ACME-CLEVELAND DEVELOPMENT COMPANY

625 ALPHA DRIVE • HIGHLAND HEIGHTS, OHIO 44143 • (216) 473-0300

QUALIFICATION OF NAMCO CONTROLS LIMIT SWITCH

MODEL EA-180

TO

IEEE STANDARDS 344 ('75), 323 ('74) AND 382 ('72)

Revision 1*

September 5, 1978

*Original dated March 3, 1978

8011060577

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I. CERTIFICATION

The undersigned certify that this report presents a true account of the tests conducted and the results obtained.

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Corporate Manager
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General Manager
Acme-Cleveland Development Company

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Attachment

II. INTRODUCTION

The following tests were carried out at or under contract to Acme-Cleveland Development Company, the research center for Acme-Cleveland Corporation. The switches tested were manufactured by Namco Controls, an Acme-Cleveland Company. The tests were carried out in order to test limit switches to the provisions of IEEE Standards 344 ('75), 323 ('74) and 382 ('72). These standards pertain to Class 1E safety-related equipment for use in nuclear power plants.

The tests consisted of the following parts:

1. Heat aging for 200 hours at 200°F.

2. Mechanical aging for 100,000 actuation cycles under electrical load.

3. Irradiation to a level of 204 megarads of gamma radiation.

4. Seismic testing to a maximum of 9.52 g's in the 1 to 35 Hz range.

5. LOCA testing to a maximum 340°F at 70 PSIG.

III. SAMPLE IDENTIFICATION

From the model EA-180, Type 23, series nuclear switches, one switch with part number EA-180-11302, Rev.-D, was selected for test purposes.

The test facility reference identification number is #61.

In order to verify that the short travel mechanism was not subject to seismic failure, one switch with part #EA-180-14302, Rev. C, was selected for testing through the seismic stage. See Appendix F.

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The test facility reference identification number for this switch was #83.**

IV. TEST PROGRAM

The test program will be presented in the order in which it was performed. Throughout the testing the following equipment was used to determine the performance level of the units.* A megohm meter measured the resistance between contacts when open. A test circuit measured the load current between contacts when closed. This circuit consisted of a 100 volt DC power supply, appropriate voltage and current meters, and a load bank set to pass 86 milliamps in parallel with a small current (6 ma) neon light.

Initial inspection. Open and closed circuit performance was measured and recorded for purposes of providing base line data. These measurements were not used in the selection of switches for test. Normal quality control inspection had been performed prior to shipment.

Heat aging. The heat aging test consisted of holding the unit suspended over water in a tank at a temperature of 200°F for 200 hours.+ A thermometer was placed such that the switch was between it and the heat source. This thermometer was monitored during heat aging. During the time of this test, the conduit opening of the switch was sealed so that the humid air could not penetrate into the switch via this route.

Mechanical aging. The switch was subjected to 100,000 actuation cycles in order to simulate the normal switching

*See Appendix E for calibration dates.
+Heat aging conditions were taken from ANSI Draft Standard N278.2.1 (Draft 3, Rev. 0). The correlation between these conditions and the qualified life is not known.
**Within this report this unit is also referred to as #83-51.

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functions of the unit during its lifetime. The actuation was accomplished by a cam mechanism operating at 70 actuations per minute. The electrical loading during this part of the test was 500 milliamps at 100 volts DC.

Irradiation. Irradiation was performed by Isomedix, Inc. Their certification is contained in Appendix A. Irradiation was carried out to a level of 204 megarads. Gamma radiation from a cobalt 60 source at 1.25 Mev. was used. The irradiation was carried out at a rate of one megarad per hour.

Seismic testing. Seismic testing was performed by Dr. Edward J. Walter and Associates. The complete description of apparatus and procedure is contained in Appendix B. Single axis tests were performed in each of the three axes. The test spectrum used is given in Table I. Note that either acceleration or displacement may be the independent variable.

