ACCELERATED DISTRIBUTION DEMONSTRATION SYSTEM

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9104190314 DOC.DATE: 91/04/15 NOTARIZED: NO DOCKET #
FACIL:50-387 Susquehanna Steam Electric Station, Unit 1, Pennsylva 05000387
50-388 Susquehanna Steam Electric Station, Unit 2, Pennsylva 05000388
AUTH.NAME AUTHOR AFFILIATION
KEISER,H.W. Pennsylvania Power & Light Co.
RECIP.NAME RECIPIENT AFFILIATION
BUTLER,W.R. Project Directorate I-2

see RA

SUBJECT: Forwards Franklin Research Ctr Rept P238, "Electrical Fault Testing of Class 1E Isolators." Rept documents successful completion of acceptance testing for Technology Energy Corp & Validyne models.

DISTRIBUTION CODE: A048D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 10+225
TITLE: OR/Licensing Submittal: Equipment Qualification

NOTES:LPDR 1 cy Transcripts. 05000387
LPDR 1 cy Transcripts. 05000388

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD1-2 LA	1	0	PD1-2 PD	1	0
	RALEIGH,J	1	1			
INTERNAL:	ACRS	6	6	NRR/DET/EMEB 7E	1	1
	NRR/DET/ESGB 8D	1	1	OC/LFMB	1	0
	OGC/HDS2	1	1	REG FILE 01	1	1
	RES/DSIR/EIB	1	1			
EXTERNAL:	NRC PDR	1	1	NSIC	1	1
NOTES:		2	2			

R I D S / A D D S

NOTE TO ALL "RIDS" RECIPIENTS:

PLEASE HELP US TO REDUCE WASTE! CONTACT THE DOCUMENT CONTROL DESK, ROOM P1-37 (EXT. 20079) TO ELIMINATE YOUR NAME FROM DISTRIBUTION LISTS FOR DOCUMENTS YOU DON'T NEED!

TOTAL NUMBER OF COPIES REQUIRED: LTTR 19 ENCL 16

R I D S / A D D S

PP&L Pennsylvania Power & Light Company

Two North Ninth Street • Allentown, PA 18101-1179 • 215/774-5151

Harold W. Keiser
Senior Vice President–Nuclear
215/774-4194

APR 15 1991

Director of Nuclear Reactor Regulation
Attention: Dr. W. R. Butler, Project Director
Project Directorate I-2
Division of Reactor Projects
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
CLASS 1E/NON 1E ISOLATION : ISOLATOR
TEST REPORT
PLA-3564 FILES R41-2, A28-3B

Docket Nos. 50-387
and 50-388

Dear Dr. Butler:

Attached are copies of Franklin Research Center's report, "Electrical Fault Testing of Class 1E Isolators", and Pennsylvania Power & Light Company's report, "Electrical Fault Testing of Class 1E Isolators." These reports document the performance of type testing of several different devices used as Class 1E to non-Class 1E isolators at Susquehanna SES. The models tested were Technology for Energy Corporation (TEC) models 156A and 156D analog signal isolators, Validyne model CM249 Carrier/Modulator card, and Bailey model 740 millivolt converter.

All of the models tested are suitable for use as Class 1E isolators. Franklin Research Center's report documents the successful completion of acceptance testing for both the TEC and the Validyn models. The Bailey Millivolt Converter successfully passed all non-energized tests, all common mode tests, and the DC transverse tests. It failed the AC transverse tests by allowing propagation of a noise pulse greater than permitted by the acceptance criteria. After evaluating the anomalies noted during the test with regard to the Susquehanna SES requirements, it is determined that the Bailey model 740 Millivolt Converter is acceptable for use as a Class 1E isolator.

Very truly yours,

H. W. Keiser

H. W. Keiser

Attachments

A048
1/1

cc: Document Control Desk (original)
NRC Region I
Mr. G.S. Barber, NRC Sr. Resident Inspector
Mr. J.J. Raleigh, NRC Project Manager

PP&L	ENGINEERING STUDIES, ANALYSES, AND EVALUATION COVERSHEET	QUALITY LEVEL	ER/CTN NO. 741119
		☒ SAFETY	SEA NO. JNPE-225
		☐ ASME	DCP NO. N/A
		☐ OTHER	
		☐ NON QUALITY	PAGE 1 OF 8

