

Procedure No. 45592-1, Revision A
 June 2, 1982 (Rosemount)
 Procedure No. 45592-2, Revision B
 June 2, 1982 (Foxboro)

Inspection Conducted: May 25-26, 1982
 June 3-5, 1982
 June 29-July 1, 1982

Assigned Inspector:

A. R. Johnson
 A. R. Johnson, Equipment Qualification
 Section, Vendor Program Branch, Region IV

9/17/82
 Date

Approved By:

H. S. Phillips
 H. S. Phillips, Chief
 Equipment Qualification Section,
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9/20/82
 Date

Summary:

Three inspections were conducted by Mr. A. R. Johnson of the NRC, Region IV, of the activities performed by Wyle Laboratories during the above periods. Accompanying Mr. Johnson on the inspections of June 3-5, 1982, and June 29-July 1, 1982, respectively, were NRC consultants Mr. J. Benson and Mr. E. E. Minor of Sandia National Laboratories. The purpose of the inspections was to witness, observe, and inspect the first 24 hours of the LOCA/HELB environmental qualification (30-day) tests for both Foxboro N-E 10 Series and Rosemount 1153 Series D pressure transmitters, including the inspection of the installation and test apparatus. The qualification test plan called for the LOCA/HELB profile test with both Foxboro and Rosemount pressure transmitters together in the test chamber. Due to a failure of the test apparatus (e.g., electrical lead wire degradation to the Rosemount transmitters), the test was shut down after the first 24-hour period, qualifying the Foxboro transmitters only. Once this anomaly was corrected, the first 24 hours of the LOCA/HELB test were rerun for qualification of the Rosemount transmitters only, after which the test was again shut down. Both Foxboro and Rosemount transmitters resumed the LOCA/HELB testing together at the 176° F plateau for the remaining 30-day period. The tests were conducted to qualify these classes of IE equipment to Category I requirements of NUREG-0588, Revision 1 (IEEE-Std. 323-1974). These inspections were a continuation of the inspection performed by the NRC inspector on April 20-22, 1982 (Inspection Report No. 99900908/82-01).

Results:

The inspection performed during this period indicated:

1. Foxboro pressure transmitters F1, F2, F3, F5, and Rosemount pressure transmitters R1, R3, R4, and R5, were within the prescribed margins set by the utility owners group necessary for their notification, and met the acceptance criteria prescribed in the qualification plan and procedure. The NRC inspector found no instances where the requirements of NUREG-0588, Revision 1, Category I (IEEE 323-1974) were not met.
2. Foxboro pressure transmitter F4, and Rosemount pressure transmitter R2 exceeded the prescribed margins set by the utility owners group necessary for their notification, and did not meet the acceptance criteria prescribed in the qualification plan and procedure. The NRC inspector could not determine that F4 and R2 transmitters met the requirements of NUREG-0588, Revision 1, Category I (IEEE 323-1974).

Details Section
Prepared by A. R. Johnson

A. Persons Contacted

- E. W. Smith - Director of Contracts, Wyle Laboratories
- B. Fowler - Lead Test Engineer, Wyle Laboratories
- L. R. Gamblin, Wyle Laboratories
- F. Johnson, Wyle Laboratories
- J. A. Sears - Corporate Engineering, Foxboro Company
- R. K. Selander - Project Engineering, Foxboro Company
- S. Wildgen - Project Engineer, Rosemount
- J. Anderson - Application Engineer, Rosemount
- R. E. Dulski - Group Supervisor, NPD, Conax Company
- F. Illig - Equipment Qualification Manager, NPD, Conax Company
- R. K. Hanneman - WEPCO Utility Owners Group
Representative/Coordinator
- G. Pannel - WEPCO Utility Owners Group
Representative, VEPCO

B. General

The purpose of the subject test program was to qualify pressure transmitters, manufactured by Rosemount and Foxboro, for use in safety-related systems in nuclear power generating stations. Wyle qualification test plan Nos. 45352-1 and 45352-2, Revision A, have incorporated the NRC staff's recommendations and resolved their concerns, and appear to meet the requirements of IEEE Std. 323-1974 and NUREG-0588, Revision 1.

