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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 10, 1997

MEMORANDUM TO: Michael D. Collins
Document Control Desk (O-5D3)
IRM/IRMB

FROM: Satish K. Aggarwal SKA
Electrical, Materials and Mechanical Engineering Branch
Division of Engineering Technology, RES

SUBJECT: LOCA TESTING OF SAFETY-RELATED CONNECTIONS

Attached is a copy of the minutes of an open public meeting held on January 23, 1997, at Conax-Buffalo Corp., NY, concerning LOCA testing of safety-related connections.

This document is released for PDR.

Attachment: As stated

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Discussion of Connections Testing (draft NUREG/CR-6412)
January 23, 1997
Visit to Conax Buffalo Corporation, Buffalo, NY

Exchange of technical information related to draft NUREG/CR-6412 that was held on January 23, 1997, at Conax Buffalo Corporation, 2300 Walden Ave., Buffalo, NY 14225.

Conax Buffalo Corporation (716) 684-4500, conaxbuf@conaxbuffalo.com
Rich Dulski, Director of Engineering
Bill Federick, Vice President, Power Group
John MacDonald, Product Manager, Nuclear Products
Ron Nikander, Project Engineer, Nuclear Products
Sandia National Laboratories
Curt Nelson (505) 845-9253, cnelson@sandia.gov
U.S. Nuclear Regulatory Commission
Satish Aggarwal, NRC/RES/DET/EMMEB (301) 415-6005, ska@nrc.gov
John Knox, NRC/NRR/DE/EELB (301) 415-2763, jlk@nrc.gov

John MacDonald gave a presentation on the Conax Buffalo product line. During questions, the following information was obtained related to the Electric Conductor Seal Assembly (ECSA):

- a solid copper conductor, not stranded, is used to ensure that there is no wicking path through the penetration.
- conductors are sealed with polysulfone, not potted with epoxy — polysulfone has been tested to 225 Mrad gamma.
- The ECSA is constructed by taking polysulfone rods and drilling holes in them to allow the Kapton-insulated conductors to be slid through. Then a stainless steel tube is placed over this and swaged down to seal the conductors inside the polysulfone and the polysulfone inside the stainless steel.
- the Kapton insulation on the solid copper conductors is applied so there is always 4 layers of polyimide at every point on the conductor (double wrap, where each wrap is half lapped). The layers of polyimide are held together with a Teflon adhesive.
- Conax has typically performed testing on ECSAs with 4 or more conductors, this allows them to pair up the conductors and connect them together into at least 2 complete circuits — testing a 2-conductor ECSA is more difficult because if you connect the 2 conductors together, there is no other electric circuit in the ECSA on which to perform relative (conductor-to-conductor) measurements.
- ECSAs are very popular in the nuclear industry and are essentially used everywhere in the plant.
- ECSAs are installed in any direction in the field and Conax Buffalo has no limitations on their installed orientation.
- It is relatively unlikely that a single ECSA would ever be used for the entire operating life of a nuclear plant. Plants typically replace the ECSA at the same time the end device is replaced.

- Conax Buffalo has no requirements for periodic maintenance once the ECSA is installed. Conax Buffalo recommends a system check when the ECSA is installed, and the plant Tech Spec will call out some type of installation check.
- Conax Buffalo has performed submergence testing on the ECSA. They do not normally perform submergence testing, but have done such testing if requested by a customer for their specific application (eg., RTD for San Onofre Nuclear Generating Station [SONGS]).
- Conax Buffalo does not typically have a pre-set pass/fail criterion for a test; however, they generally follow IEEE guidelines. They report what is measured and let the customer judge if the results are sufficient for their specific application.
- Conax Buffalo thought that the connections tested in NUREG/CR-6412 were representative of those commonly used in plants. Conax Buffalo also offers a quick-disconnect device, called a Nuclear Service Connector, that is used in 10-20 plants. This device, which is similar to the ECSA, might be a candidate for any future test program. The Nuclear Service Connector uses a metal-to-metal seal, and thus does not depend on an organic o-ring for sealing.

Conax Buffalo is very sensitive that anything related to their reports remain proprietary and not be in the public domain. They will be willing to write a letter allowing use of the activation energy in NUREG/CR-6412, however they need the references changed so that the Conax Buffalo report number and title do not appear. The references should be changed to read "Conax Buffalo Proprietary Report."

Conax Buffalo requested that the NUREG/CR-6412 report not use the term Conax to refer to Conax Buffalo. This is because the Conax company split apart many years ago into operations in Buffalo, NY and Florida. These two operations are now have different owners and using Conax Buffalo minimizes confusion over what company is being referred to.

