U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Meeting No. EA-88-178

Docket No. 50-334

License No. DPR-66

Licensee: Duquesne Light Company
ATTN: Mr. J. D. Sieber,
Vice President, Nuclear Group, P.O. Box 4
Beaver Valley Power Station Unit No: 1
Shipping Port PA-15077

Facility Name: Beaver Valley Power Station Unit No: 1

Conference At: NRC Region I, King Of Prussia, Pennsylvania

Conference Date: August 12, 1988

Approved by: J. P. Durr
J. P. Durr, Chief Engineering Branch   9/6/88
date

Conference: Environmental Qualification (EQ) enforcement conference held to discuss the significance of concerns about the environmental qualification of continental cable, containment High Range Radiation Monitors and wiring inside Limitorque motor operated valves.

1. Conference Attendees

Duquesne Light Company

J. D. Sieber, Vice President, Nuclear Group
J. O. Crockett, Gen. Manager, Corporate Nuclear Services
K. D. Grada, Manager, Nuclear Safety
N. R. Tonet, Manager, Nuclear Engineering
F. A. Oberlitner, Equipment Qualification Supervisor
W. Laughlin, Senior Engineer

Schneider Engineers

J. Archer, Manager
J. A. Murphy, Vice President
D. M. Suhan, Equipment Qualification Engineer

NRC

J. P. Durr, Chief, Engineering Branch
C. J. Anderson Chief, Plant Systems Section
Peter S. Tam, NRR, Project Manager
D. F. Limiroth, Project Engineer
P. R. Wilson, Reactor Engineer
P. H. Bissett, Senior Operations, Engineer
T. Koshy, Lead Reactor Engineer
S. H. Horwitz, Public Affairs

2. Conference Scope

The enforcement conference considered the following potential EQ violations

- Continental Cable (50-334/86-12-1)
- Containment High Range Radiation Monitor (50-334/86-12-3)
- Wiring inside Limitorque Motor Operated Valves (50-334/88-21-02)

The scope of the discussions included:

- Safety significance of each violation, number of deficiencies and number of systems and components affected
- Specific and underlying cause of each violation
- Actions taken or planned to correct the individual violations to ensure overall compliance
- A discussion of each violation in light of the Modified Enforcement Policy for EQ Requirements, GL 88-07

3. Licensee Presentation

The licensee presented their position on the EQ issues of concern. The licensee presentation is outlined in their handout which is provided as Attachment A to this document.

4. Conclusion

The NRC staff stated that the licensee's information would be considered in determining appropriate enforcement actions. The licensee will be notified of NRC's proposed actions in the near future.

ATTACHMENT A

DUQUESNE LIGHT COMPANY
HANDOUT MATERIAL

for

NUCLEAR REGULATORY COMMISSION
Beaver Valley Power Station Unit 1
Electrical Equipment Qualification

ENFORCEMENT CONFERENCE

at

KING OF PRUSSIA, PA

on

August 12, 1988

CONTENTS

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B. Chronological Evolution of Continental Cable Qualification Program

C. Chronological Evolution of Containment High Range Radiation Monitor Qualification Program

NRC ENFORCEMENT CONFERENCE

August 12, 1988

Introductory Remarks - N. R. Tonet, P.E., Manager
Nuclear Engineering Department

Nearly ten years have elapsed since the initial NRC Bulletin on Environmental Qualification was issued. Duquesne Light Company has been fully committed and aggressively involved in the implementation of an Environmental Qualification Program that is in compliance with the NRC program identified in 1979 up through today's 10CFR50.49 requirements. Throughout this period we have provided eight responses to the NRC, all of which identify our commitment and continuing effort to upgrade our EQ status through various replacement, testing, analysis and investigative techniques. We believe that our approach has been fully consistent with and in recognition of the importance of this topic to the NRC and to the industry.

To date, our attention has been focused on safety-related harsh area electrical equipment that is necessary to bring the plant to a safe hot shutdown condition. This necessitated the initiation of a significant number of design changes which are itemized on Table A (SLIDE). Prior to November 30, 1985, 15 major design change packages (DCPs) were implemented as a result of equipment being upgraded to NUREG 0588 Cat. 1 requirements and to meet NRC regulatory requirements such as NUREG 0737. (SLIDE) DCP 351 alone resulted in replacement of 36 transmitters, 54 limit switches, 39 solenoid valves, 6 wide range RTDs, 2 valve operators, installed 48 conduit seals and 51 Raychem splices on instrument circuits required for hot shutdown.

In addition, significant effort was placed on qualification testing of Continental Cable, Marathon and Buchanan terminal blocks, conduit seals, motors, etc.

(SLIDE) Various consultants have been retained to review our EQ program and supplement DLC staffing. Examples of this include an independent review of our 79-01 B submittal by EDS Nuclear, a Continental instrument cable analysis by Eco-Tech, and Design Change support by Stone and Webster for Unit 1 (Stone and Webster was also the BV-2 EQ Engineer). Our primary consulting support for Unit 1 has been through the firm of Schneider Engineers, who have assisted our personnel in the overall EQ program including preparation of EQ files, aging assessments, master EQ list development, and training.

From an industry perspective, DLC has been a member of the Nuclear Utility Group on Equipment Qualification, and as a member of EPRI has participated in various EQ and maintenance related seminars. We are also represented on the IEEE working group 3.3 on Maintenance Good Practices. Various in-house seminars were conducted on our EQ program.

Our Environmental Qualification program is fully comprehensive with consideration of equipment aging, maintenance assessment packages to identify EQ requirements, personnel training, qualified spare parts procurement, configuration management, and procedure review as elements of a very strong program. In prior audits by the NRC our program was recognized as above average on a relative basis in the manner in which it has achieved program compliance. Our recent BV-2 EQ audit resulted in zero findings. It is a program that we all take pride in sharing.

We have in the past and will continue in the future to promote upgrades in our equipment and systems as state-of-the-art technology advances. This aggressiveness may have been part of our problem with the recent Reg. Guide 1.97 field inspection results which found unidentified wiring in Limitorque motor operators. Qualification of the components prior to identifying them on our master list would have prevented this issue from arising in the way that it did.

Since we are continuing to work with the NRC on our compliance to Reg. Guide 1.97, we will provide field walkdowns and qualification reviews prior to adding these items to the EQ Master List in the future.

For those few times where EQ problems have been identified, our approach has been thorough and timely in our opinion. The results of this approach is such that after all is said and done with today's problem summary, we can say with confidence that the plant is qualified to the best of our knowledge with those few exceptions which we have defined in our EQ inspections and which will be dispositioned at the next opportunity. (Justification for continued operation have been developed for these exceptions). That is not to say that we are finished, but only to identify that we have met the intent of our program and that our future plans are in place to continually upgrade equipment, personnel, procedures or training.

Statement of Violation

Qualification of Continental Silicone Rubber insulated cable not established for operation at elevated (LOCA) temperatures.

Licensee Position Regarding Existence of Violation

DLC concurs that IR data was not obtained during the 340°F temperature excursion. This is not a significant violation subject to enforcement action under the EQ Enforcement Policy, due to the fact that cable qualification (functionality) had been established. Therefore, there was no safety significance associated with this item.

License Position Regarding Whether Enforcement Action Should Be Taken Under the EQ Enforcement Policy

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53MΩ

The two requirements for consideration in accordance with Generic Letter 88-07 deal with safety significance, and "clearly should have known" criterion.

DLC maintains that there is no safety significance as it applies to the Continental Wire and Cable (CWC) instrumentation cables at BVPS-1. The cables are utilized in all class 1E instrumentation circuits within the containment. The qualification files support functionality of the cable at elevated temperatures. From the original 79-01B submittal DLC was convinced of the cables functionality at all temperatures due to the original vendor test. All retest results confirmed the qualification status. Original qualification was established using IR readings taken after the post-LOCA temperature spike coupled with functionality testing that enveloped DLC's MSLB conditions.

The question of "clearly should have known" does not apply to the questions of IR readings at MSLB temperatures for the CWC. In response to IE Bulletin 79-01B DLC noted to the NRC that Franklin Institute Research

Laboratory report F-C2935 did not envelope the BVPS-1 postulated chemical spray composition and post accident radiation values inside the cranewall of the containment. In the 79-01B submittal DLC committed to re-testing the cable to satisfy the radiation and chemical spray issues or replacement based on the results of the re-test. The comments from the NRC in TER C5257-490 dated September 10, 1982 for the Continental Wire and Cable, included the two comments that the provided Franklin test report did not envelope the required radiation and chemical spray. The NRC added that preaging performed had not been evaluated to determine the qualified life of the cable. The TER of September, 1982 and the corresponding SER of December, 1982 raised no questions of operability or cable functionality in class 1E instrumentation loops. To meet the commitments made to re-test in the submittal, a test was conducted. Prior to the re-test DLC had evaluated the impact of a MSLB inside containment. Due to the increase in temperature peak and the absence of any cable operability concerns by DLC. or the NRC; the re-test consisted of a test run at the higher MSLB temperature with the cable functionality being monitored continuously (voltage and current). This re-test was completed in August, 1984.