Wyle Laboratories' development of test procedures No. 45592-1, Revision A, dated June 2, 1982, and No. 45592-2, Revision B, dated June 2, 1982, has been approved for use in implementing the methodologies and requirements of these test plans. The test procedures include checklist/data sheets which have been completed during the test program, providing auditable records of the qualification testing.

The purpose of this inspection, conducted by the NRC inspector, was to assure that the LOCA/HFLB environmental qualification tests were conducted in accordance with these test plans and procedures, and to review documented test records, completed by Wyle personnel during the test, for acceptance within prescribed margins to meet the IEEE Std. 323-1974 and NUREG-0588, Revision 1 requirements. The NRC inspector accomplished this effort by inspection and checkout of test specimens in the environmental test chamber, inspection and checkout of test apparatus, witness and observation of the LOCA/HELB test runs (including dry runs), review and inspection of checklist/data sheets, documented anomalies, qualification

plans, test procedures, other selected documents, and discussion with Wyle Laboratories test personnel.

C. Objectives

The objectives of the NRC inspections conducted during these periods were: to witness, observe, and inspect the LOCA/HELB environmental qualification tests, including the inspection of installation and test apparatus; to witness and observe the LOCA/HELB test profile (first 24 hours) for both the Foxboro and Rosemount pressure transmitters; and to review documented test records to assure that test results were within the prescribed margins of acceptance and licensee notification. The objectives are delineated as follows:

1. To verify test results were well within the prescribed margins of acceptance.
2. To observe and identify test results outside of the margins necessary for licensee notification.
3. To verify that test results meet the requirements of NUREG-0588, Revision 1, Category I (IEEE-323-1974).
4. To verify that the tests and inspection activities performed were in accordance with detailed test procedures.
5. To review the test procedures for conformance to the environmental qualification plan.
6. To verify that all necessary information and data were collected to allow evaluation of test results in relation to the licensee notification/acceptance criteria.
7. To witness installation and checkout of test specimens in the environmental test chamber.
8. To determine that Notices of Anomalies (NOA), where required, are prepared in a timely manner.

D. LOCA/HELB Environmental Qualification Test - Installation and Apparatus

The NRC inspector observed and inspected the installation of the five Foxboro and five Rosemount pressure transmitters into the 58-cubic foot LOCA/HELB test chamber. Each of the Foxboro and Rosemount transmitters was attached to a Wyle fabricated test fixture, utilizing the equipment manufacturer's mounting hardware mounted to universal wall mounts in the vertical orientation. Penetrations along the LOCA/HELB chamber wall allowed the electrical cabling and process tubing to enter. The chemical spray header was located at the top of the chamber, spraying vertically downward on a horizontal plane over the 10 specimens. The chamber

pressure was measured with two pressure transducers in combination with a pressure gauge. The temperature of the chamber was measured through the use of one thermocouple per transmitter. The thermocouples were positioned in such a manner as to be within 2 inches of the test specimen. Individual thermocouple readings were recorded, utilizing a Fluke 2240C datalogger. The readings of three thermocouples were then averaged and utilized for the chamber temperature control by providing the control signal for the steam inlet (Fisher, air-operated) plug valve. A separate datalogger was utilized to provide an accurate record of the electrical inputs and outputs of the test items and chamber pressure. The chamber pressure was controlled by seven ASCO (pressure-control) vent solenoids and an air inlet (Fisher, air-operated) plug valve, utilizing one of the pressure transducer outputs. Superheat steam was supplied to a rectangular manifold (holes up) inside the chamber cavity. The flow rate of the chemical spray was automatically controlled through the use of a Kates Flow Rate Controller. The flow rate was measured and recorded with an orifice plate and differential pressure transmitter. The pH of the chemical spray was monitored on the datalogger and corrected to record the proper pH. Two centrifugal pumps (one backup) were used for supply forwarding. The internal chamber condensate and chemical spray level was automatically maintained by a McDonnell & Miller ITT level controller which operates the chamber drain valve to assure that the chamber did not overflow with liquid.

The installation of test specimens and test apparatus used, as reviewed and inspected by the NRC inspector, was in accordance with Wyle test procedures No. 45592-1, Revision A, and No. 45592-2, Revision B. The NRC inspector determined that the installation and test apparatus met the requirements of NUREG-0588, Revision 1.

No nonconformances were identified.

