which exist prior to the accident shall be established in the test chamber and the switch shall be operated through one complete cycle. Environmental mechanical, electrical, and auxiliary function parameters shall be measured to provide accident simulation base line data.

The switch shall be operated through a complete cycle twice under accident load conditions at or near the maximum pressure/temperature values. Environmental mechanical and electrical parameters are to be recorded. The switch shall also be operated through a complete cycle at other intervals during the exposure as required to simulate the safety related functions of the actuator. These points are designated by the arrows in Fig. 1.

Dismantle and inspect the switch and record the condition of the switch parts.

(8) Seismic Test Procedure

The seismic standard to be used is IEEE standard 344 of 1975. The absence of cross coupling will be established so that single axis testing may be used.

Part I - Resonance Search

A sine sweep test will be run at a constant 1" displacement below 10 Hz and a constant .01" displacement above 10 Hz. The entire range will be 1 to 35 Hz. The units will be operated during this sweep test. If a resonance is found then that resonant frequency will be included in the frequencies used for sine dwell during the fragility test.

Part II - Fragility Test

This test will be run using the sine dwell method in 1/3 octave bands. Two different pieces of equipment will be used to cover the region from 1 to 10 Hz and the region from 10 to 35 Hz. The equipment used for testing in the region of 1 to 10 Hz has the limitation of a maximum displacement of 12" double stroke. This yields .6 G's at 1 Hz. The equipment will be run at this 12" double stroke up to a minimum of 4 Hz yielding accelerations in excess of 9.52 G's at 4 Hz. The test will then be run at a minimum of 9.52 G's, from 4 to 10 Hz. The test from 10 to 20 Hz will be run at a constant displacement of 0.45" double amplitude. From 20 to 35 Hz the testing will return to a level of 9.52 G's minimum. The trip angle of the switch will be monitored during seismic fragility testing.

During the entire seismic test the equipment will be monitored with appropriate accelerometers and the switches under test will be monitored by a circuit set to detect contact bounce at levels of 2 milliseconds or greater. Electrical loading will be 1/2 amp at 125 volts DC. It should be noted that the 1/2 amp test is, for these purposes, more conservative than the higher rated loads as contact bounce will show up more strongly at the lower loads. Seismic testing will be performed as single axis testing in each of three orthogonal axes parallel to the major dimensions of the switch.

The switch will be subjected to 10^6 vibratory cycles of sinusoidal motion at a non-resonant frequency between 50 and 100 Hz with .75g acceleration to simulate vibration during normal use.

This test is to be run at an outside laboratory which will furnish all appropriate calibration and standardization documents for their equipment.

(9) Performance Limits or Failure Conditions

Failure of the unit is defined as the presence of any or all of the following conditions;

Failure of one or more contact pairs to test as open when the unit is in such a condition that said contacts would normally be open. Failure of one or more contact pairs to test as closed when the unit is in such a condition that said contacts would normally be closed. Shorting of any contact to the unit housing. Shorting of any two contacts which are not of the same pair. The opening of a closed contact for more than two milliseconds during seismic testing only.

In addition to specific failure mode data, the trip angle of the switch, the contact resistance when contacts are closed and the open circuit resistance will be recorded and supplied for customer evaluation.

(10) Documentation

Documentation of results will follow the guide given in draft 3, revision 0, of Draft American National Standard N278.2.1.

It will include:

a. Description of the switches tested including drawings.

b. The equipment type test specifications for the unit selected for testing.

c. The equipment type test sequence used to test the switches.

d. Description of: test facility used, instrumentation used, actuating media that is motive power, test results, summary conclusion and recommendations. Test equipment and instrumentation calibration record references.

e. Description and justification of any adjustment disassembly or alteration other than that identified in the type test specification.

f. Date and signature of responsible person representing the switch manufacturer.

The documentation shall be arranged and maintained by the switch manufacturer in an auditable form.

(11) <u>Statement of Nonapplicable Portions of the Specification</u>

No attempt is made to qualify units for use in high temperature gas cooled reactors. Therefore, Part IV is inapplicable.

(12) A Description of Any Conditions Peculiar to the Equipment Which are Not Covered Above, But Which Would Probably Effect Said Equipment During Testing

None.

Edward L. Solem 8/31/77
Edward L. Solem
Metallurgical Research Engineer

Thomas J. Skingle 8/31/77
Thomas J. Skingle, P.E.
Coordinator, Metallurgical
Research and Development

APPENDIX

EQUIPMENT DESCRIPTIONS

The equipment used to conduct this test falls into three categories. These are:

thermal aging equipment

design basis event simulation equipment

irradiation equipment

Thermal Aging Equipment

A covered container of 18" diameter and 10" depth is used. The switch is supported in the upper half of the container. The lower half of the container is filled with water. Heat is provided by a hot plate and measured by a thermometer in close proximity to the switch.