The NRC via IE Notice 84-47, June 15, 1984 notified the industry of testing performed at Sandia National Lab on terminal blocks under accident simulation. The Sandia Report was issued September, 1984 as NUREG/CR 3691. DLC had completed the re-test previous to this report and therefore replaced terminal blocks in class 1E instrumentation circuits within the containment with qualified splices in December, 1984.

Prior to the issuance of NUREG/CR 3691, DLC and the industry were convinced the primary contributor to instrument loop inaccuracies was the sensors themselves. These concerns were addressed in the qualification testing of the sensing devices. Upon receipt of the Sandia results, terminal blocks were identified as a significant contributor to instrument loop inaccuracies. DLC responded to these results by eliminating terminal blocks in the class 1E instrumentation loops within the containment. These circuits were walked down to assure the proper application of the splicing materials.

The program of 10CFR50.49 audits were commenced in late 1984. The results of these and audits performed in 1985 indicated that more focus on instrument loop accuracies was required. DLC re-investigated their positions on this topic in a couple of methods. Wyle Labs were contacted to determine the precision of the test components utilized during the re-test in an attempt to calculate maximum leakage currents during the MSLB simulation. Wyle was unable to provide data that would allow the calculations to be meaningful.

DLC committed to utilizing analytical methods coupled to the available test data to demonstrate minimal error contribution of the cable system to the instrument loop. To accomplish this, DLC utilized testing performed on other SR insulated cables that had been qualified to utilize IR readings taken at the MSLB temperature excursions. The IR results were consistent within the same order of magnitude and therefore DLC concluded the CWC would continue to demonstrate in an acceptable manner at the MSLB temperatures. These results were discussed with the NRC during the audit and also submitted in written form post-audit.

Following the June, 1986 audit, DLC commissioned a broader study of SR insulated cable IR readings at elevated temperatures. This review concluded SR insulated cable would have IR readings in the same order of magnitude at MSLB temperatures.

The recording of cable IR readings during the MSLB peak temperature has been an evolving process which DLC has addressed through its various stages. The brief period of time the cable is exposed to the MSLB peak temperature coupled with the thermal inertia of the insulation balanced with the IR trends of SR insulated cable as a family fully supports DLC's contention that the CWC provided to BVPS-1 is fully qualified and offers no significant safety concern. Throughout the various submittals and reviews (TER, SER) no comments were aired as to cable accuracy or a doubt as to the cable's ability to perform its safety function.

Other Considerations

DLC did report test deficiencies to the NRC with its 79-01B submittals. DLC, based on their admission of testing deficiencies in chemical spray composition, and radiation exposure that did not envelope inside cranewall conditions retested the cable. As instrument loop concerns became known during 1984 and 1985 DLC continued to respond to these concerns. DLC has an inplace EQ program that continues to review their position to issues as the industry is made aware of them (i.e., IEEE Standards Committees, NUGEG, Industry Advisors). DLC's measure of commitment to a dynamic EQ program is evidenced in the most recent testing performed on CWC. DLC was able to locate surplus cable that was procured and delivered with the original cable to remove any doubt of similarity to the installed instrumentation cable. The testing performed on this original cable had IR readings were recorded during the MSLB peak. This data supports earlier silicone rubber material similarity analyses.

DLC did respond to each parameter in the evolution of instrument loop accuracies as impacted by accident service and will continue to do so.

Status

The installation of CWC SR insulated instrumentation cable at BVPS-1 is qualified.

Statement of Violation

Qualification of containment high range radiation monitor cable arrangement not established. Replaced with mineral insulated cable and qualified coaxial containment penetration on February 20, 1988 and installed new containment electrical penetration. This is limited to the two HRRMs in containment.

Licensee Position Regarding Existence of Violation

The timing of the implementation deadline date for the post TMI modifications and outage schedule of BVPS-1 caused the containment HRRM to be installed with a qualified containment penetration module consisting of a shielded, twisted instrumentation cable. DLC was unable to secure a qualifiable coaxial cable penetration during the outage window. The existence of 60 inches of the twisted pair at the penetration was not considered to invalidate the operation of the HRRM system. The HHRM provides indication of radiation field density through eight orders of magnitude. The intent of the modification and the design of the device does not allow a precise reading to be taken due to the low level signal.

Licensee Position Regarding Whether Enforcement Action Should Be Taken Under The EQ Enforcement Policy

DLC contends there is no significant safety violation in that the HRRM system configuration would have provided a relative indication of the radiation field during accident scenarios. The device would tend to read artificially high (> 10E6 rads) at the elevated temperatures associated with LOCA or MSLB. The HRRM system provides full range capabilities in one device, but it is not solely relied upon by the operator to dictate plant recovery actions in the EOPs. DLC was aware of the lack of precision of the detector but was also being responsive to the TMI modifications deadlines with the technology and knowledge available in 1981.

In addressing "clearly should have known" considerations DLC was aware of the difficulties to integrate the Victoreen HRRM into a complete system. Victoreen in their qualification test report had considerable difficulties with the coaxial cable interface. Other utilities experienced cabling problems with coax cables, in particular moisture intrusion. DLC believed their installation of a segment of twisted pair cable did not shadow the operability of the installation to any greater extent than existed in the industry. During the time table pre-November, 1985 the industry was actively qualifying components, with the understanding that a collection of qualified components had a high probability of translating into a qualified system. The topic of total instrument loop accuracy was evolving during late 1984 and 1985. However, the qualified cabling available in that time period was unable to transmit the extremely low (10E-11 to 10E-6 amps) signals concurrent with a simulated accident. In May, 1983, in response to the NRC EQ rulemaking, DLC submitted a revised EEQML listing the Victoreen HRRM.

Other Considerations

DLC was aware of the technology problems of being able to ascertain an unamplified pico ampere signal with conventional cabling during postulated accident scenarios. This problem is generic to the nuclear industry. Continuous coaxial cable was the preferred installation method, but the IR readings still left doubt as to the reliability of being able to detect the low signal levels. The various coaxial cables did not have a high success ratio during testing when the cables interfaced with a connector. The more vulnerable connector shell to cable outer jacket interface usually allowed moisture intrusion which caused signal degradation. DLC considered their installation on a par with the industry. Other utilities and the NRC recognized the inability to obtain precise containment radiation readings using components and cable that was available.

NUREG/CR 4728, February, 1988, reports the results of Sandia tests for synergistic effects of MSLB temperature combined with heat produced during exposure to radiation of a HRRM. Sandia concluded the detector passed the testing and the test anomalies observed were due to cabling and connector problems. This reinforces the contention that the existing technology continues to experience problems with low level signal transmission during simulated accident conditions.

