ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649-0001

ROGER W. KOBER
VICE PRESIDENT
ELECTRIC PRODUCTION

TELEPHONE
AREA CODE 716 546-2700

March 6, 1987

U.S. Nuclear Regulatory Commission
Region 1
Attn: Mr. Ralph Paolino
631 Park Avenue
King of Prussia, PA 19406

Subject: Inspection 87-03 - Environmental Qualification of Electrical Equipment 10CFR50.49
R.E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Paolino:

This letter is in response to the NRC's Inspection 87-03, relative to RG&E's conformance with 10CFR50.49. At the exit meeting of February 13, 1987, the NRC categorized five issues as "potential enforcement items", based on the level of review and communication available during the inspection week.

RG&E does not believe that any of the "potential enforcement items" should be categorized as violations. The items are considered fully qualified to 10CFR50.49, based on the information contained in RG&E's Environmental Qualification files at the time of the inspection. Explicit discussions of each of these items is provided in Enclosures 1-5 to this letter.

In addition to these five "potential enforcement items", a general comment relative to the auditability of RG&E's files was made, together with some suggestions for improvement. This comment is being considered for long-term improvement of RG&E's 10CFR50.49 Program.

There were also a number of minor items (e.g., typographic errors, recommendations for more explicit references, etc.) brought up by the reviewers during the inspection week. All of these items have been corrected or addressed as described in Enclosure 6 to this letter.

RG&E staff members are available to meet with appropriate NRC or NRC-contractor personnel in order to discuss any issues requiring further clarification.

Very truly yours,

Roger W. Kober

Roger W. Kober

IE02

Enclosures

ENCLOSURE 1

VICTOREEN HIGH-RANGE RADIATION MONITOR
(PACKAGE #36)

NRC "POTENTIAL ENFORCEMENT CONCERN"

The RG&E method used to seal the connector-detector-cable interface does not adequately address the test failures in the Victoreen Qualification Test Report (950.301).

RG&E RESPONSE

The RG&E sealing method, using built-up Raychem sleeves over the coaxial cable, with an overall Raychem sleeve over the connector and conduit, is depicted in Attachment 1 to this enclosure, Figure V-1 (from RG&E EEQ Package #36, Reference 3.b.1), and the Attachment 2 photograph. RG&E believes that this sealing method explicitly addresses all leakage path failure mechanisms determined in the Victoreen Qualification Test Report 950.301 (RG&E Reference 3.b.4).

The following analysis clearly demonstrates that the RG&E sealing method is acceptable:

Victoreen Test Report 950.301, Section V, pages 60 and 61 (Attachment 3) lists the failure mechanisms which occurred during the unsuccessful attempts at qualification. Attachment 4 is a set of 3 drawings which show a) a detailed representation of the detector-connector cable assembly (this is an enhanced version of Figure 2, Section VI, page 51 of Victoreen Test Report 950.301), b) a representation of the failure leakage paths described in Attachment 3, and c) a comparative representation of RG&E's installed configuration. There were no failures attributed to the connection at the base of the detector.

Failure mechanisms 1a and 1b allowed leakage at the connection of the back shell to the connector. Victoreen Termination Procedure 910077 (Attachment 5, which is Section VI of the test report 950.301) states these locations shall be potted while making up the cable termination. The cable ends come connected to the cable when shipped from Victoreen and have the required potting performed during make-up to the cable. The connector also comes with the nickel seal which seals the joint between the cable connector and the detector. This nickel seal was used in all qualification tests with no failures due to leakage past this seal reported in the test report. The final configuration Victoreen tested used no additional method of sealing the leakage path for failure mechanisms 1a and 1b (see Attachment 10 photograph). In addition to this sealing by Victoreen, RG&E has covered this area with a qualified Raychem sleeve.

Failure mechanism 1c allowed leakage through the cable jacket to the termination points between the cable and connector. Cable damage was probably caused by stress induced in the jacket by the connector. Whatever the cause, the Raychem sleeve installed by RG&E not only covers the connector but the cable jacket for 3 to 4 inches from the connector to the conduit and overlaps several inches on the conduit. The cable is located within conduit from the detector to the penetration area. This failure mechanism is thus corrected by RG&E's installation.

Failure mechanisms 2, 3 and 4 deal with failures occurring inside the backshell due to leads shorting or breaking. The shorting of leads would be enhanced by moisture intrusion (failure mechanisms 1a, b, c or 5). At RG&E, this is prevented by the use of Raychem sleeves sealing the paths which could allow leakage into this area. The breaking of the connectors was considered to be caused by the process used for making the connections. In Section VI, page 74 of the test report (Attachment 5), the breaking of the conductors is attributed to the thermal expansion of the material used in the attempt to seal the wire termination points. As stated earlier, the connectors come preattached to the cables from Victoreen. Thus the internals of the connector are identical to those which successfully passed qualification. Therefore, the failure mechanism due to wire breakage is not applicable to RG&E since the modifications performed by Victoreen to prevent this failure have not been altered by RG&E.

