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From: <glsinc@traveller.com>
To: TWD2.TWP0(ska)
Date: 12/19/96 3:02pm
Subject: Draft NUREG/CR-6412.

To : Mr. Satish Aggarwal
From : Jim Gleason, GLS

Per your request, the following are my detailed comments on the Draft NUREG/CR-6412.

1. It is my opinion that the setup used by Sandia was flawed in that it did not represent actual nuclear safety related applications for Namco EC210, Patel/EGS =BD -inch Quick Connect, Conax ECSA, Patel/EGS Conduit Seal or the Rosemount 353C Conduit seal. Sandia used a Sandia fabricated "through device" instead of a safety related end device.

Sandia notes on page 7, last paragraph " The conduit seals and connections that would normally be installed in a device such as a limit switch or pressure transmitter had their device side terminated into small, sealed chambers, called a "device enclosure", that simulate such devices. Each such connection had its own device enclosure, which was fabricated from stainless steel tube and Swagelock tube fittings (Swagelock Co., Solon, OH) as shown in Figure 2.6."=20

Sandia notes that a Helium leak test was done. Then the "conductors were inserted into the device enclosure, using phenolic inserts=85There was no attempt to physically check if connections were leaking during the test. Leaking connections could be identified during the test only if data measurements begin to show anomalies, or at the conclusion of the test if the device enclosure had moisture inside when it opened."

Sandia=92s Figure 2.6 shows that the wires enter the Sandia enclosures= through the connectors under test and exit out of the other end of the Sandia enclosure. This is not how these connectors are installed in safety related applications and it is not how the wires are routed in safety related applications.=20

Sandia did not identify exactly which of the connectors were connected in this fashion. Since Namco EC210, Patel/EGS =BD -inch Quick Connect, Conax ECSA, Patel/EGS Conduit Seal or the Rosemount 353C Conduit seals were qualified for this type of application, I have assumed that Sandia used their "sealed enclosure" on these connectors.

Sandia claims that this represents pressure transmitters and limit switches. It does not. There are no safety related transmitters or switches that allow the wires to enter with the safety related connector and exit without going back through the same safety related connector. Pressure transmitters and switches are "end devices", which mean that they are at the terminating point of a cable. Thus this installation is not representative of nuclear safety related applications. Additionally, this "Sealed enclosure" is flawed and allows leakage into the back side of the connectors in a fashion that is precluded in actual safety related applications. By letting cables exit the back side of the Sandia enclosure, and not performing a leak test after the cables were installed, the leakage path through the cable conductor, under the

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insulation was not sealed and therefore no pressure boundary was present. This lets moisture enter the back side of the connectors under test, through the Sandia enclosures.

The connectors being tested by Sandia rely on the integrity of the safety related end device to provide integrity to this end of the connector. Sandia did not simulate an actual installation.=20

During the 1980=92s peer review of Sandia=92s research, one of the strong recommendations was for Sandia to utilize actual safety related equipment rather than fabricating fixtures simulating applications since critical design elements can be missed.=20

Additionally, had Sandia known that the actual way that pressure transmitters and switches are wired, they should have realized that the cable comes into the end device through the connector, is terminated in the end device and another wire starts in the end device and exits back out of the end device through the same connector. Thus the wiring also did not simulate actual safety related installations.

As noted, Sandia did not leak test the enclosure after the wires were installed, and failed to question the integrity of their enclosures when anomalies occurred, apparently in violation of their procedure, instead, they concluded that the connectors had failed.=20

It is my opinion that when a root cause failure analysis is performed, the cause of the failures is moisture in the Sandia "sealed enclosures" and thus these failures were caused by Sandia=92s test setup and thus are a Lab= induced artifact of the testing and not indicative of the qualification status cf this equipment.

2. The Failure criteria and functional tests by Sandia are not per IEEE 323-74 nor 10CFR50.49. Both of these require that the safety related function be demonstrated. The safety related function of connectors is to provide adequate sealing and a uninterrupted power source thus having no significant loss of signal or power to and from the end device.=20

Sandia=92s electrical set up relied on "open circuits" and IR measurements= and not actual safety related circuits, or safety related functions.=20
Again during the 1980=92s Sandia Peer Review it was pointed out that Sandia should utilize actual nuclear test loops in order to judge safety related performance of circuits. The standards and requirements emphasize the demonstration of actual installed conditions. This was not done in these= tests.=20

3. The failure of the Conax ECSA at the start of aging, where it was found to have an internal short circuit, is indicative of handling damage by= Sandia.=20

I am aware of other laboratories having damaged ECSA=92s upon initial installation. The damage caused the seal to break internally and the wires to short together, similar to Sandia=92s experience.=20