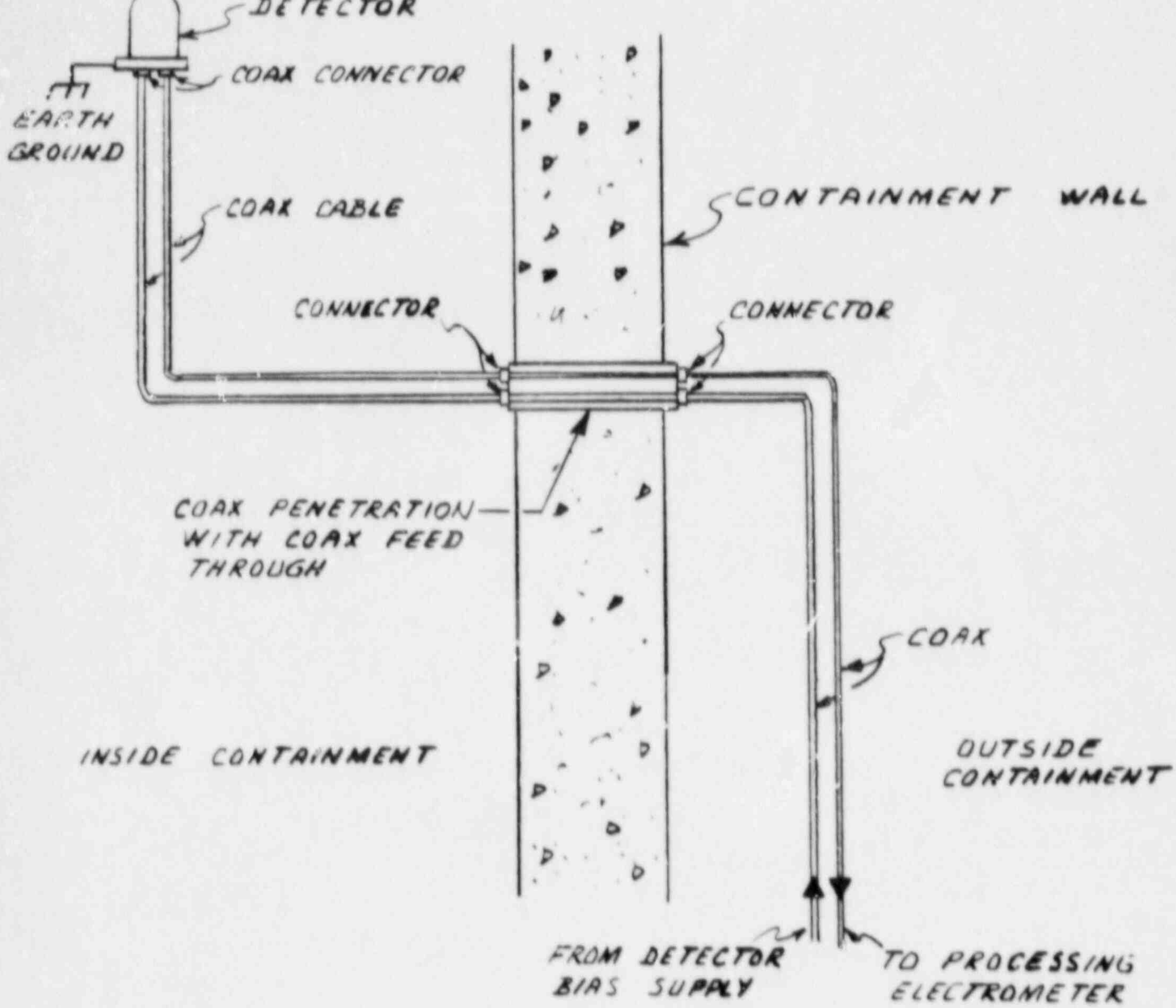
Status

DLC has installed a fully qualified cabling and containment penetration modification to enhance the HRRM system. The key factors which increase reliability of this detection system are listed below:

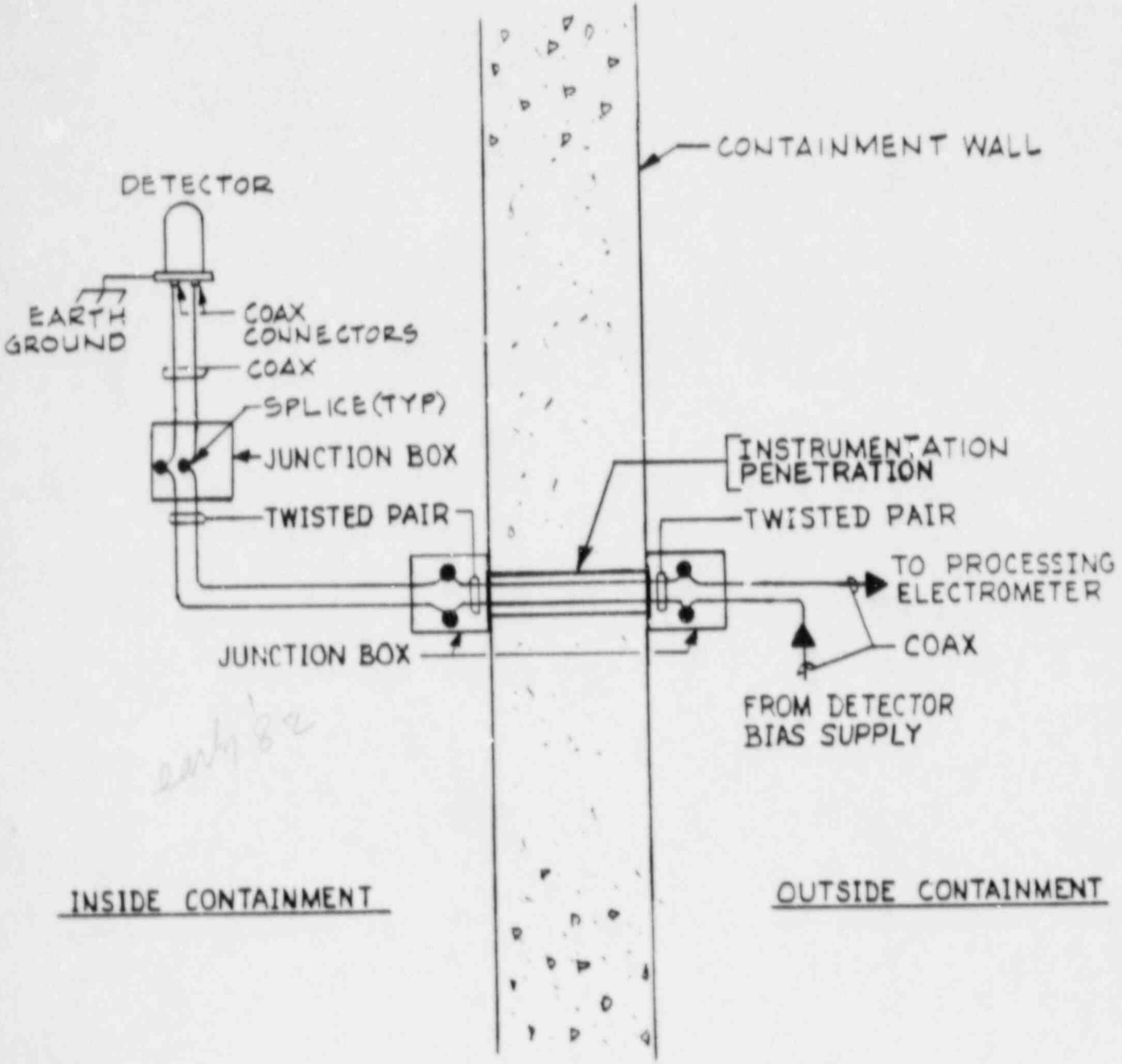
The Victoreen sponsored testing monitored a system status light during the MSLB/LOCA simulation. The data tapes were lost in transit and therefore, the ability of the monitor to detect radiation with a measure of repeatability during a DBE cannot be assessed. DLC utilized testing on an identical monitor for another utility to demonstrate the ability to sense radiation during a DBE. This was accomplished by exposing the monitor to a known source during the DBE simulation and monitoring the output of the device.

DLC chose to investigate alternate cabling methods other than a vapor-proof raceway system. Utilizing an A-E to coordinate the research, design, and acceptance testing, DLC has completed the installation of a hermetically sealed, stainless steel sheathed, mineral-insulated triaxial cable. An additional benefit is only the connection to the Victoreen detector is exposed to the DBE environment. The second cable interface is in the cable vault exterior to the containment. DLC feels this is a significant improvement in system configuration from the conventional installations.

The installation was installed in an expedient manner considering the magnitude of development, testing, engineering, procurement, and necessary construction labor for the DCP.