Failure mechanism 5 was leakage of the welds or compression fitting which would allow moisture intrusion between the outer jacket of the cable and the stress relief fitting. The installation method RG&E used does not utilize the compression fittings, flexible steel tubing, or the junction box which has its cover welded on. RG&E utilizes a multi-layer Raychem sleeve arrangement to seal the connection of the cable to the connector (see Attachments 1 and 4). RG&E considers the Raychem sleeve application to be as good as or better than the steel tubing for sealing the connector to cable since the sleeve covers the entire backshell assembly. Thus, the Raychem sleeve not only seals the point where the cable meets the backshell and stress relief fitting, but also provides additional protection for failure mechanisms 1a and 1b.

Failure mechanism 6 was a failure of the test chamber used to perform the LOCA test. This failure is not associated with the connector assembly and therefore not applicable to any type installation configuration.

The analysis of these failure mechanisms, and the graphical depictions of RG&E's seal method vs. the failure leakage paths described in Attachment 4 provides assurance that the Victoreen high range radiation monitor, as installed at Ginna Station, will perform its required safety function. All the leakage failure paths identified in the qualification test report have been addressed and corrected.

RG&E also addressed all concerns raised during a previous NRC Region I inspection of these Victoreen high range radiation monitors in Inspection Report 85-08. Pertinent sections of both the Inspection Report and RG&E's reply of October 22, 1985 are attached as Attachments 6 and 7. RG&E addressed all of the NRC's concerns at that time, with data independent of the Victoreen Test Report, where concerns arose relative to BIW cable (RG&E EEQ Package #19) and Raychem sleeves (RG&E EEQ Package #12C).

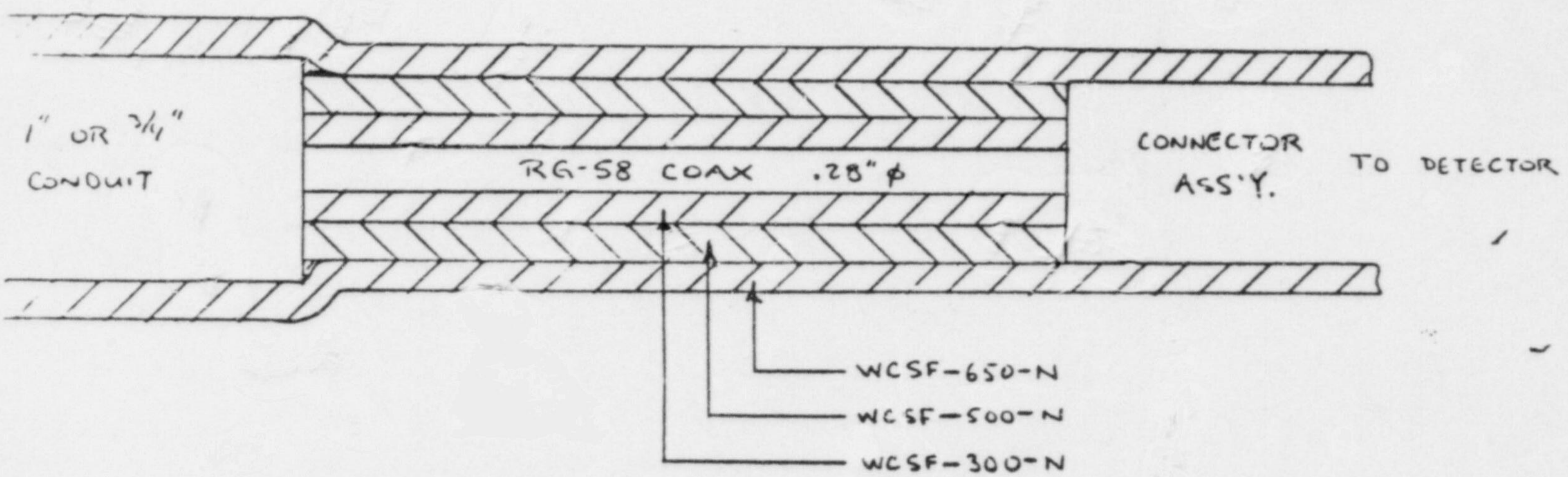
RG&E believed then, and believes now, that the system installed is qualified to 10CFR50.49, and that the documentation in the EEQ files at RG&E at the time of the inspection properly supported this qualification basis (the only new item in this response is the photograph). Therefore, RG&E does not believe that this issue should be considered a "potential enforcement item".