I am also aware that caution, which had not been sufficiently present at the first installation, was improved after the initial failures occurred and

subsequent failures were eliminated. Handing damage to ECSA=92s has occurred because the conduit extension was misaligned during installation, inadvertent torque was applied to the assembly and not the stem nuts, and because bending and unsupported attached cable or enclosures applied forces which damaged the seal during movement during testing. All of these were a result of mishandling and were eliminated in subsequent testing.=20

I=92m surprised that Conax did not point this out to Sandia after the= initial failure. In any event, Sandia should have had an immediate concern when a safety related device had failed in its initial setup test and performed a root cause failure analysis with the help of Conax. I=92m confident that all commercial laboratories with whom I have worked, would have stopped the testing and immediately investigated the source of the failure with Conax, since they are aware that much care is provided by manufacturers of safety related devices and that failures are rare at the starting point.

The failure of the Conax ECSA during the LOCA, could be do to handing damage that went undetected by Sandia. Also, the Sandia "sealed enclosure" , if it was used on the ECSA, may have lead to failure on the ECSA from the Sandia enclosure side. =20

4. Thus I am of the opinion that the 5 connector "failures" in submerged dielectric testing are an artifact of the test performed by Sandia and are not an indication of an Environmental Qualification problem. The failures were most likely do to a lack of understanding of the connectors' safety related functions, lack of understanding of the different connector categories represented by the test specimens, and a lab induced failure mode. The ten connector types tested actually represented four categories of connectors. All five failures came from one category of connector and would all be susceptible to the same lab induced failure mode.

5. The safety related function is normally demonstrated by LOCA testing, including Post-LOCA testing per IEEE 323 and 10CFR50.49. These requirements do not require another submerged dielectric test 13 months after the Post-LOCA test. It was during this "Post 13 month submerged test" that the majority of failures of the connectors occurred. Since I think that Sandia= =92s
"sealed enclosures" leaked, I also think that their "sealed enclosures" allowed corrosion over this 13 month period and thus these failures are lab induced. Lab induced since the test was un-natural and Lab induced since it was Sandia=92s "sealed enclosure" that caused the leakage. The "Post 13= month submerged test" is un-natural because qualification requires the demonstration of the safety related function during the DBA and Post DBA period, which was simulated in the Sandia chamber. The condition of connectors that are then submerged 13 months "After the LOCA and After the Post-LOCA period", is immaterial. I am unaware of any safety related device which is postulated to perform a safety related function in a submerged condition 13 months "After the LOCA and After the Post-LOCA period."

6. One of the conclusions that Sandia should have made was related to LOCA performance. Of the twelve connector types tested, 11 out of 12 passed all of the requirements for environmental qualification. (The one that failed is indicative of handing damage and may have been damaged by Sandia.)

Additionally, the connections that do not rely on end devices, such as Raychem splices, Okonite tape and EGS Grayboot connectors, passed all testing, even in after 60 year aging. Thus Sandia should have concluded that these connections met the objectives of the testing.

7. The objectives of the testing were to A) Assess accident performance of electrical connectors aged at lower temperatures and dose rates than typical industry tests and B) Investigate the performance of connectors aged to 60-year life. The testing clearly shows that both objectives have been met and that A) lower temperature and lower dose rate testing do not impact qualification and B) there is no performance degradation in extending the life to 60 years.=20

8. The results of the terminal block testing demonstrate that the previous issues reported by "Craft (5,6)," have been shown to be non-issues. This is because intermittent powering has no effect on LOCA performance of terminal blocks and the pre-aging did not change the performance during LOCA.

9. I believe that all of these problems could have been avoided by more direct observation on the details of the EQ testing at the national laboratories by knowledgeable consultants. Since the national laboratories, who through no fault of their own, have not been burdened with and scrutinized by the industry when qualifying equipment to the existing standards and regulations, as have the commercial laboratories, more supervision is warranted in order to assure that lab induced failures are minimized.=20

10. I don't believe that additional research is warranted at this time into connectors, however, I do recommend that the root cause failure analysis be performed independently of Sandia and by BNL and myself to add extra objectivity. Additionally, I recommend that the conclusions be changed to agree with the results prior to the "submerged 13 month test" and that this test portion of the testing be addressed after the root cause is known. If any additional testing of these or other connectors is necessary for resolution, I believe that testing should be done through an experienced commercial lab, directed by the national lab. As you are aware, BNL's efforts at Wyle to perform cable research could be expanded at minimal cost to include specific connectors in one of the cable tests to resolve outstanding issues noted in the Sandia test.=20

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