POWER AUTHORITY OF THE STATE OF NEW YORK

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CONTROLLER

June 28, 1979
JPN-79-37

Director of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Thomas A. Ippolito, Chief
Operating Reactors Branch No. 3
Division of Operating Reactors

Subject: James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
Reactor Protection System Power Supplies

References: 1) USNRC letter of August 7, 1978
2) Power Authority letter JNRC-78-49 of October 6, 1978

Dear Sir:

This letter transmits to you one copy of General Electric's letter G-EP1-9-6 of February 23, 1979 with attachments, which documents the results of an analysis performed on a typical GE Reactor Protection System (RPS) Motor-Generator Set protective circuit. It contains a Failure Modes and Effects Analysis (FMEA) conducted to identify what potential failure modes can have adverse effect on RPS performance and the results of tests performed to quantify the seismic performance of equipment typical of that existing in operating plants.

The Authority considers that the reasons given in its' letter JNRC-78-49, of October 6, 1978 plus the results of the attached GE analysis constitute overwhelming proof and justification for its position, expressed in the above mentioned JNRC-78-49, that no modifications to the protection system power supplies are required and that the interim surveillance program (set forth in Attachment 1 of the USNRC letter of August 7, 1978) still in effect in our JAFNPP, can be discontinued.

The Authority, therefore, respectfully requests that the Commission recognize that the JAFNPP Reactor Protection System Power Supplies can be safely operated as presently installed with

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no modifications or further qualifications being necessary and that the presently implemented interim surveillance program can be discontinued without undue risk to the health and safety of the public.

Very truly yours,

Paul J. Early
Assistant Chief Engineer-Projects

Subscribed and sworn to before
me this 28 day of June, 1979

Notary Public

RUTH C. ZAPF
Notary Public, State of New York
Commission Expires March 30, 19

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GENERAL ELECTRIC

INSTALLATION AND SERVICE ENGINEERING DIVISION

GENERAL ELECTRIC COMPANY 3532 JAMES STREET P.O. BOX 4841 SYRACUSE, NEW YORK 13221. Phone (315) 456-7321

February 23,1979
G-EP1-9-6

Mr. J.D. Leonard, Jr.
Power Authority of the State of New York
P.O. Box 41
Lycoming, New York 13093

SUBJECT: REACTOR PROTECTION SYSTEM POWER SUPPLY PROTECTIVE CIRCUIT ANALYSIS

Dear Mr. Leonard:

This letter is to document the results of an analysis performed on a typical Reactor Protection System (RPS) Motor-Generator Set protective circuit. A Failure Modes and Effects Analysis (FMEA) was conducted to identify what potential failure modes can have an adverse effect on RPS performance. A test specimen was fabricated and tested to quantify the seismic performance of equipment typical of that existing in operating plants.

For background, during the review of the Hatch 2 operating license application in June, 1978, the NRC postulated certain deficiencies in the design of the protective circuits of the motor-generator (M-G) sets which supply power to the RPS as follows:

(1) there were potential undetectable single component failures which could adversely affect the operability of RPS; and

(2) there is a postulated sequence of component malfunctions, initiated by an earthquake, which could adversely affect the operability of the RPS.

Hatch 1 and 2 were directed to implement a NRC approved, Class 1E system, capable of de-energizing the RPS power supplies when their output exceeds or falls below limits within which the equipment, being powered from the power supplies, has been designed and qualified to operate continuously and without degradation. Further, an exemption was granted to delay implementation of the equipment until the next refueling outage of Hatch 1, and until the end of the first operating

cycle for Hatch 2. Finally, Hatch 1 and 2 were directed to implement additional surveillance requirements to monitor for potential single component failures until installation of the aforementioned Class 1E system.

Letters were sent to other operating plants imposing identical surveillance requirements and requesting an evaluation of their RPS power supply protective circuits in light of the Hatch 2 Safety Evaluation Report. General Electric initiated a generic quantification program to evaluate a typical RPS Motor-Generator Set Protective Circuit.

