ENCLOSURE 1

SAFETY EVALUATION REPORT
PLANT SYSTEMS BRANCH
ROBINSON UNIT 2
DOCKET NO. 50-261

1.0 INTRODUCTION

The Carolina Power and Light Company's (CP&L) NRC Bulletin 79-01B 90-Day Report for H.B. Robinson Unit 2 stated that containment flood level for environmental qualification of equipment was 3.2 feet above elevation 228. That level was based upon calculated water volumes and measured water levels that resulted from a reactor coolant pump seal failure in May 1975. In 1988, CP&L (the licensee) discovered that the 79-01B 90-Day Report calculation of containment flood level was in error. The correct flood level was found to be approximately 3 feet higher than the previously calculated flood level. Due to this higher flood level, the licensee conducted an investigation to determine what EQ equipment would be submerged. The licensee's evaluation stated that any equipment affected by the new flood level would remain operable, achieve its function before becoming inoperable, or had backup capability.

By memorandum dated December 12, 1989, Region II requested the assistance of the Office of Nuclear Reactor Regulation (NRR) in reviewing documentation to verify the technical adequacy of the methodology used by the licensee to establish environmental qualification for cables that are submerged during or following a loss-of-cooling accident (LOCA). NRR documented in a memorandum dated April 4, 1990, that the information provided did not demonstrate submergence qualification for the cables. Further review was not performed because the licensee committed to conduct submergence tests on the cables. However, the licensee did not commit to test all submerged cables and intended to rely on the previously submitted data to qualify their cables for submergence.

Since the April 4, 1990, memorandum, additional information has become available regarding the performance of cables in post-LOCA accident environments. Under NRC contract, Sandia National Laboratories conducted submergence and high temperature steam testing on Class 1E electrical cables. The test results were published in NUREG/CR-5655 "Submergence and High Temperature Steam Testing of Class 1E Electrical Cables," dated May 1991. Subsequent to the report being issued, Region II conducted a follow-up inspection on this open item at Robinson. During the inspection (NRC Report 50-261/91-28) it was determined that the submerged cable concern was limited to cables manufactured by Boston Insulated Wire (BIW), Samuel Moore, and Continental. The Sandia test program included BIW and Samuel Moore cables. The BIW cables passed the Sandia submergence test. The Samuel Moore cable similar to the Robinson cable failed during the post-LOCA submergence test. The Continental cable was not tested.

In response to an NRC request for information, the licensee submitted a letter dated March 3, 1992, which provided CP&L's position on the submergence

qualification of the BIW, Samuel Moore, and Continental cables installed at Robinson. The letter addressed the Sandia test results and the applicability of the results to the cables installed at Robinson. The licensee stated in this letter that "it is CP&L's position that these cables have been and are still qualified for submergence at HBR-2."

These cables had previously been accepted as environmentally qualified based on vendor-sponsored testing. However, submergence was not considered prior to the recalculation of containment flood level. Therefore, this review does not address previously accepted LOCA and chemical spray testing, other than noting inclusion of that testing prior to submergence testing. This report specifically addresses the inspection concerns, focusing on the adequacy of the tests and analyses provided for the BIW, Samuel Moore, and Continental cables to demonstrate qualification for submerged conditions.

2.0 EVALUATION

H.B. Robinson, Unit 2 had a construction permit issued in April 1967, beginning commercial operation in March 1971. Therefore, in order to demonstrate qualification of safety related electric equipment located in a harsh environment, Robinson is required to meet the Division of Operating Reactors "Guidelines for Evaluating Qualification of Class 1E Electrical Equipment in Operating Reactors," (DOR Guidelines), dated November 13, 1979. While Robinson is required to meet the DOR Guidelines, the licensee's qualification data packages document qualification to Category I requirements of NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Revision 1, for the Samuel Moore and Continental cables. The licensee's qualification of the BIW cable is documented to the requirements of the DOR guidelines. In NUREG-0588 (paragraph 2.2.(5)) and the DOR Guidelines (paragraph 4.1.3), the Staff's position is stated such that equipment that could be submerged should be actually flooded during qualification testing.

2.1 BIW Cable

The Robinson Environmental Qualification Documentation Package (EQDP) No. 36.0, Revision 1, documents the environmental qualification testing for the BIW cables that can become submerged during or following a LOCA. The requirement for submerged operation is for 30 days inside containment. EQDP 36.0 references BIW test report B915, which did not include testing of the cables for long-term post-accident operation under submerged conditions, but included long-term water absorption testing on cables that had not been thermally aged or irradiated. Since the long-term water absorption test was not performed on cables following a LOCA test, it is not considered adequate to demonstrate qualification for submerged operation. Therefore, the information in EQDP No. 36.0, Revision 1, is not sufficient to demonstrate qualification of BIW cable for 30 days of submerged operation at Robinson.