TABLE I

SEISMIC TEST SPECTRUM (INPUT MOTION)

Frequency	Peak Acceleration	Peak to Peak Displacement
1-4 Hz	0.6-9.52 g's	12 inches
4-10 Hz	9.52 g's	
10-20 Hz		0.45 inches
20-35 Hz	9.52 g's	

Seismic Testing - Cross Coupling. All of the parts and assemblies of which the switch is comprised may be classified into three categories depending upon the geometric constraints upon their movement within the unit. The first category is components free to revolve about an axis but which have balanced angular masses about that axis. The second

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category is components which are free to rotate about an axis within a range the limits of which are 9° to either side of a principal axis of the switch. The third category is parts which are constrained to linear movement in a line which is within 9° of a major axis of the switch.

The contact lever arm assembly (83) is in the first category. As the angular moment of inertia of this component is balanced about the central axis, vibration will not result in any torque about the axis. Therefore, it is not necessary to consider this component in the analysis of cross coupling.

Components belonging to the second category are the lever shaft assembly (94), the latches (19) and the rocker arm (65).

The parts belonging to the third class are the contact carrier plate assemblies which are located at the ends of the contact lever assembly (83) and the roller assembly (75, 80 and 81).

The linear motions of category 3 components except (75, 80 and 81) and the tangential motions of the category 2 components are all within 9° of the Y axis. Therefore, a vibration with a deviation of 9° from the Y axis would cause a higher G loading along the direction of motion of these components than motion directly along the Y axis. Therefore, the G levels used in single axis testing should be multiplied by a factor of .98 (i.e. cosine of 9°) in order to compensate for possible effects due to multi-axis vibration.

Movement of components (75, 80 and 81) is within 9° of the X axis. Therefore, it could cross-couple with the Y axis movements of

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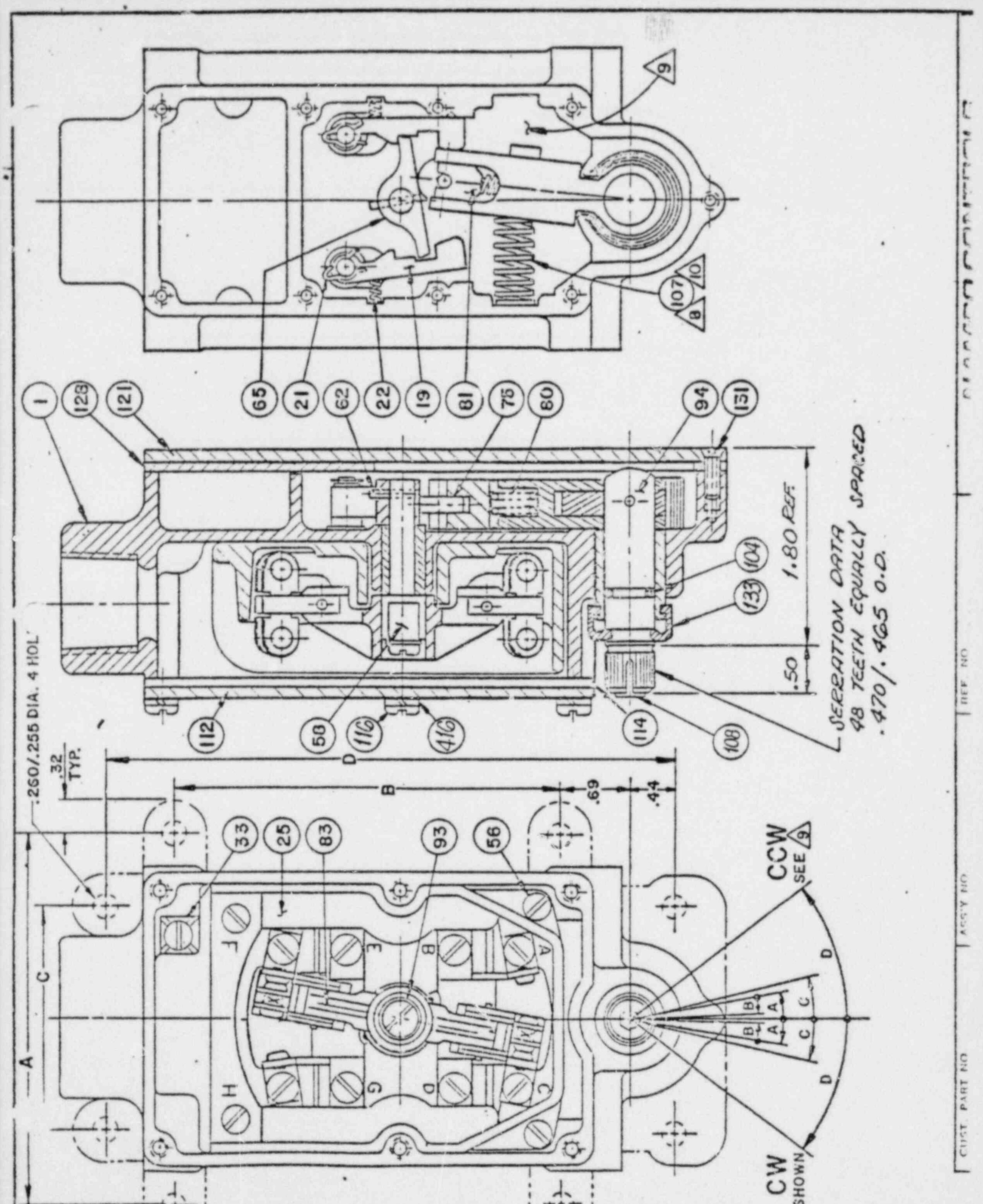
SERRATION DATA
98 TEETH EQUALLY SPACED
.470/.465 O.D.
1.80 REF.
.50
.260/.255 DIA. 4 HOLE
.32 TYP.
CW AS SHOWN
CCW SEE 9
CUST. PART NO.
ASSY NO.
REF. NO.