The program was conducted in two phases using the circuit defined by Attachment 1; (1) a Failure Modes and Effects Analysis (FMEA), where hypothesized single and common mode failures are analyzed and; (2) a seismic performance evaluation test where a test specimen was tested under simulated seismic conditions on a shaker table. The part numbers of the components used are as follows:

Description	GE Part Number
Over-Voltage Relay	3300A03B0918
Under-Frequency Relay	3300A84A2284-005
Circuit Breaker and Under Voltage Relay	3300A84A0005-118

The FMEA was a combined effort between General Electric's Nuclear Energy Business Group Availability Engineering Operation and the Small A.C. Motor Products Department, which designed and manufactured the Motor-Generator Set. The FMEA summary concludes that the risk of an RPS failure with the present design is sufficiently low and acceptable. The entire letter is included as Attachment 2.

The seismic performance test was performed by Wyle Laboratories to General Electric specifications (Attachment 3). The test summary concludes that the specimen demonstrated sufficient integrity to withstand the prescribed simulated seismic environment without compromise of structure or electrical functions. The entire test summary is included as Attachment 4.

In conclusion, the results of this quantification program are in consonance with our previous position, which remains that no modification to the RPS system should be required.

Very truly yours,

E.R. Eggen
Service Manager-Nuclear

ERE/SLG/slf

Attachments

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Attachment 1

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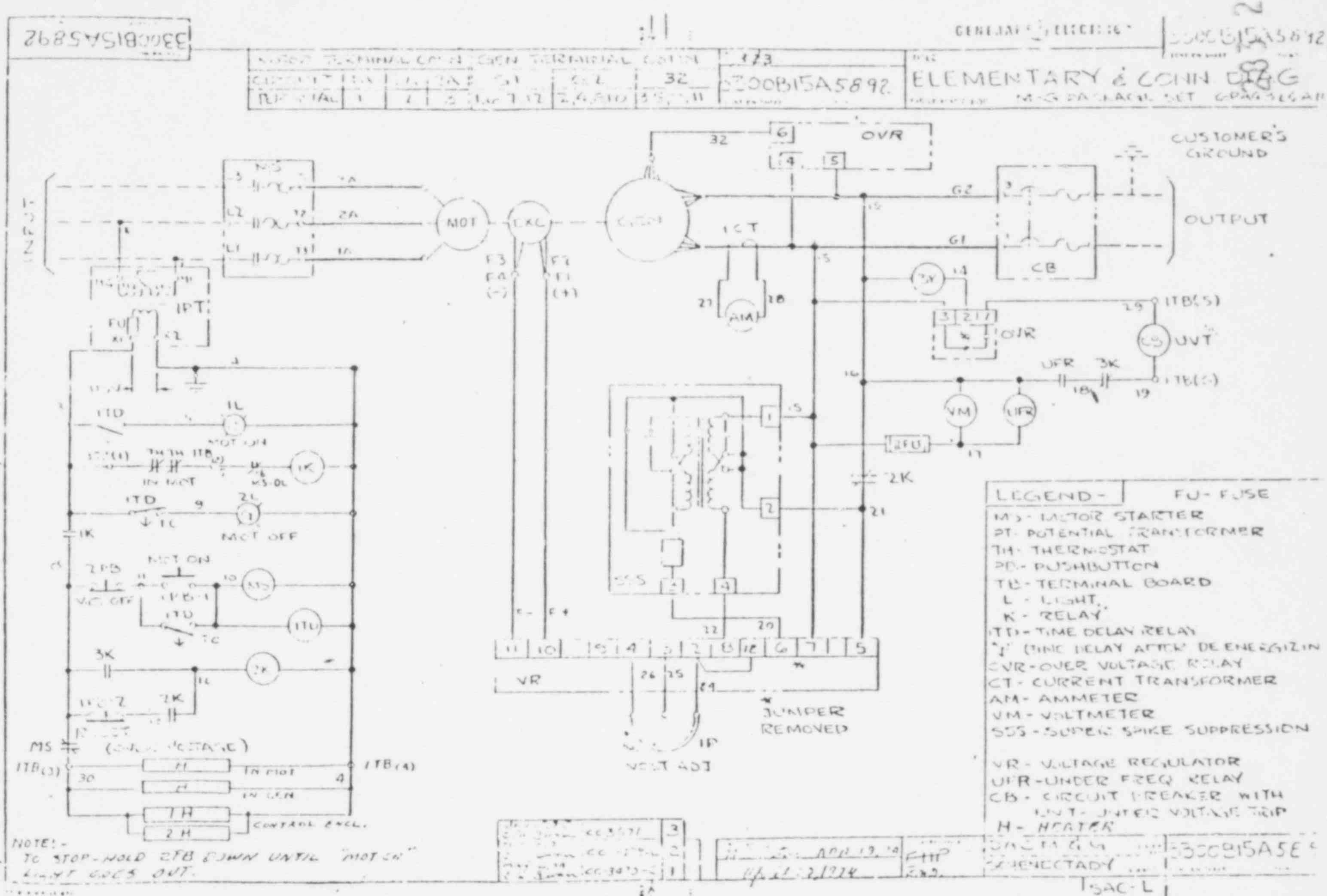