As a result of the NRC inspection, RG&E has evaluated the feasibility of adding a potting material at the connector-detector interface. Even though no leakage paths were identified in this area in the Victoreen test report, the effort required to seal this area with RTV7403 is minimal. Therefore, although RG&E does not believe any safety requirement for this potting installation exists, the simplicity and minimal expense of this change is such that RG&E has added the RTV7403 (see Attachment 8). The installation of RTV7403 is identical to its application as noted in EEQ Package #36, Reference 3.b.3 (see Attachment 9 drawing, which is from that report). The adhesion of the RTV to the detector metal is demonstrated in that qualification report. RG&E takes credit only for this metal sealing and adhesion, not for the additional RTV7403 filet which overlaps the Raychem sleeve.

ATTACHMENT 1 TO ENCLOSURE 1

Figure V-1

CONTAINMENT HIGH RANGE MONITOR
SLEEVING AT DETECTOR END

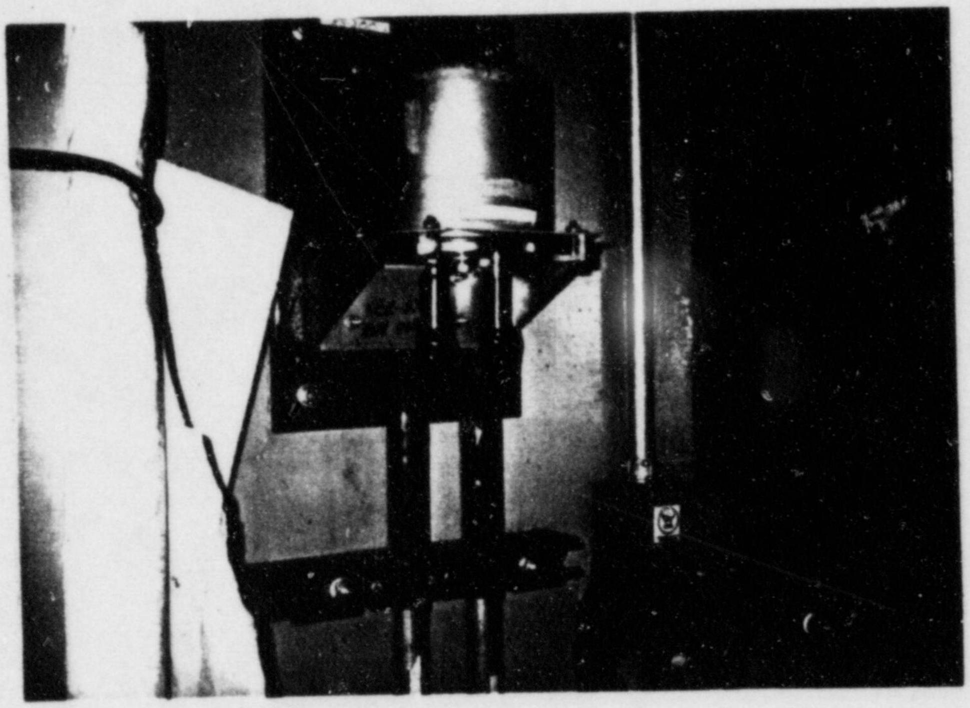


NOTES: 1) IF EXCESSIVE CABLE SLACK EXISTS AT DETECTOR, CABLE MAY BE PULLED BACK AT PENETRATION END.
2) OUTER SLEEVE SHALL HAVE 2" MINIMUM OVERLAP ONTO CONDUIT. OVERLAP ONTO CONNECTER SHALL BE MAXIMUM TO THE EXTENT PRACTICAL.

NUMBER	REVISION	INITIAL DATE	DRAWN BY	CHECKED BY	RESP. ENG.	ENG. MANG'R.
0	ORIGINAL		RAB 1/28/82	[illegible] 1/28/82	RAB 1/28/82	[illegible] 1/28/82

ROCHESTER GAS & ELECTRIC CORP. ROCHESTER, NEW YORK	CV HIGH RANGE MONITOR SLEEVING DETAIL-EWR 2606B	SCALE — / NO. 03021-409

ATTACHMENT 2 TO ENCLOSURE 1



ATTACHMENT 3 TO ENCLOSURE 1

VICTOREEN, INC.

Qualification Test Data

Qualification Test Plan, 907351, Rev. 5

Design Basis Event, (LOCA), (4.11)

See Wyle Lab., Nuclear Environmental Qualification Test Report, 45050-1, Sections VI and VII.

Results:

During the course of the LOCA testing per 907351, eight (8) unsuccessful attempts were made prior to the ninth and final successful run.