VENDOR RECOMMENDED DESIGN



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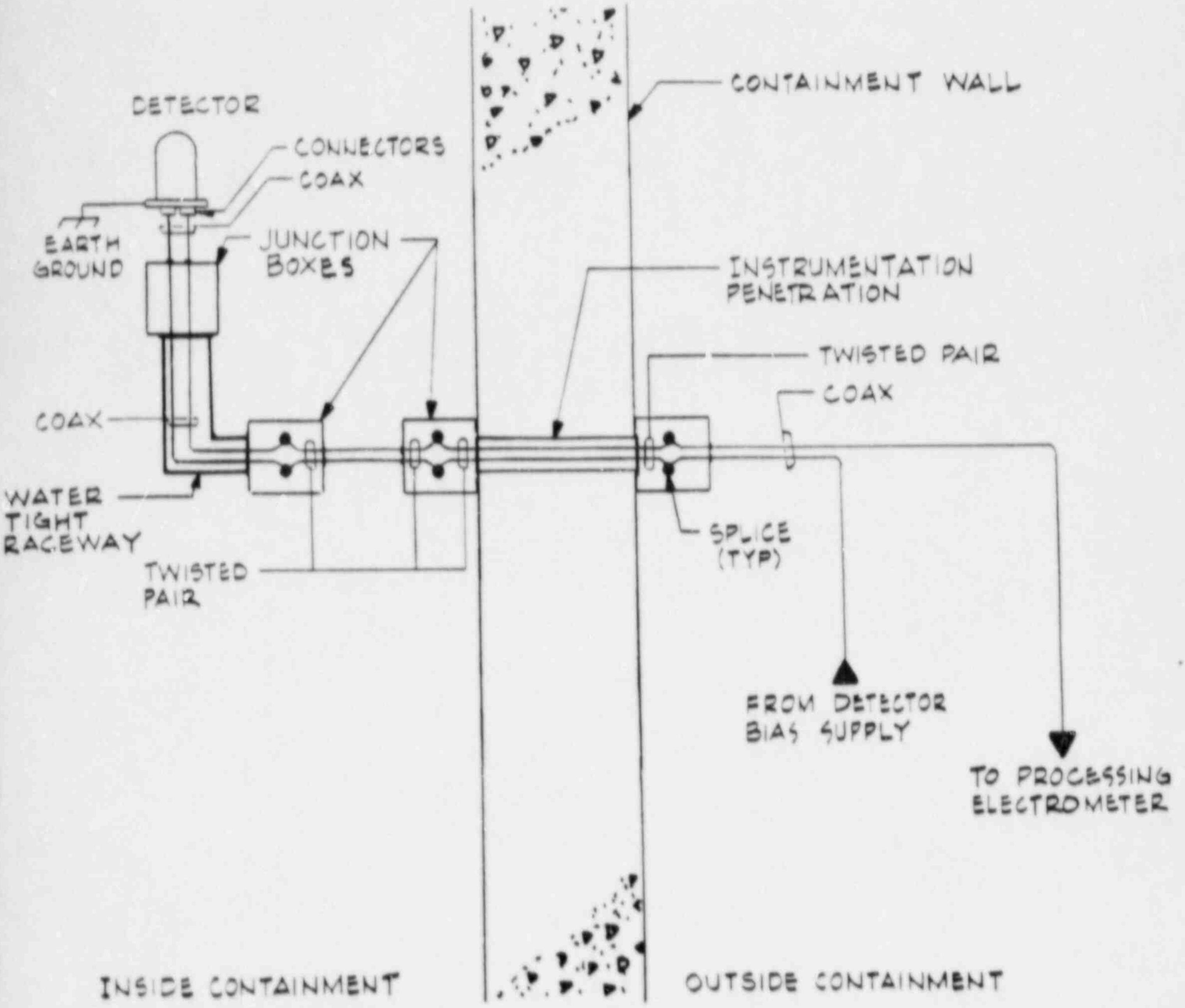
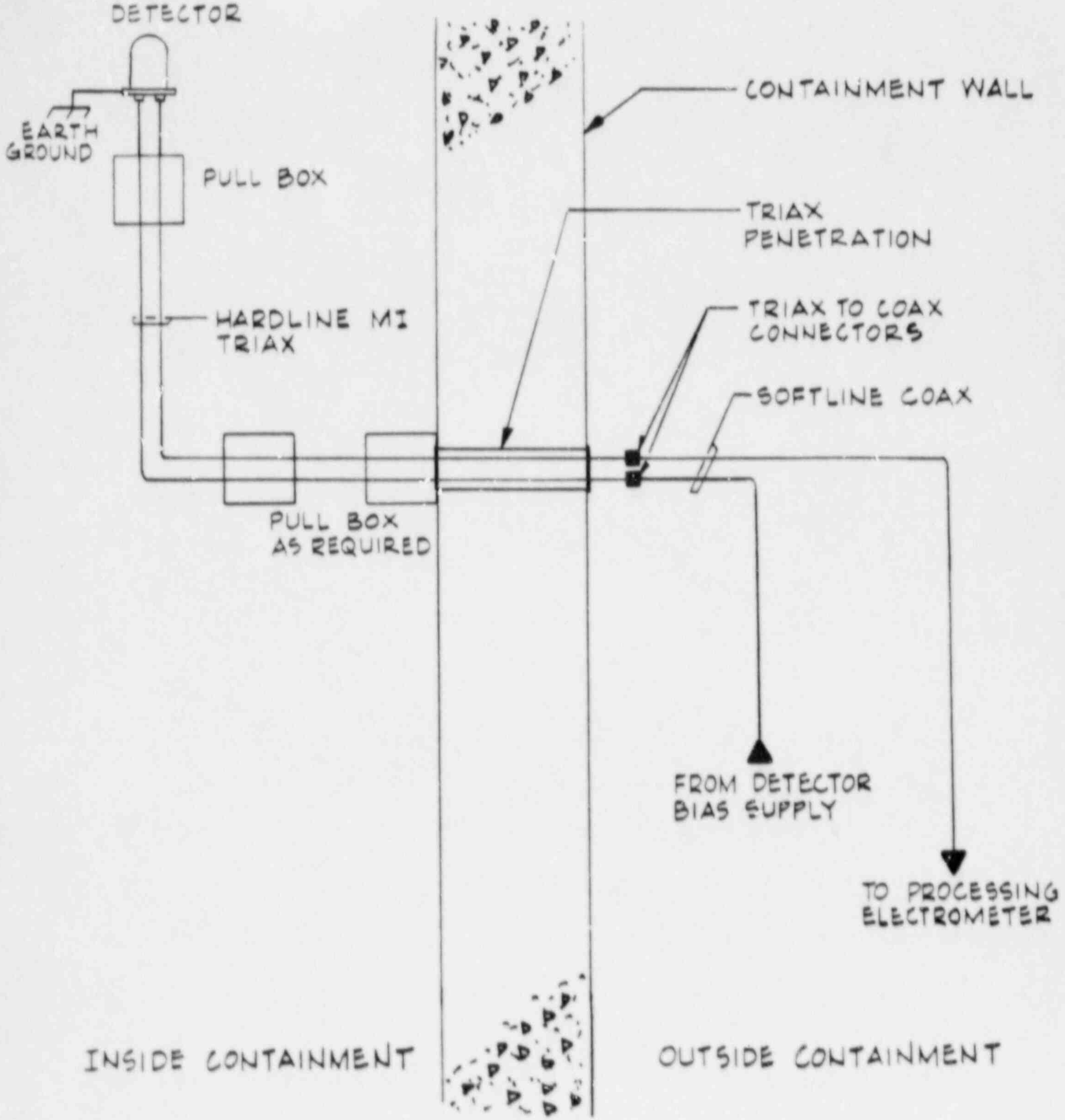


AS BUILT CONFIGURATION



EXISTING CONFIGURATION

MAY-JUNE 1988 ACTIVITIES

THE WIRE NUT ISSUE

Background

On May 11, 1988 an NRC inspector found an unanalysed wire nut installed in MOV-SI-885B while inspecting MOV's equipped with dual voltage motors to determine the type of connectors used to splice motor winding leads. It is believed that most dual voltage MOV's were equipped with Thomas & Betts (T & B) crimp type connectors. These have been separately tested by another utility and are being accepted by the NRC where their presence can be confirmed. The wire nut found in MOV-SI-885B had not been similarly tested and was not considered acceptable.

Cause

The wire nut in MOV-SI-885B had been installed by DLC maintenance under MWR 875974 on April 11, 1987 after a motor lead was smashed during the Mini Outage EQ inspection. Wire nuts were also installed in MOV-SI-864A during a motor replacement under MWR 871661, Jan. 6, 1988.

Corrective Action

All of the wire nuts were replaced with qualified Raychem splices. A review of MWR's did not indicate any other suspect repairs. In addition, 37 other MOV's equipped with dual voltage motors were inspected between May 11, 1988 and June 11, 1988 and all of them had the approved T & B connectors installed.

Current Status

Four MOV's with dual voltage motors inside the containment have not been inspected for winding lead connectors.

Maintenance supervisors have been instructed to perform a timely post maintenance review of EQ MWR's prior to turning the equipment over to OPS to assure equipment has been properly repaired and restored to a qualified condition. In addition, we have committed to perform additional EQ training and to review our maintenance procedures to assure that similar problems do not reccur.

UNOR 88-47 was issued on this topic which determined that it was not reportable based on 8700-JPO-(88-47) which was submitted to the NRC on May 20, 1988.

INCOMPLETE REG. GUIDE 1.97 INSPECTIONS

Background

On May 12, 1988 an NRC inspector found an unidentifiable wire jumper in MOV-RW-105D while inspecting for motor winding lead connectors. The question of unqualified wires was originally raised by IEIN 86-03 and was the subject of previous inspections carried out under EM's 30056, 30543, and 73602, as noted above. MOV-RW-105D was one of 31 MOV's added to the EEQML to satisfy the requirements of Reg. Guide 1.97 and was listed on EM 73602 as requiring inspection.