ATTACHMENT 2

Nuclear Energy Engineering Division
San Jose, California

February 1, 1979
Revision 1

cc: D.L. Allred, R.J. Bogisich, R.J. Brandon, R.O. Brugge, T.Y. Fukushima, J.F. Kilty, M.R. Lane, R.J. McCandless, K.R. Miller, E.H. Perkins, G.C. Ross, R.A. Siemer, B.A. Smith, D.L. Wilmer

S.L. Gummersall
M/C 888

Subject: EWA EAC93-4N, DRF C71-11
Reactor Protection System (RPS)
M/G Set Protective Circuit Failure
Mode and Effects Analysis (FMEA)

A. Introduction

Each of the two Motor/Generator (M/G) sets has its own protective circuit. The purpose of this protective circuit is to protect relays and components of the RPS bus loads against a failure of the M/G set regulator to maintain its output within the specified tolerances. An FMEA was conducted to identify what potential failure modes can have an adverse effect on RPS performance. This FMEA is a qualitative reliability tool for investigation of every possible outcome, regardless how improbable it is.

B. Summary of Conclusions

It is unlikely that the M/G set protective circuit will fail to perform its function. It is also unlikely that after this failure, a severe earthquake will occur and damage the M/G set in such a way that the resulting over/under voltage and underfrequency output will have the potential of damaging relays and components of the RPS bus loads.

However, even if the above very unlikely scenario occurs, there is only a very small probability that the plant will not be automatically or manually scrammed before relays and components of the RPS bus loads are disabled, and that this damage of the M/G output deviation will remain undetected until the next demand for a scram.

Therefore, because the combined probability of the above chain of events that leads to an RPS failure is negligible, the risk of an RPS failure with the present design is sufficiently low and acceptable.

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C. Discussion

The attached FMEA is self-explanatory. It is divided into two parts: a single failure analysis and a common mode analysis (i.e., a seismic event immediate effect). A possible failure mode for each item is listed on the left side and the cause and the estimated probability for each mode is listed on the right side. Given that these single failures have occurred, the plant safety and availability implications are also listed with estimated probability and seriousness rating. Although some of the postulated single failures can disable the protective circuit, it is unlikely that the protective circuit will fail during the reactor life. The circuit is in a protected environment and static condition during the M/G set operation, without any mechanical, electrical or thermal stresses or frequent cycling. In fact, the protective circuit breaker is rarely tripped. It is tripped only when the M/G set is tripped, due to lack of off-site power or for an annual maintenance. This light duty cycle is considerably smaller than what the circuit is designed for. The FMEA also reveals that a seismic event may only cause an inadvertent scram (failure in the safe direction). The protective circuit has overvoltage and underfrequency relays. The undervoltage trip protection is incorporated in the circuit breaker itself. The accuracy and repeatability of these relays is superior to the undervoltage trip. However, when the M/G coasts down, the circuit breaker trips due to underfrequency, since the regulator continues to maintain the voltage level.

Even if the protective circuit function fails, it will not have any effect unless the respective M/G voltage and frequency regulator also fails. Although to date the M/G set has not officially been qualified for a seismic event, the regulator failure is unrealistic and unlikely. For a combined M/G regulator and protective circuit function failure to cause an adverse effect on RPS components, the M/G has to continue to run for a long time while providing over/under voltage or under-frequency outside the specified limits. An M/G regulator failure is being postulated as a result of an unlikely severe earthquake. But even then, it is unrealistic that this earthquake can change the voltage regulator setting so that it may cause a significant damaging effect on the RPS function. It is also unrealistic to consider a continuous underfrequency condition because the M/G induction motor will probably overheat, if forced to run at a low frequency. It will probably trip on overcurrent or burn out long before any damage to the RPS can be postulated. But even if it is postulated that due to a severe earthquake, the regulator voltage setting can change, the Neutron Monitoring System (NMS) will trip the reactor on appreciable undervoltage or overvoltage conditions. An overvoltage will also probably burn out the M/G indicator lights in the control room before causing heat damage to RPS relays and coils. In addition, a considerable voltage reduction will cause the RPS logic relays and scram contactors to drop out and trip the reactor. Assuming that the unlikely M/G regulator failure is postulated due to a severe earthquake, it is unlikely that this failure will remain undetected for a long time. There is only a small