Electrical Fault Testing of Class IE Isolators

REVISION NO.	DATE	PREPARED BY	REVIEWED/VERIFIED BY	APPROVED BY
0	4/11/91	T. J. Wright	John P. Akus 4/11/91	D. J. [illegible] 4/12/91

1.0 OBJECTIVE:

This report examines the results of the Class 1E Isolator Testing that was performed by Franklin Research Center (FRC), and evaluates the significance of the observed anomalies against specific SSES requirements. The purpose and scope of the project was to perform type testing of several different devices used as Class 1E to non-Class 1E isolators at Susquehanna SES. The models tested were Technology for Energy Corporation (TEC) models 156A and 156D analog signal isolators, Validyne model CM249 Carrier/Modulator card, and Bailey model 740 millivolt converter.

2.0 CONCLUSIONS AND RECOMMENDATIONS:

All of the models referenced above are suitable for use as Class 1E isolators. FRC Report P238, Electrical Fault Testing of Class 1E Isolators, documents the successful completion of acceptance testing for both the TEC and the Validyne models. The Bailey Millivolt Converter successfully passed all non-energized tests; all common mode tests, and the DC transverse tests. It failed the AC transverse tests by allowing propagation of a noise pulse greater than permitted by the acceptance criteria. After evaluating the anomalies noted during the test with regard to SSES requirements, it is determined that the model 740 Millivolt Converter is acceptable for use as a class 1E isolator.

3.0 REFERENCES:

A. FRC Report P238, Electrical Fault Testing of Class 1E Isolators.

B. PP&L Technical Specification J-1077, Rev. 0, Electrical Fault Testing of Class 1E Isolators. Also by included by reference are:

1. IEEE Standard 279-1971, Criteria for Protection Systems for Nuclear Power Generation Stations.
2. IEEE Standard 384-1981, Criteria for Independence of Class 1E Equipment and Circuits.
3. IEEE Standard 472-1974, IEEE Guide for Surge Withstand Capability (SWC) Tests.

C. SEA-JNPE-150, Rev. 1, Isolation capabilities of BOP Isolators.

D. PP&L Calculation J-CRR-245, Rev 0, A Determination of a Nominal Loop Accuracy of All NSSS Analog Loops.

E. PP&L Service Order S-03449-5, Contract with Franklin Research Center to perform testing in accordance with PP&L Specification J-1077.

F. Engineering Work Request M00322, Testing of Electrical Isolators.

G. US NRC Reports 50-387/90-06 and 50-388/90-06.

H. Letter from Tony Franklin of TEC to T. J. Wright of PP&L dated 2/27/91 regarding similarity of various TEC model isolators.

I. Installation and Service Manual, 4574K10-100, for Type 740 Millivolt Converters.

4.0 ASSUMPTIONS/INPUTS:

The following documents form the Design Basis of this report and meet the definition of Design Inputs as required by EPM-QA-207. Additional Inputs as defined by EPM-QA-208 are not required.

A. The PP&L commitment to perform testing of isolators as referenced in the Combined Inspection Report 50-387/90-06 and 50-388/90-06 provides the basis and motivation for this project.

B. SEA-JNPE-150, Rev. 1 documented the need for additional testing of the TEC, Validyne, and Bailey isolators. That evaluation was the basis for the selection of the models to be tested by FRC.

C. SEA-JNPE-150 also documented the definitions, terms and credible fault voltages used as the basis for preparation of Specification J-1077.

D. Representative samples of isolator models procured to the same specification as those used at Susquehanna Steam Electric Station were tested. This criterion was established to ensure similarity between the models tested and those installed in the plant.

5.0 METHOD:

A. FRC report P238 was reviewed for adherence to the Franklin QA test procedure and PP&L Service order S-03449-5.

B. Anomalies were evaluated against both the acceptance criteria included in the FRC QA test procedure and the supporting documentation containing the design basis criteria for the Electrical Fault Test Specification.

6.0 RESULTS:

FRC Report P238 documents the results of Electrical Fault Testing of three different isolator models. The models tested were Validyne model CM249 Carrier/Modulator, TEC models 156A and 156D Analog Signal Isolators, and Bailey model 740 Millivolt Converter. A detailed description of the results for each of those models is presented below. Unless otherwise noted, all of the energized tests were performed for the full time specified in the QA test procedure. No external power fuses were consumed by the testing.