Cause

EM 73602 was entitled "6R - Limitorque Inspections" but was not explicit as to when the inspections had to be complete. Due to outage scheduling constraints only the five MOV's inside the containment were inspected during 6-R including four Reg. Guide 1.97 EQ inspections and one terminal block inspection. The EEQML was subsequently revised to add all 31 Reg. Guide 1.97 MOV's with the result that 27 uninspected MOV's appeared on the list.

Corrective Action

MOV-RW-105D was reworked via MWR 882833. Inspection of the remaining EM 73602 MOV's was conducted between May 12 and June 11, 1988 during which 17 were reworked, 6 were found to have satisfactory wire and 3 remain to be reworked as noted below.

Current Status

Three MOV's which were found to contain unanalysed wire have not been reworked due to operational constraints, MOV-CR-308A, B C. We submitted 8700-JCO-(88-48) for these MOV's to the NRC on May 20, 1988 along with a JCO for MOV-FW-156A, B, C which were subsequently reworked. We submitted 8700-JCO-(88-48) on May 20, 1988 for MOV-RW-105D and the remaining EM 73602 MOV's which were reworked. We are also reviewing our procedures regarding additions to the EEQML to assure that all equipment listed is in a qualified condition prior to being included on the list.

UNOR 88-48 has been issued on this topic which determined that it was not reportable.

REINSPECTION OF PREVIOUSLY INSPECTED MOV'S

Background

On June 6, 1988, while performing inspections of MOV's with dual voltage motors, unanalysed jumper wires were found in five MOV's that were among the original 42 MOV's on the EEQML and had been inspected under EM 63506 during 5-R. We conducted a review of both the EM 63506 and EM 63456 inspection activities to determine whether any more of them might also be suspect. The results of this review indicated that, in addition to the 5 MOV's noted above, 13 other MOV's merited reinspection. Twenty-four MOV's were determined not to require reinspection for the following reasons:

1. Inspection records and wire specimens removed during earlier EQ inspections indicated proper rework (11 MOV's).

2. MOV's were inspected for dual voltage motor connectors in June 1988 during which jumper wires were also being examined (4 MOV's).

3. Wiring was reinspected during inspection of field wiring in June, 1988 (4 MOV's).

4. Wiring had been inspected during the BVPS-1 EQ audit and was found acceptable (2 MOV's).

5. MOV-SI-865A, B, C were removed from the EEQML in June, 1988 (3 MOV's).

Cause

It turned out that each of the 5 deficient and 13 suspect MOV's had been inspected during 5-R under EM 30506 which was the very first round of MOV EQ inspection activities. Interviews with persons involved in those inspections indicated that, although the inspection checklist did not make such a distinction, it was interpreted to apply only to "vendor supplied" jumper wires. It appears that they did not fully understand the scope of the inspection and thus exempted certain wires from scrutiny. Persons performing subsequent inspections did not make this distinction resulting in the proper replacement of any jumper wire that was not identified as qualified.

Corrective Action

Between June 9 and June 11, 1988 wires in the 5 deficient MOV's were replaced with qualified wire. The 13 suspect MOV's were inspected with the result that 11 were reworked and 2 were found to be acceptable.

Current Status

8700-JPO-(88-57) was prepared on this topic and UONR 88-57 was issued which determined that it was not reportable.

REINSPECTION OF PREVIOUSLY INSPECTED MOV'S (CONT'D)

FUTURE ACTIONS

A task force has been established consisting of representatives from Maintenance, QC, and NERU to review existing programs and procedures affecting EQ MOV's. Topics under review include:

1. Procurement and stocking of spare parts.
2. Maintenance procedures.
3. EECML additions and deletions.
4. Training.
5. Post maintenance review of MRW's.
6. Development of a configuration control matrix for MOV's.

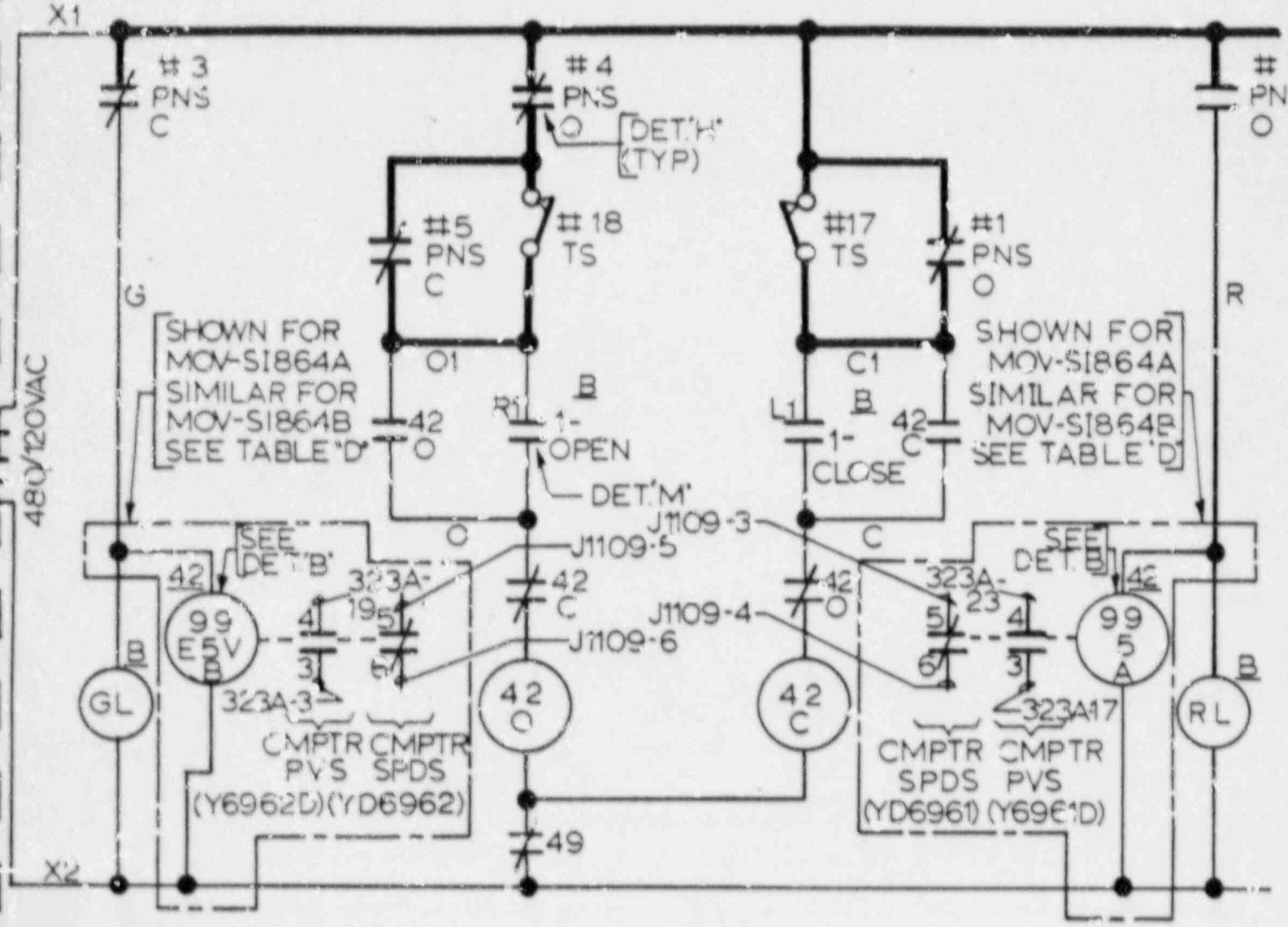
TRAINING STATUS

1. TRAINING FOR MAINTENANCE CRAFT AND SUPERVISION - THE HAS BEEN PREPARED AND HAS BEEN DISTRIBUTED FOR FINAL COMMENTS. TRAINING SESSIONS HAVE BEEN SCHEDULED AS FOLLOWS: UNIT 1 - AUGUST 25, 1988
UNIT 2 - AUGUST 16, 1988