probability that the plant will not be automatically or manually scrammed after a severe earthquake and before the Class 1E RPS components are damaged. It is also unlikely that following a severe earthquake, the RPS circuits and the M/G protective circuit will not be checked. Therefore, the probability that the above very unlikely scenario (of protective circuit functional failure, M/G failure and no immediate scram or checks) will occur before the reactor has to scram upon demand (due to a transient) is negligible and the risk is sufficiently low and acceptable.

A. A. Strod
Safety System Reliability
Availability Engineering
MC 166, X56994

Verified by:
R. A. Siemer, LSE
Reactor Trip System

D. L. Wilmer, LSE
Neutron Monitoring System

Qualification Notes:

1. The protective circuit was designed by General Electric Small AC Motor Department. Availability Engineering performed the FMEA, based on the designer's qualitative inputs and the designer approved the attached final version.

2. The operating plants data base is not large enough to support the unlikely protective circuit failure claim.

3. This FMEA applies only to plants with an M/G set and a protective circuit similar to the one described by General Electric drawing 3300B15A5892, Rev. 3.

4. This FMEA assesses the M/G set and protective circuit design capability versus General Electric requirements.

Attachment
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Attachment 3

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GENERAL ELECTRIC

NUCLEAR ENERGY DIVISION

REVISION STATUS SHEET

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CONT ON SHEET 2 SH NO. 1

DOCUMENT TITLE SEISMIC QUANTIFICATION OF RPS MOTOR-GENERATOR PROTECTIVE CIRCUIT COMPONENTS

☒ SPECIFICATION ☐ DRAWING ☐ OTHER ______ TYPE TEST SPECIFICATION

FMF BWR 3-4-5-6

LEGEND OR DESCRIPTION OF GROUPS

MPL No. N/A

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1. SCOPE

1.1 The purpose of this test specification is to define the test requirements necessary to quantify the seismic performance of the Reactor Protection System (RPS) Motor-Generator (MG) set under and over voltage and under frequency protective circuit components.

2. APPLICABLE DOCUMENTS

2.1 General Electric Documents. The following documents form a part of this specification to the extent specified herein.

2.1.1 Supporting Documents

a.	Test Mockup, RPS-MG Set Protective Circuit	829E576
b.	Seismic Qualification Procedure for Class IE Electrical Equipment	22A4320
c.	MG Set Outline	3300C11A3272

2.2 Codes and Standards

a. Institute of Electrical and Electronic Engineers (IEEE) IEEE 344-1975 Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations

3. REQUIREMENTS

3.1 The mockup test circuit (Reference 2.1.1.a) which includes the active components that make up the RPS MG set over and under voltage and under frequency protective circuit will be seismically exercised to evaluate the ability of the components to function during adverse operating conditions.

3.2 The test mockup will be stimulated to the requirements listed below and the acceleration response spectrum shown in Figure 1.

a. Frequency: 1 to 33 Hz

b. Acceleration: ∿ 0.2 to 7 g

c. Directions
   (1) Dual Axis (Vertical and Horizontal)
   (2) Dual Axis (Vertical and Horizontal Rotated 90°, 180°, and 270°.)

3.3 The input to the test mockup will be adjusted to trip conditions for each operating parameter and the output w 'l be monitored during each of the seismic conditions.

3.4 After seismic vibration evaluation has been completed under the test conditions outlined in Paragraphs 3.2 and 3.3, and if no failure is encountered, a vibration fragility test will then be performed to determine the maximum seismic conditions under which the protective components of the RPS MG set can function.

3.5 Special note should be made that the mockup housing is not similar to the actual instrument enclosure on the MG set. The intent of this test is to evaluate the circuit components located in a mounting orientation similar to their true positions, regardless of the performance of the enclosure. This test will not attempt to determine the natural frequency of individual components; however, an attempt will be made to determine any mockup resonances between 1 and 50 Hz to stimulate worse case operating conditions during fragility tests.