E. LOCA/HELB Environmental Qualification Test - Dry Run

A calibration of the LOCA/HELB chamber, using masses to simulate the transmitters, was performed prior to the LOCA/HELB environmental qualification test.

The purpose of the calibration was to verify operability of the instrumentation system and that the 350° F ramp could be met in approximately 10 seconds. Three dry runs were made on May 25, 1982, using the two 90-KW electric superheaters as a superheat steam source. Adjustments to the steam inlet and pressure controls were made between runs, with results as follows:

Run No. 1 -- 220° F @ 60 psig @ 10 seconds
 Run No. 2 -- 350° F @ 87 psig @ 15 seconds
 Run No. 3 -- 360° F @ 87 psig @ 20 seconds

On May 26, 1982, one dry run was made using a standard, oil-fired boiler (with a hot rock superheater) as a superheat steam source. Results were as follows:

Run No. 1 -- 350° F @ 87 psig @ 10 seconds

Results of the calibration were provided to the lead utility owners group representative and approved prior to the LOCA/HELB environmental qualification test.

The NRC inspector determined that the dry run and calibration of the LOCA/HELB chamber were in accordance with the Wyle test procedures No. 45592-1, Revision A, and No. 45592-2, Revision B, and met the requirements of NUREG-0588, Revision 1.

No nonconformances were identified.

F. LOCA/HELB Environmental Qualification Test - Foxboro and Rosemount Pressure Transmitters

1. First 24 Hours of 30-Day Test

Qualification Test Procedures No. 45592-1, Revision A, and No. 45592-2, Revision B, required both Foxboro and Rosemount pressure transmitters (specimens for test) to qualify to the harsh environment test profile together in the test chamber.

- a. On June 3, 1982, this test commenced, after stabilizing at 120° F for 2 hours, obtaining the first 350° F/85 psig qualification test profile (additional peak transient - margin ramp) required in NUREG-0588, Revision 1. Foxboro transmitters F1 through F5 and Rosemount transmitters R1, R3, R4, and R5 were within the prescribed margins set by the licensee necessary for his notification (Foxboro \pm 15 percent, Rosemount \pm 8 percent), and were within the prescribed margins of acceptance. Rosemount transmitter output R2, however, exceeded the notification criteria 4 minutes into the test (erratic, then signal went off scale), and later returned to normal after the margin ramp profile was completed.
- b. On June 4, 1982, the second transient ramp of the LOCA/HELB time-temperature/pressure test profile commenced, after stabilizing for 2 hours at 120° F. The output signals from all five Rosemount transmitters (R1 through R5) became erratic and exceeded the full-scale output (off scale) at the 320° F/60 psig plateau. This occurred during the chemical spray injection, prior to the first five-point calibration and voltage variation checks, which were scheduled 30 minutes from time zero into the test. The lead utility owners group representative elected to shut the test down once the first 24-hour period to qualify the

Foxboro transmitters was completed on June 5, 1982, at approximately 10:00 a.m. An investigation into the apparent cause of malfunction for all five Rosemount pressure transmitters (R1 through R5) was then scheduled during this shutdown period.

- c. During the second transient ramp of the LOCA/HELB time-temperature/pressure test profile, the output signal from Foxboro transmitter F4 became erratic and exceeded the full-scale output (off scale) at the 320° F/60 psig plateau during the chemical spray injection (approximately 18 minutes into the test). Earlier, at the 350° F/60 psig plateau, the F4 transmitter signal displayed as high as 100 percent output. During the five-point calibration check, 30 minutes into the test, the signal output did not respond. During the scheduled shutdown (week of June 6, 1982), as ordered by the lead utility owners group representative, the Foxboro F4 pressure transmitter was removed from the LOCA/HELB chamber for inspection purposes. The top cover was removed, and about one-fourth inch of water was observed as having intruded into the bottom of the unit. Water intrusion (steam condensate), during the above part of the LOCA/HELB test, was evidenced either through an inadequate O-ring seal or the zero adjustment screw. The Foxboro F4 transmitter was returned to the manufacturer for further analysis. The lead utility owners group representative and Foxboro corporate engineering representative elected to negate the above transmitter F4 from the remainder of the LOCA/HELB testing. The NRC inspector could not ascertain Foxboro's position as to why the F4 transmitter failed. The NRC inspector questioned whether this failure constituted earlier replacement of O-rings in the life of a plant, or whether this failure was regarded as a random event and, thus, reasonable assurance exists that the equipment would not fail. This matter is considered as an unresolved technical issue which requires clarification to the NRC staff prior to the staff's review of the end user's (applicant's) environmental qualification program, and development of a Safety Evaluation Report (SER) for each end user's facility.
- d. During the second transient ramp of the LOCA/HELB time-temperature/pressure test profile, the output signal from Foxboro transmitter F1 exceeded the prescribed margin of ± 15 percent required for licensee notification. The signal output indicated as low as $-17 \frac{1}{2}$ percent at the 320° F/60 psig plateau, 2 hours and 52 minutes into the test. The lead utility owners group representative authorized the test to continue.