6.1 Validyne model CM249

The Validyne model CM249 was tested in accordance with the QA test procedure and successfully passed all acceptance criteria. No anomalies were noted. As stated in the final report, the devices ceased to function as signal processing units after being subjected to the energized transverse fault mode, however, the units satisfactorily functioned as isolation devices by not allowing the fault to propagate to the 1E side.

6.2 TEC models 156A and 156D

Two different models of the TEC Analog Signal Isolators were tested. The 156A has an input range of 1-5 Volts DC and the 156D has an input range of 4-20 mA DC. Both models have an output range of 4-20 mA DC. As identified in the FRC test report, the two models were considered equivalent for the performance of the fault testing. This assumption was based on conversations with the Manager of Nuclear Product Engineering of TEC, and is documented in a Letter from Tony Franklin of TEC to T. J. Wright dated 2/27/91 (Reference H). As stated in that letter, all TEC 156 Analog Isolators utilize the same isolation device and internal fuses. The differences are only in the input and output stages, those differences would not have a significant affect on the surge withstand capability of the isolators.

The decision to combine the testing was based on economic reasons in order to reduce the number of isolators destroyed by the testing process and to allow completion of the testing with the available isolators. Therefore, both models were used interchangeably during the test with circuit configurations appropriate to the type of model being tested. No anomalies were noted during performance of the tests. As expected, the devices ceased to function as signal processing units after being subjected to the energized transverse fault mode, however, the units satisfactorily functioned as isolation devices by not allowing the fault to propagate to the 1E side. Based on the letter from TEC documenting similarity, the results for the tested models also apply to all other TEC model 156 Isolators.

6.3 Bailey model 740 Millivolt Converter

Several discrepancies, anomalies, and procedure changes were noted during the testing of the Bailey model 740 millivolt converters.

A. Internal fusing:

PP&L's original test specification called for testing of the isolators with their internal fuses functional (normal configuration), and shorted out. It was perceived that the fuses should be shorted during the test because the voltages planned to be used during insulation resistance testing would exceed the voltage ratings of the fuses. Thus to ensure that testing would not induce fuse damage, the requirement to short circuit the fuses during testing was added.

Subsequently, the issue was reconsidered, and a decision made that testing in the "as installed configuration" would be a more valid test. The Bailey millivolt converters used at SSES are installed in the factory standard configuration (fuses installed), and this was verified in the field. Therefore, PP&L instructed FRC to modify their test plan by elimination of those test runs that had short circuited the internal fusing.

B. Isolator incompatibility with a 50 ohm output load in voltage output configuration:

Another discrepancy observed during the testing was the inability of the converter to provide the proper output when connected to a 50 ohm load. As identified in the FRC test report, PP&L waived the requirement to perform that portion of the test. That decision was based on a review of the design basis for that requirement, and evaluation of the test configuration of the device.

The plan to test the output of the devices for different loads was included in PP&L Specification J-1077, step 4.2.5. This was based on IEEE Standard 472-1974 Appendix A1, which is a guide for surge withstand testing. Inclusion of a range of output impedances was made with the intent to gather as much data as possible when performing testing rather than to risk missing that data should it be required at a future time.

A review of the specifications of the Bailey Converters tested shows that recommended output load be greater or equal to 1.5 KOhms for voltage output, and less than or equal to 600 Ohms for current output. Both the current and the voltage output configurations are used at SSES. The output option is selected by placement of movable jumpers on the printed circuit board. The voltage output option was selected for the test program to simplify the test circuit configuration. Because the voltage output configuration was selected, the 50 Ohm test was outside of the design specification range for the device. Further, a 50 Ohm load is not used at SSES for devices configured as voltage output. Therefore, the requirement for the 50 Ohm test was dropped.

C. Redefinition of input signal range:

The Bailey millivolt converters are 0 to 160 millivolt input devices. As used in field application, they are provided with a resistive voltage divider at the isolator terminals to convert the typical 1 - 5 volt, or 4 - 20 milliamp signals to the 0 - 160 millivolt range. PP&L's test specification limited noise transmission to 2 % of signal range.

Initial testing at FRC used recorders with 0 - 160 mv full scale deflection, and simulated transmitters generating a 160 mv full range signal. The test equipment used required a high gain, and that gain resulted in an excessive noise to signal ratio. The test was then rewritten to include the resistive signal dividers in the test setup allowing lower gains to be used in the test equipment by applying the noise transmission acceptance criteria to the 1-5 volt simulated transmitter inputs. This change more accurately reflected actual field installations and service.