Failures were traced to one or more of the following:

1. Moisture penetrating to the center conductor of the cables:
   a.) leakage of the seal at the connector threads to the back shell
   b.) leakage of the seal into the back shell at the set screw threads of the back shell
   c.) leakage through the outer insulating jacket of the cable, thence along the inner insulation surface (between the inner insulation and shield) into the back shell, and reaching the inner termination of the cable to the connector.

VICTOREEN, INC.

Qualification Test Data

Qualification Test Plan, 907351, Rev. 5

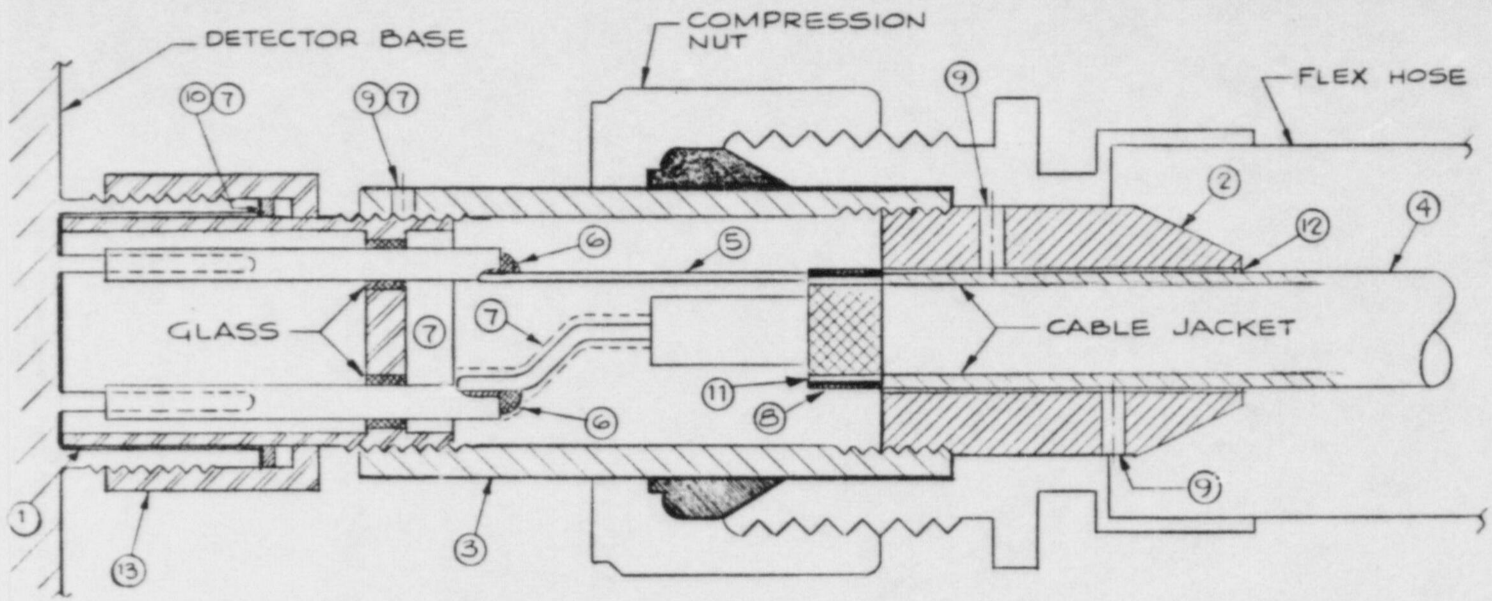
Design Basis Event, (LOCA), (4.11) continued

2. Electrical shorts occurring between the center conductor and the shield at the termination area inside the back shell of the connector.
3. Open or broken connection of the center conductor of the cable at the termination inside the back shell of the connector.
4. Open or broken connection of the shield at the termination inside the back shell of the connector.
5. Leakage of the stainless steel welds or compression seals of the stainless steel cable enclosures (see deviation to test plan 907351).
6. Loss of control of the LOCA environmental chamber used to conduct the test.

Various means were used to correct the above causes of failure leading to the final successful LOCA test.

The final configuration was as given in the High Range Containment Monitor Termination Procedure, 910077, (see appendix, this report), which is a deviation from the test plan, 907351, as written.