2. PROCEDURE REVIEW - THE PROCEDURE REVIEW IS IN PROGRESS AND WILL BE COMPLETED BY AUGUST 31, 1988.

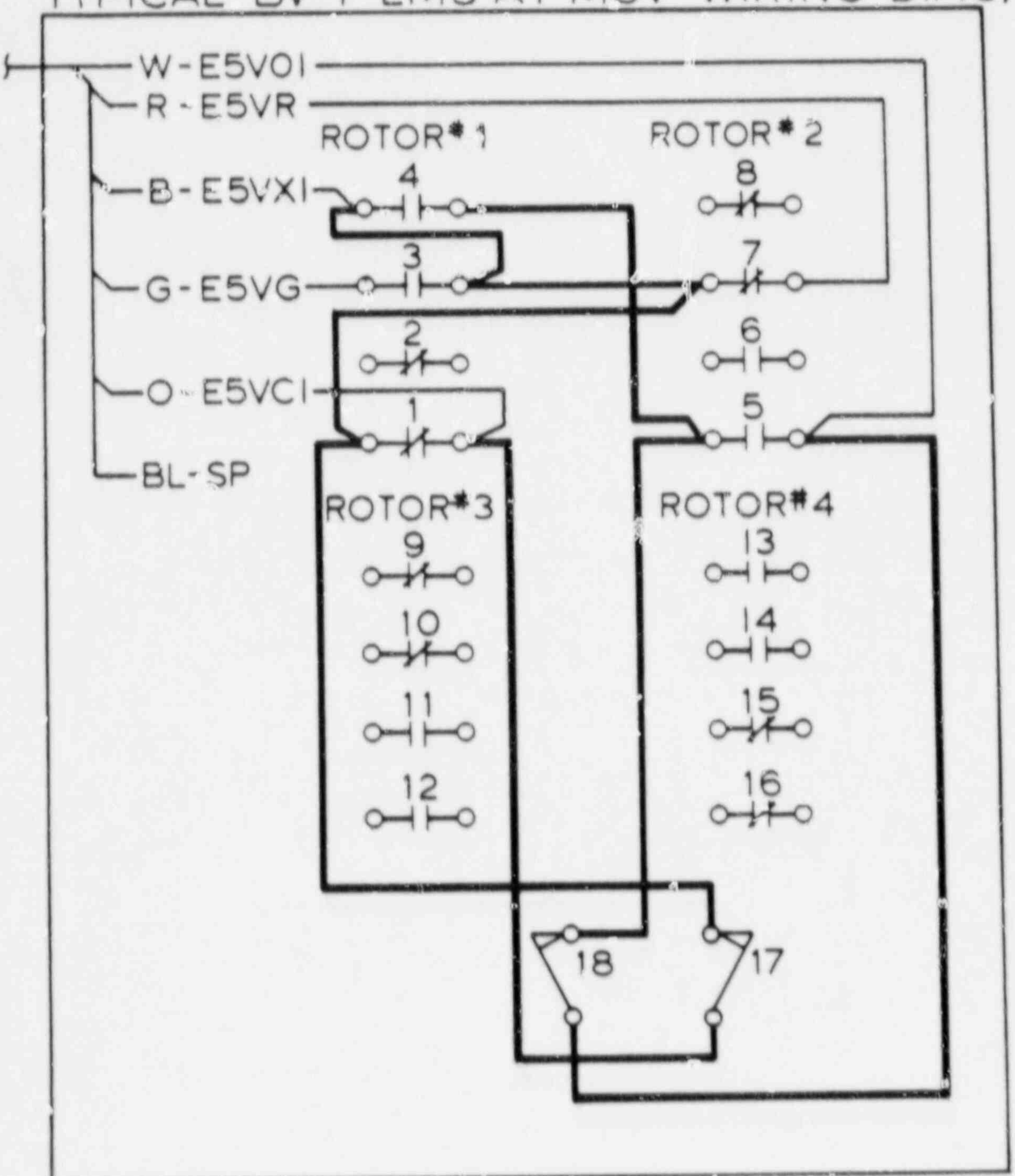
3. INCREASED SUPERVISORY REVIEW OF MWR'S - THIS WAS IMPLEMENTED VIA MEMO DATED MAY 20, 1988.

4. EQ TRAINING OF EQ INSPECTORS SCHEDULED FOR AUGUST 17, 18, 1988.



TYPICAL BV-1 MOTOR-OPERATED VALVE ELEMENTARY DIA.

TYPICAL BV-1 LMS AT MOV WIRING DIAG.



(VALVE SHOWN IN OPEN POSITION)

Current Status of Program

A task force was established after the recent Limitorque (May, 1988) issues consisting of representatives from engineering, maintenance, and quality control. Topics being reviewed by this task force:

1. Procurement and stocking of Spare Parts.
2. Review of Maintenance Procedures.
3. When equipment is added to the EEQML.
4. Training of maintenance, quality control and engineering.
5. Post maintenance reviews of MWR's.
6. Engineering review of MWR's.
7. Development of configuration control matrix for MOV's.

Recent Q/A audits of BV-1 and BV-2 have revealed no major deficiencies with minor observations noted. The BV-1 audit identifies the need for better documenting the training of craft personnel to do Raychem Splices. In response to this finding, Raychem has recently conducted training for DLCo instructors to train craft personnel in order to document training completed.

As a result of the BV-2 NRC audit, Inspector Report No. 50-412/88200, DLCo has recently submitted procedure change request to clarify EQ categories, completed the Q/A audit of the BV-2 EQ program, and scheduled training for Q/C inspectors (August 17, 18, 1988).

A DCP has been initiated to replace the Gamma Metrics junction box "O" ring during the BV-2 first refueling outage. The BV-2 maintenance assessment package (MAP) has been revised to cover inspecting a permanent sample of 10 operators every outage and a different set of 20 each outage. Acceptance criteria for surveillance tests is being reviewed. BV-1 is replacing approximately 16 Barton Transmitters during the 7th Refueling Outage since they are approaching 10 years of service.

Since 1985, eight design changes have been implemented related to equipment upgrades. These include Reg. Guide 1.97 transmitters, MCC transformers, Hydrogen recombiners, inadequate core cooling and installation of Conax containment penetrations and Mineral Insulated cable for the BV-1 high range radiation monitors.

DLCo is continuing to take an active position with respect to EQ with the highest priority being safety.

EQ RELATED DESIGN CHANGES AFTER 1985 — CAPITAL COSTS

EQ RELATED DESIGN CHANGES AFTER 1985	CAPITAL COSTS
DCP-514 - REPLACE OBSOLETE TRANSMITTERS	$ 415,551
DCP-564 - MCC CONTROL TRANSMITTERS	$ 127,939
DCP-621 - H_2 RECOMBINER	$2,212,826
DCP-643 - CONTAINMENT SUMP LEVEL TRANSMITTER	$ 58,344
DCP-668 - INADEQUATE CORE COOLING	O&M
DCP-690 - HI-TEMP WIRE REPLACEMENT	$4,091,847
DCP-800 - RM 219A, 219B PENETRATION REPLACEMENT	$ 681,438
DCP-818 - ITT BARTON TRANSMITTER SUPPORTS	O&M
	$7,587,945

CONCLUSIONS

In summary, DLCo believes the qualification of the Continental cable was established prior to November 30, 1985 based upon IR readings taken between 200-150°F coupled with functionality testing that enveloped Beaver Valley Unit 1's MSLB conditions. DLCo reported deficiencies of the original Franklin testing in the 79-01B submittal which resulted in a retest of the cable in 1984. Responding to NRC concerns of Insulation Resistance, DLCo commissioned an analysis be performed and retested the cable in 1987. The analysis and retest confirmed DLCo's position, the cable has always been qualified. Performance data was in the file as of November 30, 1985 based upon IR readings taken after the Post-LOCA spike coupled with functionality testing that enveloped DLCo's MSLB conditions.

DLCo considers the qualification of the high range radiation monitoring system to be as qualified as technology permitted as of November 30, 1985. With DLCo's configuration any leakage current at the splice interface would have had a positive effect on the output reading of the monitor, thus any error would be conservative. As technology developed, DLCo took action in 1986 to replace the original cable configuration with a qualified mineral insulated cable with one connection inside containment. This configuration is qualified and is a significant improvement over conventional systems.

DLCo will continue to take an active position with respect to EQ and will take into account new information and practices as the EQ arena continues to evolve.