the other category 2 and 3 components. The X axis movements of (75, 80 and 81) cannot cause any Y axis movements directly. It can, however, allow Y axis movements of (65) and (94). It is shown below that movements of (94) cannot occur at 10 g's due to the preloaded force of spring (107).

A	B	C	D	E	F	G
Preload* Force (107)	Weight of Non-Cylindrical Parts of (94)	Weight of (81)	Total Off Axis Weight (B+C)	Mechanical Advantage	Effective Weight** (DxE)	Minimum g Loading for Movement (A/F)
3,220 gm	53.9 gm	12.9 gm	66.8 gm	2	133.6 gm	24.1 g's

In order to determine that movement of (65) due to cross coupling was not a factor in these tests a separate test was run with components (75, 80 and 81) completely removed.+ This conservatively simulates any cross coupling between components (75, 80 and 81) and (65).

Due to the above considerations cross coupling is not considered limiting in this unit and, therefore, single axis vibration testing is considered suitable.

It can be seen from the data in Appendix B that the switch used in the present qualification was not used in the seismic qualification. Switches #32, 33 and 45 which were included in the seismic testing are internally identical to the switch #61 covered in this present qualification. The only difference between switch #61 and switches 32, 33 and 45 was the material for O-rings, lubrication and gaskets. It was not considered necessary, therefore, to

*Blueprint specified minimum.
**All mass is conservatively assumed to be concentrated at the end of the lever shaft assembly.
+See page 12(B)

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take new seismic data on the present switch.** In order to simulate the condition of a switch which has undergone a seismic event switch #61 was seismically conditioned by subjecting it to all vibrations contained in the seismic tests. Electrical load was applied during these vibrations, however, the performance of the switch was not monitored during this conditioning (see Appendix C).

LOCA Test. The temperature pressure profile for the test is given in Fig. 1*.

The first four days of LOCA testing was performed in a chamber of 12" height and 8" diameter. The switch was mounted in the chamber in a horizontal position such that the lever shaft pointed upwards. The switch was attached by means of a threaded pipe. Teflon tape was used for sealing the pipe threads.+ This pipe ran through an O-ring type feed-through in the chamber. The electrical connections from the switch were run through this same pipe. Actuation of the switch was provided by a rotary feedthrough in the top of the chamber.