ATTACHMENT 4 TO ENCLOSURE 1



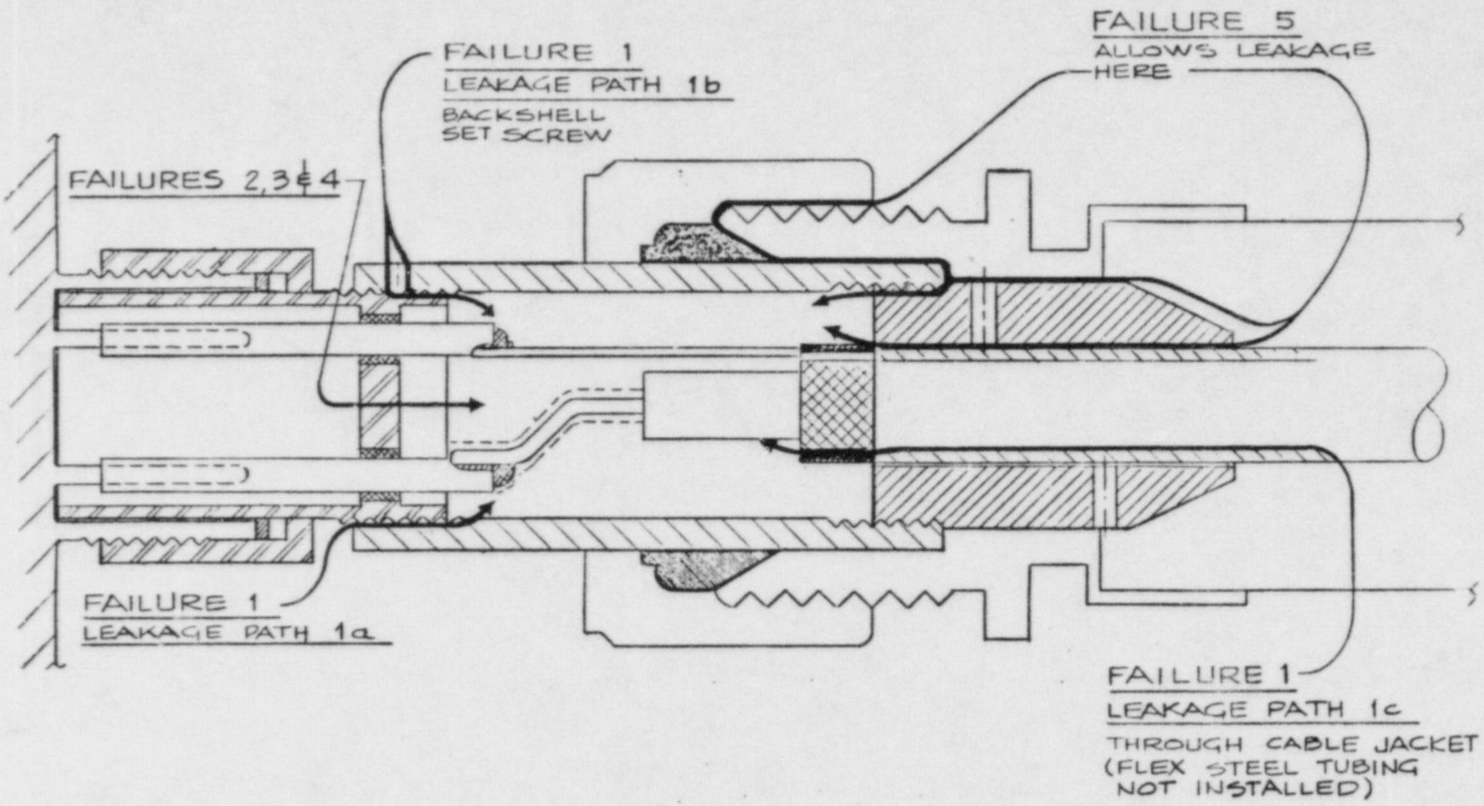
CABLE TERMINATION ASSEMBLY

TABLE 1

ITEM	PART. NO.	QTY.	DESCRIPTION
1	877-1-58	1	Cable Connector w/Nut
2	878-1-12A	1	Strain Relief, Male
3	878-1-12B	1	Strain Relief,Female (Backshell)
4	878-1-[illegible]	A/R	Cable
5	MS#B-0072-1	A/R	22 Ga. Insul.Wire, Copper
6	MS#A-0015	A/R	High Temp. Solder
7	MS#J-4375	A/R	Potting Resin
8	MS#H-6229	A/R	Shrink Sleeving
9	5-957	3	Set Screw, #8-32 x 1/8" lg.
10	877-1-60	1	Nickel Seal
11	878-1-14	1	Crimp Sleeve
12	878-1-15	A/R	Glue
13			Cable Connector Nut