4. TEST PROCEDURE

4.1 Test Setup

4.1.1 Mount the RPS MG Set Protective Circuit mockup on the seismic shaker table in a manner that simulates mounting on the motor generator set. Refer to Reference 2.1.1.c for actual instrument panel configuration.

4.1.2 Connect the input of the mockup to test equipment that is capable of providing under and over voltage and under frequency trip conditions.

a. Nominal Voltage 115 V

b. Nominal Frequency 60 Hz

c. Over Voltage 126.5 V

d. Under Voltage 103.5 V

e. Under Frequency 57 Hz

4.1.3 Connect the output of the mockup to an analog strip chart recorder that also contains a time reference signal and accelerometer signals from the shaker table and mockup chassis.

4.2 Proof Tests

4.2.1 Natural Frequency Exploratory Test. The mockup shall be subjected to a continuous sinusoidal vibration over the frequency range of 1 to 33 Hz at an acceleration level of ≈ 0.5 g in each one of the 4 (Reference Paragraph 3.2.c) test axes. If any resonances are detected, they shall be recorded. If no reasonances are detected, increase the frequency to 50 Hz or until the first resonance is detected, whichever comes first. Sweep rate shall be one octave per minute.

4.2.2 Random Vibration Test

4.2.2.1 The mockup shall be seismically stimulated at random frequency and "g" levels shown in the acceleration response spectrum in Figure 1, and the directional requirements listed in Paragraph 3.2.

4.2.2.2 Functional trips for over and under voltage and under frequency shall be stimulated at test increments.

4.2.2.3 The mockup output shall be recorded on the analog strip chart recorder for each test sequence. Data signals and test parameters shall be appropriately identified on the recording paper.

4.3 Fragility Test. The vibration fragility test will be performed as a function of frequency by increasing the acceleration level at resonant frequencies detected in Paragraph 4.2.1, if any, or at 33 Hz, until a nondestructive malfunction, such as a false trip or failure to respond to a valid trip signal, is observed. The over and under voltage and under frequency trips shall be exercised during the test.

5. ACCEPTABILITY

5.1 Quantification of the RPS MG Set protective components' operational characteristics in a seismic environment, regardless of their performance, provides the basis of test acceptance.

6. TEST EQUIPMENT

6.1 All test equipment used in support of this test shall be in current calibration that is traceable to National Bureau of Standards.

7. DOCUMENTATION

7.1 A comprehensive test report shall be prepared. The following items are to be included under appropriate headings:

a. Description of the test setup, including the shaker table, electrical stimulation, sensors, recording, and test equipment.

b. Test results, including recorder strip chart traces.

c. Photographs of test setup and any components that encounter destructive failure.

d. Any additional information that the tester feels is pertinent to evaluation.