In order to produce the portions of the required test which call for pressure below saturation air pressure was applied to the interior of the switch. Air pressure was adjusted so that the differential pressure between the interior and the exterior of the switch was as specified. The test chamber (exterior to the switch) was held at the specified temperature under saturated conditions.

**The switches (32, 33 & 45) which were seismically tested had been subjected to heat aging, wear cycling and irradiation prior to seismic testing. See Appendix G.

*The recorded pressure temperature data is presented on pages 8-11(D).

+No attempt is made to qualify the connection method. These test procedures are based on the assumption that the user will ensure that no steam enters the unit via this connection during an actual LOCA.

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The switch was subjected to a caustic spray during this portion of LOCA test. The flow rate of the spray was 230 cc's per minute providing the necessary coverage of .015 gallons per minute per square foot of cross-section. The pH of the spray was maintained between 10 and 11. The spray was composed of boric acid, water, sodium thoiosulfate and sodium hydroxide, and was recycled during the entire time. Spraying was initiated following the second transient temperature rise.

The switch was transferred from the high pressure chamber to a low pressure chamber following the first four days of the LOCA test. It remained in this low pressure chamber for the rest of the 30 day LOCA period. During this part of the test the switch was sprayed with distilled water which was continuously recycled.

Two data acquisition methods were used during the LOCA. The temperature was recorded on a strip chart recorder via a thermocouple. During the transient sections of the LOCA the digital readout from the thermocouple, as well as the reading of the pressure gage, were recorded on video tape. The data is recorded on scenes 611 and 612 of this tape which is on file in the library of Acme-Cleveland Development Company.

The switch was actuated ten times during the peak level of the second transient of the LOCA and at other times as noted in Fig. 1. Data were taken twice during the second peak level and at the conclusion of the test.

V. RESULTS

During all phases of the test, the open contact resistance of the switch remained above 50 kilohms. The closed

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circuit current remained within two milliamps of the specified load. During seismic testing, the trip point (with 1-1/2 inch arm) varied by .107" or less* for all units seismically tested.

Detailed performance data are presented in Appendices B, D and F.

VI. CONCLUSIONS

Switch #61 representing revision level D of model #EA-180-11302 maintained a 50K Ω open circuit resistance with all other performance satisfactory during all sections of the test.

Switch #83 representing revision level C of model #EA-180-14302 maintained trip position within .107" of original with all other performance satisfactory throughout all sections of the test performed on it.**

The tests were carried out from June of 1977 to January of 1978.

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March 3, 1978

*.0625" for standard travel switches.