The resistive networks required for conversion of the input signals were fabricated by FRC to PP&L design simulating the actual Bailey voltage divider consisting of two precision resistors. Local fabrication was used because of long lead times for the factory components. These changes to the original plan are considered valid because: a) inclusion of the voltage divider networks reflects the actual field configuration of the isolators; b) the locally fabricated networks used only passive components reflecting original design equipment. PP&L believes this test procedure change would not impact on the validity of the fault testing of the isolators in any way.

D. Component damage on Bailey Isolators during transverse testing mode.

Physical damage to several components on the circuit board was observed during the transverse mode energized fault tests. Although noted in the visual inspection portion of the test documentation, determination of acceptability is not documented in the summary portion of the FRC test report. This analysis documents that acceptability.

As stated in the inspection report, no evidence of deposits or arcing were observed on the aluminum shield barrier. The barrier referenced in that comment is a safety enclosure consisting of two aluminum plates which was constructed for the test setup. The plates were positioned on either side of the circuit board at approximately the same position that would be occupied by other circuit cards in the card rack. The observation of no residue or arcing on the plates is sufficient to conclude that the circuit card destruction would not affect adjacent cards. This meets the criteria to contain any ignition, explosion, or arcing within the isolator case as required by Specification J-1077 section 4.3.2.

E. Noise Pulse Transmission outside of acceptance criteria limits during AC Transverse Fault Testing:

The FRC Test Report noted an anomaly in the failure of the Bailey converter to pass the acceptance criteria for the Transverse mode AC faults to the power and signal connections. The criterion for a propagated voltage to not exceed 2 percent of input span is specified in Specification J-1077 and is derived from data presented in Calculation J-CRR-245. The assumption that formed the basis for selection of that value was that the error introduced by the propagated fault would be continuous over the entire duration of the fault condition. Since the error was assumed to be continuous, a value less than the loop accuracy was chosen as the maximum propagated voltage allowed. Since the actual test data shows that the propagated fault was present for less than 20 milliseconds, engineering judgement needs to be applied to evaluation of the test results.

As stated in the FRC test report section 7.2, the amplitude and duration of the propagated voltage spikes were 6.4 and 7.1 percent of span for a time of 20 milliseconds. This statement was found to be a slight understatement of the error. Analysis of the strip chart data shows the correct values to be 8.0 and 9.0 percent of span respectively, amounting to a noise pulse of 320 and 360 milliVolts. This error is documented here for correctness, however, it does not affect the results of this analysis.

The maximum observed amplitude of the spikes are far less than the maximum normal voltage applied to the input circuit, therefore, there is no evidence of destructive potential. Since the observed fault presents no challenge to the integrity of the 1E circuit, the only effects that need to be analyzed are the response of other instruments connected to the loop.

The test configuration did not include other devices connected to the circuit, which would by their nature reduce the observed amplitude and duration of the spike. Analysis of the other instruments which would normally be included in the loop was considered to determine if the .36 Volt spike would prevent them from performing their safety function. The types of active instruments connected to the 1E side of the circuit include bistables, controllers, indicators, and signal processing units.

The duration of the observed fault borders on the nominal minimum response time for most of these devices.

Bistables nominally have a time response of one to two cycles (16 to 33 msec.). Given a worst case scenario, where the process parameter is very close to the setpoint, a propagated spike could cause the signal to exceed the setpoint for the duration of the spike. In most cases, the circuitry would not respond to the spike. At the worst, an actuation could occur, but that actuation would be the same as if process variations had caused it.

Quoting the definition of Isolation Devices as specified in IEEE 279-1971, section 4.7.2, "No credible failure at the output of an isolation device shall prevent the associated protection system channel from meeting the minimum performance requirements specified in the design bases.". An actuation of type described above would not prevent the associated safety system from performing it's function, therefore, the performance of the isolation function does not violate the acceptance criteria.

Indicators and controllers inherently do not respond to spikes of the observed duration and their output would remain unaffected. Most signal processing units such as square root converters have internal capacitors which tend to filter out these types of disturbances and add to the time response of the circuit.

Based on a review of the functional requirements for isolators, and applying engineering judgement to the analysis given above, the Bailey millivolt converter satisfactorily performs the function of a class 1E isolator.