Design Basis Event Simulation Equipment

The design basis event is simulated within an insulated pressure chamber. An external steam boiler supplies the steam reserve needed to produce the required pressure transients and also provides pressure control for maintenance of constant pressure below 100 psi when required. An internal heater provides auxiliary heating when needed. An external, high pressure pump connects to a spray nozzle mounted in the chamber to provide the specified spray exposure.

The basic pressure chamber is constructed of low carbon steel and insulated with fiberglass and asbestos cement. The insulation is covered with cheesecloth. The chamber is basically cylindrical, having an 8" diameter through most of its length. The interior depth of the chamber is 9".

Attached to the bottom of the pressure chamber is a rectangular box containing a 5200 watt immersion type heating element. Power input to this element is controlled by a Honeywell temperature controller. Water from the main chamber may pass to this box and back through five holes of 3/4" diameter. This element provides reserve heating power during periods of fast warm-up and is the primary heat source during periods of constant temperature.

A 1/2" pipe connects the chamber to a 60 KW electric boiler. Steam from this boiler provides the primary means of both heating and pressurizing the chamber. A solenoid valve in the pipe line between the boiler and the chamber allows for rapid steam entry during transient periods.

A rotary motion feed through is provided in the top of the chamber so that the switch may be actuated while under LOCA test. Switch trip angle is monitored via a scale on the feed through.

A chemical spray is required by the specification. (Table 1, page 12).* The spray system used is basically of the recirculating type, having a spray nozzle at the top center of the chamber, an external pump and a return drain from near the bottom of the chamber to the pump. Two valves are provided between the drain and the pump to allow draining of condensate water from the chamber and addition of fresh chemical spray

*IEEE Standard 382 of 1972.

mixture as needed. This valving also allows for periodic sampling of the spray mixture for verification of chemical analysis.

The pump is a Burks model 3CT5M. It is driven by a 1/3 horsepower electric motor. The pump is connected to the chamber by high pressure hose of stainless steel braid over teflon construction. The spray nozzle is of the flat spray type. It has a .021" orifice and is rated at .05 gallons per minute and 50° coverage at 20 psi. A traceably calibrated Brooks flowmeter is mounted in the spray line.

The switch itself is held by a feedthrough pipe which is screwed into the threaded conduit hole of the switch housing provided for normal wiring connections. This pipe is fed through the chamber wall and sealed with an O-ring fitting, thus allowing maintenance of atmospheric pressure within the switch, observations of fluid leaking to the interior of the housing and feedthrough of switch wiring.

The temperature within the chamber, within 1" of the switch, is monitored with a chromel-alumel thermocouple housed in an Inconel steel tube, the entire assembly having a one second time constant for registering 62.3% of a temperature change. This thermocouple is connected to a solid state digital readout sensitive to $\pm 1^{\circ}F$. This thermocouple system has been calibrated to NBS standards by Marlin Labs. Pressure is monitored via a Marsh type 103 Mastergauge calibrated to NBS standards.

Water level is monitored via a sight gauge in order to insure that the switch is above water and that the immersion heating element is immersed.

A manual exhaust valve is mounted into the top of the chamber for use when it is desired to lower the chamber pressure rapidly and for purging the chamber of air.

A number of features are provided to ensure safe operation of the system. Three present safety valves are included. A 250 psi valve protects the boiler, a 130 psi valve protects the chamber and a 200 psi valve guards the high pressure spray system against nozzle stoppage. In addition, an electrical cutoff is supplied which is convenient to the operating area but does not require close approach to the system for actuation.

The four day, 200°F, 10 psi portion of the LOCA is carried out in a separate chamber of low pressure design. A distilled water spray is used during this portion of the test. This chamber contains a chemical spray and flowmeter arrangement similar to the high pressure chamber. Temperature is monitored via a bimetallic thermometer. Pressure is monitored via a mechanical pressure gauge.

Seismic Equipment

Seismic testing will be performed by an independent laboratory equipment for which they will provide appropriate documentation. Equipment will include single axis shake tables of electrical, hydraulic and/or mechanical design, and recording accelerometers.

Irradiation Equipment

Irradiation will be performed by Atomic Energy of Canada, Ltd. or Isomedix, Inc. using a cobalt 60 source of gamma radiation at the 1.25 Mev. energy level.