GENERAL ELECTRIC
NUCLEAR ENERGY DIVISION

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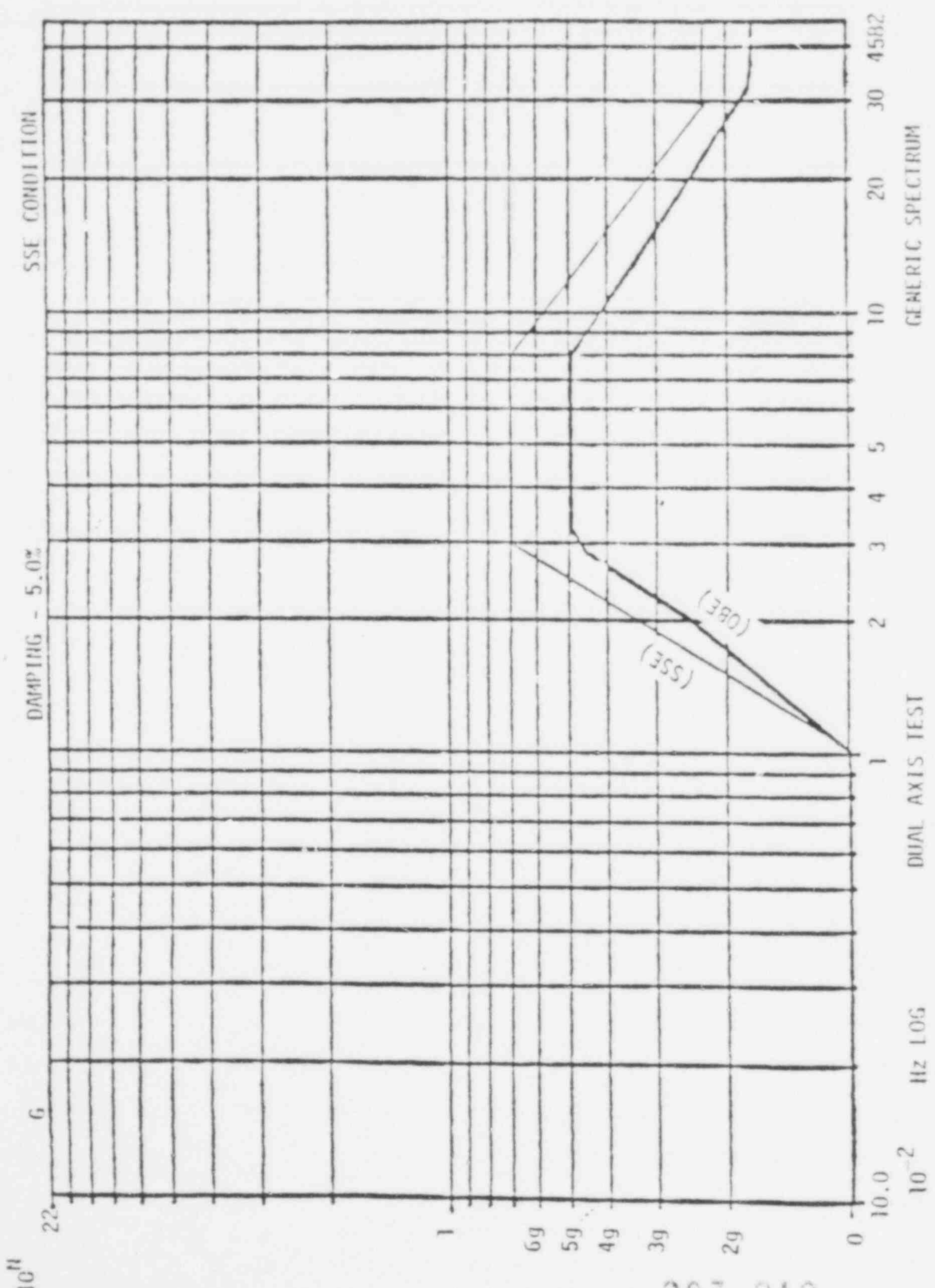

FIGURE 1 ACCELERATION RESPONSE SPECTRUM

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WYLE LABORATORIES

December 29, 1978

General Electric Company
175 Curtner Avenue
San Jose, CA 95125

Attention: Mr. Ken Miller, M/C 889

Subject: GE Purchase Order No. 205-XC393

Reference: 1. Wyle Laboratories Job No. 44092
2. Wyle Laboratories Test Procedure 541/1157/DK

Gentlemen:

The under and over voltage and under frequency protective circuits, mounted in a mockup test panel, were subjected to a simulated Seismic Test Program as required by the General Electric Purchase Order 205-XC393 and Wyle Laboratories' Seismic Test Procedure No. 541/1157/DK, Revision A. This test program was completed on December 28, 1978.

The Seismic Qualification Test Program consisted of random multifrequency testing in each of four test orientations. The specimen was instrumented with accelerometers, electrically powered, and monitored for functional operation during the test program.

The specimen demonstrated sufficient integrity to withstand, without compromise of structure or electrical functions, the prescribed simulated seismic environment.

Upon completion of the qualification level testing the specimen was subjected to Fragility Level (Sine Dwell) Testing in each of four test orientations. Fragility levels were established in each test orientation as follows:

Orientation	Fragility Level (g)	Frequency (Hz)
SS/V (+)	3.6	45
SS/V (-)	3.4	45
FB/V (-)	3.4	45
FB/V (+)	3.2*	45

* Overvoltage relay malfunctioned approximately two (2) seconds into test. The main breaker could not be re-set and testing was terminated.

EASTERN OPERATIONS
7800 Governors Drive West
Huntsville, Alabama 35807
837-4411 Area Code 205
TWX 810-726-2225

The Fragility Levels shown are the highest test level attained at which no malfunctions occurred.

Sincerely,

WYLE LABORATORIES
Huntsville Facility

Dawn King (Ms.)
Contracts Administrator

for Herschel Jordan
Manager, Seismic Projects

cc: Mr. Ken Rooney, M/C 728