However, Sandia tested the same type of BIW cable used at Robinson, as documented in NUREG/CR-5655. The cable construction was similar, by the same manufacturer, and with identical materials, but the number of conductors was different. H.B. Robinson cable had 4 #16 AWG conductors, while the tested

cable had 2 #16 conductors. The difference in number of conductors does not impact the use of the tested cables to demonstrate the qualification of the installed Robinson cables for submerged operation following a design basis event. The cables tested at Sandia were pre-aged, using simultaneous thermal and radiation aging, followed by accident radiation exposure. The Sandia testing simulated a LOCA with an environmental envelope that exceeded the Robinson environmental envelope. Following the LOCA test, a submergence test for 1000 hours above 90°C (194°F) was conducted. This testing demonstrated the adequacy of the BIW cable for 1000 hours of submerged operation at 250-Vdc, which is in excess of the requirement for 30-day submerged operation at Robinson.

TABLE 1 -- BIW Cable

	H. B. Robinson-2 cable	Sandia sample closest to H. B. Robinson-2 cable
Cable type	BOSTRAD 7E/15948H-004	BOSTRAD 7E
Cable description	4C/#16 AWG, 7 strand tinned copper, 25 mils EPR with 15 mils BOSTRAD 7 CSPE jacket, aluminum/polyester tape with #18 AWG 7 strand tinned copper drain wire, 45 mils BOSTRAD 7 CSPE cable jacket.	2C/#16 AWG twisted, shielded pair, EPR insulation, individual CSPE jacket, overall CSPE jacket, 600V.
Normal service conditions	49°C (120°F) for 100% of life 5V @ 2mA (RTD extension cable)	Aged at 97°C (207°F) for 6 months, equivalent to 55°C (131°F) for 40 years. 1390 kGy total radiation dose.
Design basis events	Peak temperature - 129°C (265°F) Peak pressure - 290 kPa gage (42 psig)	Peak temperature - 175°C (347°F) Peak pressure - 500 kPa gage (72.5 psig)
Submergence	Post-LOCA bend and submersion test per IEEE Std 383-1974 @ 2400-Vac for 5 minutes immersed in water.	Conductors passed the 250-Vdc insulation resistance test throughout and after the 1000-hour submergence test at above 90°C (194°F).

The Sandia testing referenced in the March 3, 1993, CP&L letter demonstrates that the BIW cable at Robinson could be qualified for submerged operation following a LOCA. However, NRC sponsored Sandia National Laboratory tests are not acceptable for documenting qualification of equipment by licensees. Based on this fact and the fact that the licensee's other documentation to support qualification is not adequate for submergence, qualification of the Robinson's BIW cable has not been demonstrated for submerged operation following a LOCA.

2.2 Samuel Moore Cable

EQDP No. 11.1, Revision 1, documents the environmental qualification testing for the Samuel Moore cables that can become submerged. The cable is required to be operable for 30 days after a design basis event. The testing by Isomedix referenced in the file included periodic functional testing while submerged, but the licensee states that it did not conclusively show long-term qualification of the cables for submergence. The vendor performed periodic Specific Inductive Capacity and power factor tests of unaged cables submerged in water for 52 weeks. These tests demonstrated electrical stability of the

cables. However, the vendor tests did not include the peak pressures and temperatures of a simulated LOCA, radiation exposure, thermal aging, mandrel bend tests, chemical sprays, or voltage withstand tests. Since the information provided in EQDP No. 11.1 does not include testing of the Samuel Moore cable for 30-days of submerged operation in the chemical solution found in the containment, EQDP No. 11.1 does not demonstrated qualification for submerged conditions at Robinson.

In the March 3, 1992, letter, CP&L referenced Sandia tests on Samuel Moore cables. The Robinson cable construction differs slightly from the cable tested at Sandia. The test was conducted at 90°C (194°F) or higher. The Samuel Moore cables failed electrically prior to the end of the submergence exposure. One conductor passed the 250-Vdc insulation resistance test through the 47 hour test point. Both conductors failed the 100-Vdc insulation resistance test at the 166 hour test point. Since failures occurred during the Sandia test, the test does not demonstrate qualification for submerged operation of the cable.