ATTACHMENT 4

FIGURE 1

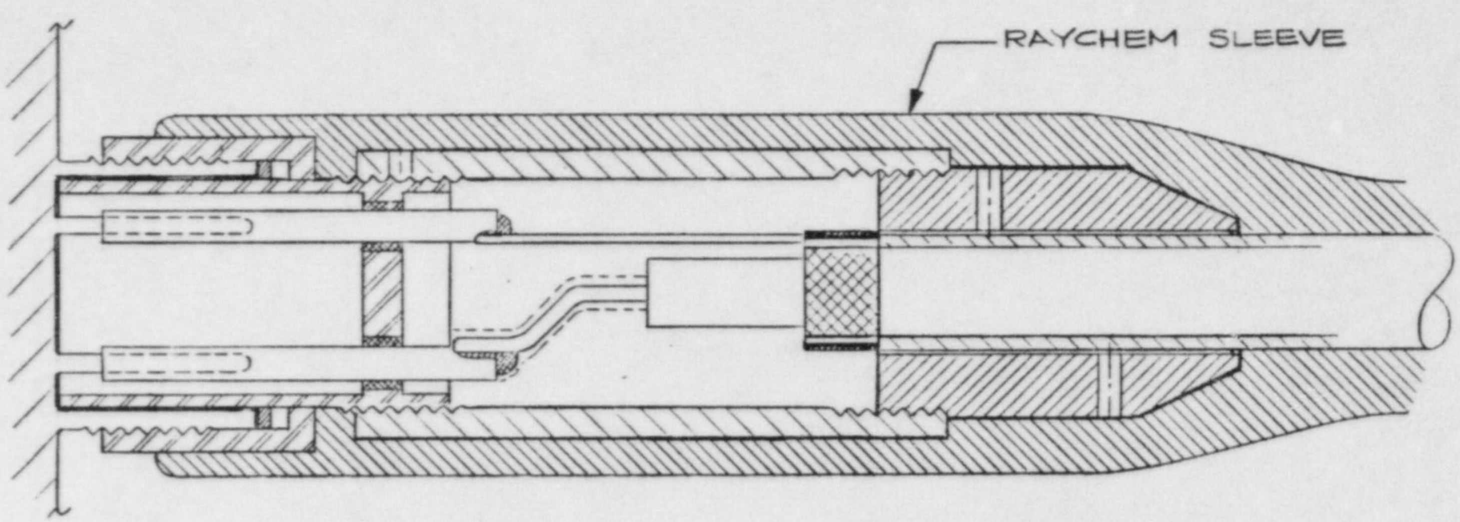


FAILURE MECHANISMS IDENTIFIED

IN VICTOREEN TEST REPORT NO. 950.301

ATTACHMENT 4

FIGURE 2



RG&E HIGH RANGE MONITOR CONNECTION

ATTACHMENT 4

FIGURE 3

ATTACHMENT I

TERMINATION OF CABLES FOR IN-CONTAINMENT USE

During the qualification program for the Model 877-1 Detector for in-containment use during a Loss of Coolant Accident, one of the major problems encountered was the terminations of the cables used to deliver high voltage to the detector and, to return the resultant signal to the externally mounted readout device. Much effort and time was expended with several failures occurring before Victoreen was able to successfully pass a LOCA Test.

The objective of the termination was to connect and seal the co-axial cable to a hermetically sealed connector body, such that, under worst-case conditions as prescribed in the Qualification Test Plan 907351, the following could be maintained:

1) A leakage resistance in excess of 1 megohm at 500V DC;

2) Continuity of the connections;

3) And to preclude steam from reaching the terminals or insulators, particularly steam mixed with containment sprays, that would result in a failure.

The coax cable (Victoreen Part No. 878-1-9, previously qualified by Boston Insulated Wire Company, Report No. B913) used for this testing has a tefzel insulated inner-core and outerjacket. It is terminated to a connector (Victoreen Part No. 877-1-58) manufactured by Hermetic Seal Corp., consisting of a stainless steel body with glass beads to insulate the pins. Prior to all tests, the cable and its terminations were thermally aged and radiation aged in accordance with the test plan.

Problems encountered - Early attempts to seal the termination of the connectors, involved the use of two (2) materials. The material used around the actual electrical connections themselves, in all cases, was Dow Corning Sylgard, No. 186. This material is, and proved to be, radiation resistant to a total dosage of 200 megarads and has an inherently very high volumetric resistivity, and thus seems to be ideally suited as an acceptable sealing compound. In addition to the Sylgard mentioned above, epoxies were used around the Sylgard in an attempt to add mechanical strength for handling. Epoxies in themselves do not have the inherent volumetric resistivity at elevated temperatures and could cause electrical leakage. The thermal coefficient of expansion of the Sylgard is sufficiently large for the temperature range requirement and, in some cases, caused breakage of the electrical connections. Although some breakage was experienced at the actual point of attachment, in most cases of wire separation, breakage occurred along the stripped portion of the wire itself.