**See Appendix F.

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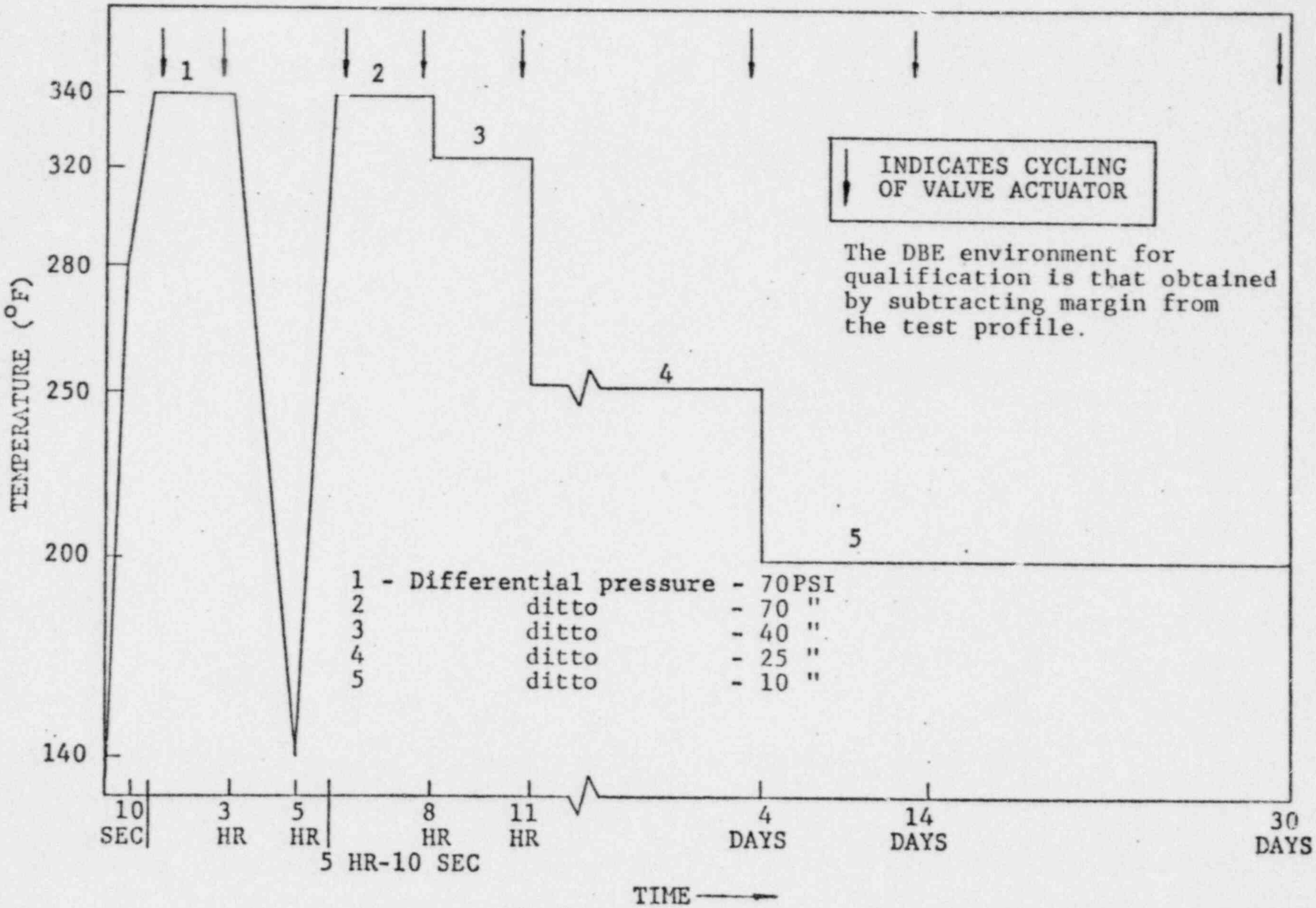

Fig 1

Test Chamber Temperature Profile for Accident Environment Simulation

VII. APPENDICES

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APPENDIX A

Irradiation

ISOMEDIX

November 9, 1977

Mr. Edward L. Solem
Metallurgy Engineer
Acme-Cleveland Development Co.
625 Alpha Drive
Highland Heights, Ohio 44143

Dear Mr. Solem:

This will summarize parameters pertinent to the irradiation of two switches per your Purchase Order of October 12, 1977. The units were identified as switches 59 and 61.

The units were placed in a Cobalt-60 gamma field such that the dose rate was .7 Mrad/hr. The units were exposed for 291.5 hours, yielding a minimum dose of 204 megarads.

The samples were rotated and turned during exposure to obtain the most even dose distribution. Irradiation was conducted in air at ambient temperature and pressure. Radiant heat from the source heated the samples somewhat, but the temperature did not exceed 110°F as indicated by previous measurements on an oil solution in the same relative position.

Dosimetry was performed using an Atomic Energy of Canada, Ltd. (AECL), Red Perspex system with Type BC-2 readout. Calibration of the Perspex is made by AECL using Ceric dosimetry traceable to the U.S. National Bureau of Standards. Isomedix regularly cross-calibrates its AECL system with an inhouse Harwell Perspex system, and makes semi-annual calibrations directly with NBS, using the NBS Radiochromic Dye system. A copy of the dosimetry correlation report is available upon request.

Irradiation was initiated on October 7, 1977 and completed on October 24, 1977.

Very truly yours,

Jonathan C. Young

Jonathan C. Young
Production Manager

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APPENDIX B

Seismic Tests

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