APPENDIX A

Overall DLC Electrical
Equipment Qualification
Program Synopsis

- Summary of NRC Reporting
- Summary of Previous Actions

EQUIPMENT QUALIFICATION
PROGRAM

SUMMARY OF NRC REPORTING FOR BV-1

- INITIAL 79-01B SUBMITTAL - DEC. 31, 1980
- AMENDMENT 1 79-01B SUBMITTAL - OCT. 15, 1981
- 30 DAY RESPONSE 1982 NRC SER - JAN. 27, 1983
- 90 DAY RESPONSE 1982 NRC SER - MAR. 27, 1983
- NRC OVERVIEW MEETING IN BETHESDA - APR. 5, 1984
- NRC DETAILED EQ AUDIT AT BVPS-1 - JUNE. 1986
- NRC 1986 AUDIT ASSESSMENT/CLOSE-OUT - MAY. 1988
- NRC EQ ENFORCEMENT CONFERENCE - AUG 12, 1988

BVPS-1 EQUIPMENT QUALIFICATION PROGRAM

ITEMS REPLACED:

FISCHER & PORTER TRANSMITTER

GEMS LEVEL TRANSMITTERS

MASON-NEILAN LEVEL TRANSMITTER

SOSTMAN RTD'S

UNHOLTZ-DICKIE CHARGE - AMP FLOW DETECTORS

NAMCO 2400X LIMIT SWITCHES

TRINITY RTD'S

ASCO HP-8320 SOLENOID VALVES

ASCO LB-831654 SOLENOID VALVES

ASCO LB 31924 SOLENOID VALVES

BVPS-1 EQUIPMENT QUALIFICATION PROGRAM

ITEMS RETESTED:

VIKING PENETRATION

BUCHANAN TERMINAL BLOCK

CONTINENTAL CABLE

ITEMS TESTED:

RAYCHEM SEALING KIT

RAYCHEM CABLE INSULATION REPAIR KIT

CROUSE HINDS CONDUIT SEAL FITTING

RAYCHEM CABLE SLEEVES

ITEM ANALYSED:

LOUIS ALLIS MOTOR

EQ RELATED DESIGN CHANGE PACKAGES PRIOR TO 1985 — CAPITAL COSTS

EQ RELATED DESIGN CHANGE PACKAGES PRIOR TO 1985	CAPITAL COSTS
DCP-180 - Diesel Gen. Circuit Sequencing	O&M
DCP-204 - Uninterruptible Power Supply Systems	O&M
DCP-248 - Feedwater Control Valve Modification	O&M
DCP-292 - Acoustical Valve Monitoring	$ 180,334
DCP-293 - Subcooling Monitoring System	O&M
DCP-294 - Hydrogen Monitoring System	$ 3,861,297
DCP-295 - Reactor Coolant Gas Vent	$ 2,293,737
DCP-297 - Containment Pressure Monitoring	?
DCP-298 - Sump Level Indication System	O&M
DCP-303 - Radiation Monitoring System	O&M
DCP-320 - Post Accident Sampling System	$ 6,042,094
DCP-333 - Reactor Vessel Level Indicating System	$11,256,174
DCP-337 - Diesel Gen. 1 & 2 Auto Load Seq. Timers	O&M
DCP-351 - Replacement of Qualified Equipment	$ 6,881,[illegible]
DCP-408 - Automatic Isolation of Auxiliary Steam & Steam Generator Blowdown Valves	$ 6,358,085
Min.	$36,903,327

OUTSIDE SUPPORT

ORGANIZATION	PROGRAM
Ecotech	• Continental Cable Material Traceability Analysis
EDS Nuclear (Now Impell Corp.)	• Independent Review of 79-01B Program • Motor Analysis
Farwell and Hendricks	• Equipment Testing
Schneider Engineers	• EQ Files • EQ Training • Aging Assessments • Maintenance Assessment Packages
Stone & Webster Engineering Corp.	• 79-01B Submittal • Test Plan • NUREG 737 Equipment
Wyle Laboratories	• Equipment Testing
Westinghouse	• 79-01B Submittal • Motor Aging Assessment

APPENDIX B

Chronological Evolution of
Continental Cable Qualification
Program Status

Continental Cable Environmental Qualification Program

Time Frame	DLC Qualification Activity	Nuclear Industry Evolution
1970	Original Continental Cable Test at Franklin Research Center F-C2935. Cables were continuously energized with 600V, 12 to 14 amperes applied during preconditioning, steam exposure, and post LOCA periods. Dielectric measurements made after approximately 3 hours following the high temperature peak test. It was concluded that leakage currents did not reveal any breakdown of the insulation.	Initial type testing conducted concurrent with the development of IEEE-323, 1971. IEEE-383, 1974 basically stated that the cable should pass a 5-minute voltage withstand test underwater following radiation exposure, operated under rated voltage and load while simultaneously exposed to LOCA conditions within the specified electrical parameters, and pass a voltage withstand test under water for the post-LOCA simulation test.
1978	Initial response to IE Bulletin 78-08 (May 31, 1978) program identified Continental Cable.	Qualification testing programs well underway in NTOL plants, with a few licensed to meet IEEE-323-1974.
1979	Response to IE Bulletin 79-01 (Feb. 8, 1979) program and DOR Guidelines included the preparation of SCEW sheets.	
1980	o First detailed submittal to NRC of the cable's qualification status as a result of the NRC's IE Bulletin 79-01B (January 14, 1980) and CLI-80-21 (May 23, 1980 - DOR & NUREG 0588). IE Bulletin 79-01B included the DOR Guidelines and NUREG 0588.	DOR Guidelines in Section 5.2.5 state that components should be normally energized during the tests and should be representative of actual operating conditions. Failure criteria should include instrument accuracy requirements based on the maximum error assumed in the plant safety analysis

Continental Cable Environmental Qualification Program

Time Frame	DLC Qualification Activity	Nuclear Industry Evolution
	o DLC prepared detailed qualification file on the cable, addressing qualification testing and ability to satisfy NRC requirements. A SCEW sheet checklist and status worksheet were transmitted to the NRC as summary information as part of the formal submittal required by the NRC of all harsh area equipment requiring environmental qualification. This DLC submittal pointed out that the chemical spray and radiation testing performed in 1970 on the Continental Cable had not completely enveloped the BVPS-1 plant's service conditions and that DLC was in the process of determining if further qualification testing was appropriate.	
	o A meeting was held in Bethesda with the NRC resulting with the requirement that additional information would be provided by DLC. This additional information in the form of a revised transmittal was sent to the NRC on Dec. 31, 1980.	
1981	o NRC issued Safety Evaluation Report (TER) (June 23, 1981).	
	o DLC transmittal (October 15, 1981) a response to the TER along with a complete revision to the previous IE 79-01B transmittal.	
1982	o NRC issued Safety Evaluation Report (December 16, 1988)	

Continental Cable Environmental Qualification Program

Time Frame	DLC Qualification Activity	Nuclear Industry Evolution
1982	DLC responded to the NRC's Technical Evaluation Report addressing concerns related to chemical spray and radiation. The evaluation was based on the 284°F North Anna temperature profile and as depicted by Attachment 1, the NRC review of the cable denoted no deficiency with the following test sequence or with cable functionality: - Irradiation - Temperature/Humidity Test - LOCA Simulation - Megger and Dielectric Test where it was clear that the dielectric was measured after the peak LOCA temperature simulations. As a result of this NRC assessment, DLC had made the decision to retest the cable to address only the two qualification areas of radiation and chemical spray. o DLC, based on its understanding of the DOR Guidelines requirements, as well as the findings of the NRC TER Continental cable assessment, understood functional testing and accuracy to be focused on instruments per se and did not address insulation resistance accordingly.	
1983 & 1984	Continued conducting engineering review of file contents and test report. Acknowledged that the test had to envelope a newly-defined MSLB temperature profile of 350°F for BVPS-1 as well as satisfy the plant's service condition for the radiation and chemical spray parameters.	

Continental Cable Environmental Qualification Program

Time Frame	DLC Qualification Activity	Nuclear Industry Evolution
August 1985	Performed a successful test of Continental Cable at Wyle Laboratory to address the radiation and chemical spray concerns. Prepared summary statement for file and completed assessment of Continental Cable location. Insulation resistance readings at the peak temperature conditions were not taken during this test because the known focus to DLC at that time relative to cable performance was insulation breakdown and the cable's tested insulation resistance readings from the 1970 Franklin test were considered to be of an exceptionally high amount, 53 Mohms, to preclude any concern, even though the IR readings were taken after its initial temperature spike. For the cable insulation to have been unqualified for its use in instrument circuits at BVPS-1 would mean that the insulation resistance would have had to increase from less than 1 Mohm to 53 Mohms in a relatively short time frame as the temperature dropped from 340°F to 150°F. This large of a swing was considered by DLC to be highly unlikely and was, therefore, qualified as a result of the initial testing and the follow-up testing. During the accident simulation testing, the cable's current was measured and was to remain within specified level at an applied voltage level.	NRC detailed EQ Inspection Audit Program focused on need to have insulation resistance data available especially for instrumentation cable.