Although Victoreen was not successful in finding a suitable combination of epoxy, silicon rubber, or other types of sealing compounds for making this connection, it does not preclude the possibility of existing sealing compounds with sufficiently high resistivity, radiation resistance, and a coefficient of expansion that can successfully accomplish this type of cable termination.

The LOCA chamber test that Victoreen was able to successfully conduct, however, did not rely on sealing compounds to prevent the entrance of contaminated steam into the seal area. Three separate tests relative to the detector and cable were conducted that successfully survived the LOCA condition:

ATTACHMENT I
TERMINATION OF CABLES FOR IN-CONTAINMENT USE (Cont'd.)

1) During the first test, the detector was mounted and sealed to the flange of the LOCA chamber such that the detector volume was internal but with the connector surface external to the environment of the LOCA chamber, (see Photographs No. 1 & 2 attached);

2) The second test utilized copper tubing to shield and protect the cable terminations. One end of the tubing was epoxied to both the connector and the detector, located inside the test chamber. The other end of the tubing penetrated and was sealed externally to the flange of the LOCA chamber. This meant that the cable, during the LOCA ramps, was not subjected to the steam environment, (see Photographs No. 3 & 4 attached);

3) The final method of sealing the connector and cable from the LOCA environment was through the use of stainless steel jacketing. In this test, electrical penetrations were made in the flange of the LOCA chamber utilizing the same sealed connector parts as are used on the 877-1 Detector.

The detector end of the cable was inserted into a flexible metal hose, manufactured by "Swagelok", with the tube fitting of the hose swaged to the cable connector backshell. From the flexible tubing the cable then entered a stainless steel pull-box either directly swaged to the flexible tubing or via rigid stainless steel tubing swaged to both the pull-box and the flexible tubing. Additional flexible tubing, in like manner, was used to join the pull-box to the backshell of the penetration connector, (see Photographs No. 5, 6 & 7 attached).

From the discussion above, it is very critical that all vapor/liquid sprays be kept away from the electrical connection points. The resultant electrical leakage, can cause an excess drain on the high voltage power supply when across the HV cable, or shunt the current output of the chamber in the case of the signal cable, and in either event, the containment monitor will fail.

KES:rs
3/31/81

ATTACHMENT 6 TO ENCLOSURE 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
631 PARK AVENUE
KING OF PRUSSIA, PENNSYLVANIA 19406

SEP 27 1985

Docket No. 50-244

Rochester Gas and Electric Corporation
ATTN: Mr. Roger W. Kober
Vice President
Electric and Steam Production
49 East Avenue
Rochester, New York 14649

Gentlemen:

Subject: Inspection Report No. 50-244/85-08

A special team inspection was conducted on June 10-14, 1985 to review systems and procedures at Ginna Station for post-accident sampling and monitoring as specified in NUREG-0737. Within the scope of this review, no violations were observed. However, several areas were identified that should be improved to ensure reliability of system operation and credibility of the information generated.

We are particularly concerned about the following items:

- the coaxial signal cable and connection for the containment high range radiation monitors may not withstand an accident environment;
- the ability to obtain a representative coolant sample at low reactor system pressure is uncertain;
- testing of the PASS system should be completed to ensure the accuracy, range, and sensitivity of the coolant analysis data; and
- the calculated sensitivity of the steam line radiation monitors has not been verified by empirical data.

Additionally, subsequent to the inspection we learned that the Eberline SPING-4 system used to monitor particulate, iodine, and noble gases in the station vent may be damaged by high radiation levels and fail to function in accident conditions. This information was relayed to your staff on September 4, 1985. In this regard, please provide this office with a description of action taken or planned relative to these particular items within 25 days of the date of this letter.

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2pp.

Your cooperation with us in this matter is appreciated.

Sincerely,

Ronald R. Bellamy /for

Thomas T. Martin, Director
Division of Radiation Safety
and Safeguards

Enclosure:
NRC Region I Inspection Report No. 50-244/85-08

cc w/encl:
Harry H. Voigt, Esquire
Central Records (4 copies)
Director, Power Division
Public Document Room (PDR)
Local Public Document Room (LPDR)
Nuclear Safety Information Center (NSIC)
NRC Resident Inspector
State of New York

7.0 Containment High Range Radiation Monitor, Item II.F.1-3

Position

NUREG-0737 item II.F.1-3 requires the installation of two high range radiation monitors capable of detecting and measuring radiation levels within the reactor containment during and following an accident. Specific requirements are set forth in Table II.F.1, Attachment 3.