TABLE 2 -- Samuel Moore Cable

	H. B. Robinson-2 cable	Sandia sample closest to H. B. Robinson-2 cable
Cable type	Dekoron 1X52-68340-001	Dekoron Dekorad Type 1952
Cable description	2/C #16 AWG, 7 strand tinned copper conductors, 20/10 mil EPDM/Hypalon insulator/conductor jacket, aluminum-mylar shield, 45 mil Hypalon cable jacket.	2/C #16 AWG twisted, shielded pair, EPDM insulation, individual CSPE jackets, overall CSPE jacket, 600 V.
Normal service conditions	49°C (120°F) for 100% of life	Aged at 97°C (207°F) for 6 months, equivalent to 55°C (131°F) for 40 years. Total radiation dose at least 1290 kGy.
Design basis events	Peak temperature - 129°C (265°F) Peak pressure - 290 kPa gage (42 psig)	Peak temperature - 175°C (347°F) Peak pressure - 500 kPa gage (72.5 psig)
Submergence	Two tests provided. See narrative. Post-LOCA bend and submersion test per IEEE Std 383-1974 for 5 minutes immersed in water.	The test was conducted at 90°C (194°F) or higher. One conductor passed the 250-Vdc insulation resistance test through the 47 hour test point. Both conductors failed the 100-Vdc insulation resistance test at the 166 hour test point.

Since failures of the Samuel Moore cable occurred during the Sandia testing, the Sandia tests do not provide a basis as to whether the Samuel Moore cables could be qualified for Robinson post-LOCA submergence conditions. Additionally as stated above, the information in Robinson EQDP file 11.1 is not considered adequate to demonstrate qualification of the Samuel Moore Dekoron 2/C #16 AWG, EPDM insulated, Hypalon jacketed cable for post-LOCA submerged operation. Therefore, qualification of the Samuel Moore cable has not been established for submerged operation at Robinson.

2.3 Continental Cable

The Robinson EQDP file 10.0, Revision 1, documents the environmental qualification testing for the Continental cables that can become submerged. The cable is required to be operable for 30 days after a LOCA.

The cable was not specifically designed for submergence; however, the licensee considers it qualified for submergence based on accelerated water absorption testing by the vendor and LOCA testing by Wyle.

Continental performed Accelerated Water Absorption testing for 14 days in 75°C (167°F) water. Water absorption (mg/in^2), increase in capacitance, and stability factor were measured. The tests performed by Continental did not include a simulated LOCA test or a chemical spray test. Dielectric strength was not demonstrated. The 75°C (167°F) temperature does not encompass the containment temperature for the first 24 post-accident hours. Therefore, the vendor test does not demonstrate the adequacy of the Continental silicone cable for submerged operation following a LOCA after 40-years of plant service.

EQDP 10.0, Revision 1, also referenced a Wyle Laboratories LOCA test on Continental cable samples that had been removed from the H.B. Robinson-2 containment after 17 years of operation. That immersion test did not demonstrate satisfactory operation for 30 days, nor did it simulate the chemical solution in which the cables could be submerged during and after a design-basis event.

The Sandia test referenced in the March 3, 1993, CP&L letter was on single conductor silicone-insulated wire of another manufacturer, and therefore, not applicable to submergence of Continental cable. NUREG-0588 does not permit product substitution for testing of cables because consistent polymer formulations between manufacturers cannot be proven. The Sandia testing of Rockbestos Firewall SR cable does not demonstrate environmental qualification of the Continental cable.

Since the vendor and Wyle tests are not considered adequate to demonstrate qualification of the Continental cable and the Sandia testing did not test the Continental cable, qualification of the Continental cable has not been established for submerged operation at Robinson.

3.0 CONCLUSION

The staff has reviewed the available documentation on the three cable types of concern, and has determined that the licensee's documentation does not demonstrate qualification for submergence. Based on the data included in the H.B. Robinson-2 EQDP file 36.0 and the licensee submittal dated March 3, 1992, the H.B. Robinson-2 application of Boston Insulated Wire (BIW) BOSTRAD 7E cable probably could be qualified for submerged operation since Sandia performed successful tests for submergence. However, the Sandia tests cannot be used by a licensee to demonstrate qualification.

Based on the data included in the H.B. Robinson-2 EQDP file 11.1, qualification for submerged operation of the H.B. Robinson-2 application of Samuel Moore cable has not been demonstrated. The Sandia testing reported in NUREG-5655 does not demonstrate qualification of the Samuel Moore cable for submerged operation.

The documentation provided in EQDP file 10.0 does not demonstrate qualification of the Continental silicone-insulated cable for submergence at H.B. Robinson-2. The Sandia testing reported in NUREG-5655 does not apply to the Continental silicone-insulated cable.