Viewed photographs of the test specimens taken at various times during the test. Based upon what could be seen in the photographs and discussion of the test, Bill Federick and Rich Dulski had the following suggestions:

- Agreed that post mortem testing should be performed.
- From the examination of photographs, it appears that the reduced measurements observed during the test program were the result of damage to the Kapton insulation external to the ECSA.
- Probable locations of damage was where the conductors entered the polysulfone of the ECSA. Photographs taken before and after the accident steam exposure show that the conductors, which had entered the ECSA in a straight fashion before the steam exposure, had a pronounced angle after the steam exposure. The post-steam photographs showed what appeared to be a green substance at the conductor/polysulfone interface which might have been copper oxide formed where the conductor was bent and possibly the insulation was breached.
- Suggested detailed investigation at any location along the Kapton-insulated conductors

where there could have been mechanical rubbing of the conductor.

- The penetrations used on the test chamber should be checked carefully to insure that there was no insulation damage in that region. If there is any damage, might want to think about different methods of getting cables into and out of the test chamber; these include using Conax Buffalo glands, and/or overdesigned Raychem splices inside the test chamber to connect to a heavier cable that would be used to enter and exit the test chamber and perform as a lead wire.
- Thought that the ECSA was thermally overaged in NUREG/CR-6412, however they felt that the thermal aging did not contribute to the reduced values that were reported.
- Would like to have seen flexible conduit added over the Kapton wire (as required in their installation manual) in order to minimize the possibility of mechanical damage to the wire.
- Suggested that the testing on a connection be stopped once it is clear that there is trouble for that connection. They felt that if a problem occurred early in the test, the connection with the problem should be removed from the test and the root cause for the trouble should be identified. Continuing the test for the connection and reporting how bad the ensuing measurements are is somewhat unfair as the reader has already been made aware of the problem and more reporting of the problem essentially "piles it on."
- Recommended that the torques on the ECSA and the device enclosures be verified before these devices are taken apart at the end of the test.
- Saw no obvious flaws in the device enclosures used to simulate an end device; however, they would have liked the device enclosure to be able to test for leakage once the ECSA was installed, and they are interested in what the interior of the device enclosure looks like after completion of the testing.
- Bill Federick had Curt Nelson explain the time domain reflectometry (TDR) results related to where would changes be expected and how does the lead wires affect the results.

Bill Federick talked about how Conax Buffalo developed their activation energy for the ECSA. Conax Buffalo performed thermal aging tests on ECSA devices during which they measured insulation resistance (IR), dielectric withstand, and helium gas leakage. Prior to the testing, Conax Buffalo set a end-of-life criterion for each of these three measurements. Based on how much aging was required to degrade the ECSAs to any one of the three end-of-life values, they obtained several points and generated an end-of-life curve. The leakage value was what typically limited the end-of-life. When the end-of-life curve was plotted, it showed Arrhenius form and its slope was used as the activation energy for performing lifetime calculations. Note that the resulting activation energy is not based on any material property, but is based on an assembly functional test. While the resulting activation energy is much higher than what would be obtained for a polymer material, Conax Buffalo argues that the result is more representative of how the ECSA will actually perform. The only organic materials contained in the ECSA are polysulfone and Kapton (polyimide and Teflon).

After lunch, John MacDonald gave a tour of the Conax Buffalo manufacturing,

engineering, and testing facilities.

Satish Aggarwal returned 2 reports and a sample ECSA to Conax Buffalo. These had been provided to him earlier by Conax Buffalo.

Comments by Satish Aggarwal, USNRC:

- A draft Information Notice was being prepared by the NRC, and that, if issued, it will be out in the next few weeks or months. Bill Federick noted that such an Information Notice would be issued well before any of the post mortem measurements on the connections would be issued; he expressed concern about the timing of such an Information Notice because it would then put manufacturers such as Conax Buffalo in a position where they did not have all the information available to explain the significance of such an Information Notice to their customers.
- Don't know what further testing, if any, will be done (other than post mortem testing which has already begun).
- Would like to perform baseline testing (i.e., perform LOCA simulation on unaged specimens), however this may not be possible because identical specimens to those tested in draft NUREG/CR-6412 may not be available.
- Based on the initial scoping results obtained in draft NUREG/CR-6412, the NRC may decide to start a detailed program to test connections.
- Bill Federick stated that Conax Buffalo would be willing to donate connections for further testing by the NRC.

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