Continental Cable Environmental Qualification Program

Time Frame	DLC Qualification Activity	Nuclear Industry Evolution
June 1986	NRC detailed audit of BVPS-1 environmental qualification program raised the question of lack of cable insulation resistance readings not being available during the MSLB temperature peak period. DLC commented that the Continental cable's silicone rubber insulation had very good physical characteristics (including insulation resistance) in high temperature environments as referenced by other quoted testing conducted on silicone rubber. DLC continued to take the position that the Continental cable was qualified and committed to determine if further analysis could provide the appropriate linkage to other testing of similar silicone rubber compounds.	
1987	DLC addressed the cable insulation resistance issue that was raised during the 1986 audit by retesting again the Continental cable. The insulation resis tance measured had a minimum value of 6.6 E6 ohms during the two high temperature dwells, test connection anomalies not withstanding.	

EQUIPMENT ENVIRONMENTAL QUALIFICATION REVIEW OF EQUIPMENT ITEM NO. 22

NRC REQUIREMENTS WITH SECTION REFERENCE (DOR/0588-I/0588-II)	LICENSEE SUBMITTAL	QUALIFICATION DOCUMENTATION	DEFICIENCY (X OR NOTE NO.)
Acceptance Criteria (5.2.5/2.2.1/2.2.1)	N/A	Not Stated	
Accuracy (5.2.5/-/-)	↓	Not Applicable	
Number of Specimens	↓	2	
Test Instruments Calibrated	↓	Yes	
Safety Function (Active/ Passive) (-/2.1.3/2.1.3)	active	Not Applicable	
Test Duration (5.2.1/-/-)	N/A	32 Hours	
Accident Duration (Envir. Above Normal) (5.2.1/-/-)	~24 hr	Not Applicable	
Required Function Time	6 mo	Not Applicable	
Test Sequence (General) (5.2.3/2.3.1/2.3.1)	N/A	Irradiation Temperature/Humidity Test LOCA Simulation Megger and Dielectric Test	
Test Sequence (NUREG-0588, Cat. I) (-/2.3.1/-) 1. Representative Sample 2. Baseline Data 3. Performance Extremes 4. Thermal Aging 5. Radiation Aging 6. Wear Aging 7. Vibration/Seismic 8. DBE Exposure 9. Post-DBE Exposure 10. Inspection	↓		
Aging (5.2.4, 7.0/4.0/4.0) Thermal Aging/Basis	No potential	151°F, 100%RH/ 6hours	X
Material Aging Evaluation (7.0/-/-)	↓	Not Stated	Note 1
Materials Susceptible (Thermal) (5.2.4, 7.0/-/-)	↓	Not Stated	
Radiation Aging, Type	Gamma	Not Stated	

APPENDIX C

Chronological Evolution of
Victoreen Containment High Range
Radiation Monitor
Qualification Program Status

Victoreen Radiation Monitor Qualification Program

Time Frame	DLC Qualification Activity	Nuclear Industry Evolution
		NUREG 737 TIM action item, containment high range radiation monitor system, was required to be installed by 1/1/82. Regulatory Guide 1.97, Rev. 2 permitted the high range radiation monitor to be within a factor of 2 of any given reading.
1980	High range radiation monitor procurement specification prepared by DLC. Victoreen qualification testing was underway.	
1981	Purchase order issued. Qualification testing completed but report was not immediately issued. System designers were concentrating on potential noise and capacitive interference.	
1982	Radiation detector system installed. Manufacturer's manual specified ± 36% of input radiation system accuracy accumulative at meter and ± 28% of input radiation system accuracy analog output. Decision to install a majority of the cable as coax wire and utilize an existing instrument penetration was made.	
1983	Victoreen qualification test report was made available. DLC Evaluators recognized that the unit was subjected to harsh service conditions but did not monitor a radiation source simultaneously.	
1984	Testing completed for an identical unit at Indian Point 2 qualified the radiation monitor for harsh service condition while actually monitoring a radiation source.	

Victoreen Radiation Monitor Qualification Program

Time Frame	DLC Qualification Activity	Nuclear Industry Evolution
1985	DLC evaluated the high range radiation monitor for revised MSLB peak temperature.	
1986	NRC EQ audit raised the issue of potentially high leakage current existing during design basis event conditions where the twisted shielded pair cable was installed. DLC believed that the shielded twisted pair arrangement was not a significant concern because its length of run of previously tested Brand Rex cable was relatively short and that coaxial cables had indeed been installed for almost all of the cable run inside the containment. Separate DLC EQ files had qualified the Brand Rex instrument cable, the Viking penetration, and the Raychem splice. At this point in time, DLC was convinced that the components in the as-configured system were similar enough to what had been qualified to represent a qualified radiation monitor system, however, the amount of inaccuracy that could be incurred was not appropriately addressed.	
	DLC decided to install mineral insulated triaxial cable from the radiation monitor on through the electrical penetration to improve the system's reliability and accuracy.	
1988	Mineral insulated triaxial cable system installation was completed during the sixth refueling outage.	

Safety Perspective - High Range Radiation Monitors

The qualification deficiency of the BV1 HRRM would have caused the monitors to respond up-scale to a HELB regardless of whether there was a degraded core condition or not. This was due solely to the fact that the applied voltage of 500V in conjunction with the reduced insulation resistance of the cable would have acted to provide sufficient current output to effectively shunt the current output of the detector. The detectors current output starts at 10^{-11} amps and spans 7 decades.

Although this review is geared towards the anticipated detector response, the conclusion would similarly apply to a low or divergent reading between the HRRMs. My review will cover operator diagnostics and mitigation of a HELB and subsequent use of the information for event classification and providing protective action recommendations.

Emergency Procedure E-0 is entered on four conditions:

- Rx trip
- SIS
- or conditions dictating a need for these ESF circuits to actuate.

The initial operator monitoring of the High-Range Radiation Monitors (HRRM) is procedurally required on step 24 of E-0 which is entered on a reactor trip or safety injection. Step 24 requires the operator to check if the RCS is intact by monitoring if the containment radiation is consistent with pre-event values and also checking that containment pressure and sump level are consistent with pre-event values. If <u>any</u> of these three indications indicates a positive response, then the operator is directed to E-1 for a loss of reactor or secondary coolant.

Step 4 of E-1 has the operator determine if the fault is in the reactor coolant system or secondary system by monitoring for a depressurized steam generator or any steam generator pressure decreasing in an uncontrolled manner. If either of these conditions exist, the operator then transitions to E-2 for faulted steam generator isolation; otherwise, the operator remains in E-1 for a loss of coolant accident.

Therefore, an inadequate response from the HRRM would not, in itself, mislead the operator during the diagnostic or mitigation phases of the LOCA.

The instrument response of the HRRM is used, however, in defining adverse containment conditions in the Emergency Operating Procedures. These criteria are:

- containment pressure > 5 psig

or

- containment radiation > 10^5 R/HR

or

- integrated containment radiation > 10^6 R

When any of these conditions exist, then the operator is given more restrictive instrumentation limits, for control purposes, to account for the instrument errors associated with a hostile containment environment.

The indication from the HRRM is also used in the site Emergency Preparedness Plan for event classification and providing offsite protective action recommendations. These procedures, however, state that individual radiation monitor readings are to be treated as symptoms, rather than definite evidence, that a significant release has occurred. Protective action recommendations are based on an overall assessment of plant conditions and <u>not</u> on any single indication. As an example, the protective action recommendation procedure requires an assessment of the following parameters to determine if actual or imminent core damage is expected:

- RCS sample compared to pre-accident data
- RVLIS indicates that core was uncovered

- 5 CETC ≥ 1200F
- ECCS equipment status
- H_2 concentration in containment
- RM-219A,B (HRRM)
- RM-201

The RM-201 and RM-202 radiation monitors are [redacted] capable of providing backup information to that provided by RM-219A,B by use of a correction factor.

Conclusion

Since the deficiencies associated with the HRRM would not affect operator response during a LOCA, or the subsequent mitigation actions in minimizing the release, classification of the event, or providing a proper protective action recommendation, the equipment deficiency is not considered safety significant. Since alternative monitoring was available during the period that the technical specifications were in effect, the technical requirements of the license were fulfulled. Recent testing of the General Atomic HRRM established that generic issues remain with the qualification of these monitors at low signal levels due to leakage currents or galvanic action in the coaxial connections or cables. Therefore, the Reg. Guide 1.97 accuracy requirements for the system (detector, cable, connections) cannot be met at lower dose rates for any commercially available system.

<u>References</u>

Rev. 2 OM 53A E-0, E-1, E-2

EPP I-1 Issue 8 Rev. 3 Pgs. 13-20

EPP/IP 4.1 Issue 8 Rev. 0 Pgs. 17-23

BVPS-RCM 2.12 Issue 2 Pg. 8

NUREG/CR-4728 Feb. 1988 <u>Equipment Qualification Research Test of a High-Range Radiation Monitor</u>