2. Degradation of ECSA Kapton Lead Wires to the Rosemount Pressure Transmitters R1 through R5

During the scheduled shutdown (week of June 6, 1982), as ordered by the lead utility owners group representative, an investigation was performed by Wyle personnel involving Conax NPD engineers and specialists. Rosemount pressure transmitters (R1 through R5) employed Conax

electrical connector seal assemblies (ECSA), Model No. N-11001-35, as the electrical interface to each Rosemount transmitter. This type of ECSA had been previously qualified to the harsh environment by the Conax Corporation, as evidenced in their generic prototype test report IPS 353 dated May 1977, entitled "Design Qualification Test Report - General-Type Test of Conax Electrical Penetrator, Part No. 7641-1000." Further evidence of previous qualifications of this type of ECSA was offered in the Conax Report No. ISP 409, Revision A, dated May 21, 1979, for Arkansas Nuclear Unit No. 2. The latter report employed qualification by analysis of the former generic-type test report. The ECSA construction consisted of two No. 16 AWG copper-insulated lead wires, Kapton-coated, extending through the polysulfone seal assembly of the ECSA, and extending three to four feet in length beyond, to a point where they were spliced to the Tefzel-coated chamber input lead wires, using a Raychem-type WCSF-N nuclear splicing sleeve (heat-shrinkable polyolefin). At a point inboard of these nuclear splices, the ECSA Kapton-coated lead wires were found to have been degraded as a result of the effects of the chemical spray during the test. At the conclusion of the investigation, having corrected this deficiency by the absence of moisture, it was observed that all Rosemount transmitters were functional with the exception of R2. Transmitter R2 was removed and returned to Rosemount for analysis. The following repair was ordered by the lead utility owners group representative, and the following disposition of the Conax ECSA's occurred:

- ECSA (R1) -- The Kapton lead wires were trimmed back beyond the suspected damaged area, and a new splice was made using Raychem sleeving. The spliced area was located inside the flexible conduit which covered the Kapton lead wires from the ECSA back to the splicing for some length.
- ECSA (R2, R4, and R5) -- The complete ECSA was replaced, with the exception of the body seal, and the Tefzel lead wires were spliced to the Kapton leads. Each Kapton lead was individually covered with polyolefin heat-shrinkable tubing. The spliced area was located outside of the flexible conduit.
- ECSA (R3) -- A visual inspection of the ECSA revealed that the Kapton insulation was damaged where the leads exited the polysulfone seal. The Conax representative ordered the ECSA replaced with a new ECSA in the same manner as transmitters R2, R4, and R5 above.

The NRC inspector could not determine reasons for degradation (flaking off) of the Kapton-insulated wire leads to the Conax ECSA, Model N-11001-35, due to the influence of the chemical spray during

the test. It should be noted, however, that each ECSA was pre-stressed-aged with its associated Rosemount pressure transmitter during the required accelerated thermal and irradiation aging process required by the qualification plan. The handling of the aged Kapton ECSA lead wires to the Tefzel-coated chamber input leads may or may not be typical of a normal nuclear power plant installation over a 40-year life. The NRC inspector understood that only the Rosemount pressure transmitters were undergoing qualification testing, and that use of this ECSA with this Rosemount transmitter type on a nuclear power plant application was questionable. This matter is considered as an unresolved technical issue which requires clarification to the NRC staff prior to the staff's review of the end user's (applicant's) environmental qualification program, and development of a SER for each end user's facility.

3. Rosemount Pressure Transmitter R2 (11-53005) - Analysis and Repair at the Manufacturer

After the scheduled shutdown on June 5, 1982, when the first 24 hours of the test were completed and the test chamber opened, the inoperative Rosemount pressure transmitter R2 was returned to the manufacturer for analysis and possible repair. Rosemount's investigation narrowed the deficiency to the sensor housing assembly. A small pinhole in the weld between the clamp and housing and a void adjacent to the pinhole were observed when x-rayed. The sensing module was found to be partially full of water, and an attempt to oven-dry the unit still resulted in some leakage current when checked within a 24-hour period.

In a June 24, 1982 letter to R. K. Hanneman (WEPCO) from S. Wildgen (Rosemount), it was stated that a new sensor housing assembly (unaged), including metal O-rings, module neck thread sealant, and cover O-rings, was installed and reassembled into the above subject transmitter and returned to Wyle Laboratories to continue the qualification test program. The sensor housing assembly materials were reported by Rosemount as inert and, therefore, not affected by the prestressing of thermal and functional aging or irradiation. Rosemount also claimed that the replaced O-rings and sealant were also used on the R1, R3, R4, and R5 transmitters and can qualify by similarity. Rosemount also reported their corrective action, as a result of the R2 transmitter failure during the LOCA/HELB test, was to impose 100 percent inspection of welds between the sensor housing and clamp and between the clamp and sensor cell.

The NRC inspector could not determine whether the R2 transmitter failure was caused by inadequate control of the manufacturer's production process (special processes -- welding), or whether the failure was regarded as a random failure and that reasonable assurance exists that the equipment would not fail. This matter is considered an unresolved item.

G. LOCA/HELB Environmental Qualification Test Rerun - Rosemount Pressure Transmitters

1. First 24 Hours of 30-Day Test

On June 29, 1982, at 2:55 p.m., the LOCA/HELB environmental qualification test rerun of the transmitters commenced after stabilizing at 120° F for 2 hours. A rerun of the first 24 hours of this test, as ordered by the lead utility owners group representative, pertained to the five Rosemount pressure transmitters only (see Section F). The test rerun was carried out in accordance with the Wyle Qualification Test Procedure No. 45592-1, Revision A, without the additional peak transient-margin ramp. Credit for margin would be applied from the first 24-hour test conducted on June 3-4, 1982 (see Section F), which indicated a test apparatus failure due to lead wire degradation. Rosemount transmitters R1, R2, R3, R4, and R5 were within the prescribed margins set by the licensee necessary for his notification (± 8 percent), and were within the prescribed margins of acceptance.

On June 29, 1982, having ramped to the 350° F/85 psig plateau after 2 to 3 minutes, the automatic mode of the superheat steam supply controller was lost. The remainder of the LOCA/HELB profile was controlled manually.

The chemical spray injection did not come on at 10 minutes into the test, but injected approximately 5 minutes later.

No nonconformances were identified.

H. Summary

Within the scope of these inspections, as conducted during these tests covered in this report, the NRC inspector determined that:

1. Foxboro pressure transmitters F1, F2, F3, F5, and Rosemount pressure transmitters R1, R3, R4, R5, were within the prescribed margins set by the utility owners group necessary for their notification, and met the acceptance criteria prescribed in the qualification plan and procedure. The NRC inspector found no instances where the requirements of NUREG-0588, Revision 1, Category I (IEEE 323-1974) were not met.
2. Foxboro pressure transmitter F4, and Rosemount pressure transmitter R2 exceeded the prescribed margins set by the utility owners group necessary for their notification, and did not meet the acceptance criteria prescribed in the qualification plan and procedure (refer to Sections F.1.c and F.3 of this report). The NRC inspector could not

determine that F4 and R2 transmitters met the requirements of NUREG-0588, Revision 1, Category I (IEEE 323-1974).

3. Qualification test procedures conformed to the qualification test plans.
4. Test and test inspection activities performed were in accordance with detailed test procedures.
5. All necessary information and data collected to allow evaluation of test results was properly recorded and documented.
6. The installation of test specimens in the environmental test chamber was in accordance with the qualification test procedures.
7. NOA's were prepared in a timely manner, properly documented, and properly dispositioned.