Observations

The licensee has installed two Victoreen Model 875 High Range Containment Area Monitoring Systems with readouts mounted in the control room. Test data provided by the manufacturer certifies that the range and response of the monitoring systems meet Table II.F.1-3 technical specifications. Insitu tests of detector response to radiation were conducted in May 1982 and May 1984 using an Iridium-192 radiography source. The licensee recently purchased and has on-site a Victoreen High Range Field Calibrator Model No. 878-10-5 containing 250 mCi of Cesium-137 to be used for response checks and calibration of the monitoring system in the future.

The positioning of the detectors inside containment could not be verified by direct observation. A review of installation drawings was inadequate to establish the field of view of the detectors. The licensee was requested to verify that the detectors view a large fraction of the containment volume.

This item will be reviewed in a future inspection. (85-08-13)

The system component parts were verified to be environmentally qualified to withstand design basis accident conditions with the exception of the containment detector/connector/cable assembly. Victoreen Environmental Qualification (EQ) test report No. 950.301 cites eight test failures in attempting to qualify this assembly. The ninth and only successful test consists of complete isolation of the cable and termination from the LOCA environment using metal conduit.

The licensee's installation does not conform to the qualified Victoreen configuration. The licensee is using Raychem shrink sleeve to achieve a sealed cable termination based on engineering assumptions for qualified shrink sleeving and test results for multi-layered Raychem shrink sleeve configuration over the cables. The licensee determined that stress cracking of shrink sleeves during testing by Victoreen was due to misapplications and that properly applied shrink sleeves would not experience stress cracks. However, no environmental testing of properly applied shrink sleeves on coaxial cable were performed.

In reviewing the licensee's evaluation of the Victoreen test report the inspector noted that the licensee does not address all problem areas identified. Critical items omitted in the licensee's review include hardening of the cable, sleeves and red sealant material; and powdering of the cable electrical insulation.

This item is unresolved pending the licensee's re-evaluation of the Victoreen EQ test results and supporting data establishing the environmental qualification of the installed cable assembly. (85-08-14)

ATTACHMENT 7 TO ENCLOSURE 1

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649-0001

ROGER W. KOBER
VICE PRESIDENT
ELECTRIC & STEAM PRODUCTION

TELEPHONE
AREA CODE 716 546-2700

October 22, 1985

Dr. Thomas E. Murley, Regional Administrator
U.S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Region I
631 Park Avenue
King of Prussia, Pennsylvania 19406

Subject: Inspection Report No. 50-244/85-08
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Dr. Murley:

Inspection Report 50-244/85-08 was sent to RG&E with a letter dated September 27, 1985 from Mr. Thomas T. Martin. The inspection report concerned an inspection conducted June 10-14, 1985 to review systems and procedures for post-accident sampling and monitoring. A response was requested within 25 days to several items noted in the letter even though no violations were identified during the inspection. Each of the items of the letter are addressed in Attachment A to this letter. In addition, all of the inspection report Recommendations for post-accident sampling are also addressed in the attachment. Other inspection Findings and Observations will be reviewed for appropriate action even though no response is provided, or required, with this letter.

Very truly yours,

Bruce A Snow for

Roger W. Kober

Attachment

8512040043 3pp.

ATTACHMENT A

Response to Inspection Report 50-244/85-08

An inspection was conducted June 10-14, 1985 to review systems and procedures at Ginna Station for post-accident sampling and monitoring as specified in NUREG-0737. During that inspection no violations were observed, however, several concerns were listed in the inspection report and the cover letter dated September 27, 1985 from Mr. Thomas T. Martin. The following responses address each of the items listed in that letter, and in the case of the PASS, all recommendations in the inspection report.

Item: The coaxial signal cable and connection for the containment high range radiation monitors may not withstand an accident environment.

Response:

The report states that the licensee does not address all problem areas of the Victoreen test report and that "critical items omitted in the licensee's review include hardening of the cable, sleeves and red sealant material; and powdering of the cable electrical insulation." All of these items were addressed by RG&E and documented in either the system design package or in the Environmental Qualification Files. RG&E was aware of the failure described in the Victoreen EQ test report and designed a connector system using qualification data independent of the Victoreen tests. RG&E also enclosed the coaxial cable completely within conduit, which assures that in an actual accident the cable will be subject to a less severe environment than in the test where it was exposed directly to steam and caustic spray.

During the inspection the qualification of Raychem sleeving material was questioned. Several test reports on Raychem sleeves for both LOCA/HELB environment and flame propagation (IEEE 383) were made available. RG&E has a number of qualification test reports on Raychem sleeves; some on tests done by the vendor, some by utilities, and one by RG&E. We have thoroughly reviewed these test reports over the course of several projects and consider this material qualified in accordance with current standards. The inspector indicated his concern was based on NRC "internal documents" not provided to RG&E, however, the test reports available for the Raychem sleeves adequately establish qualification to withstand an accident environment.

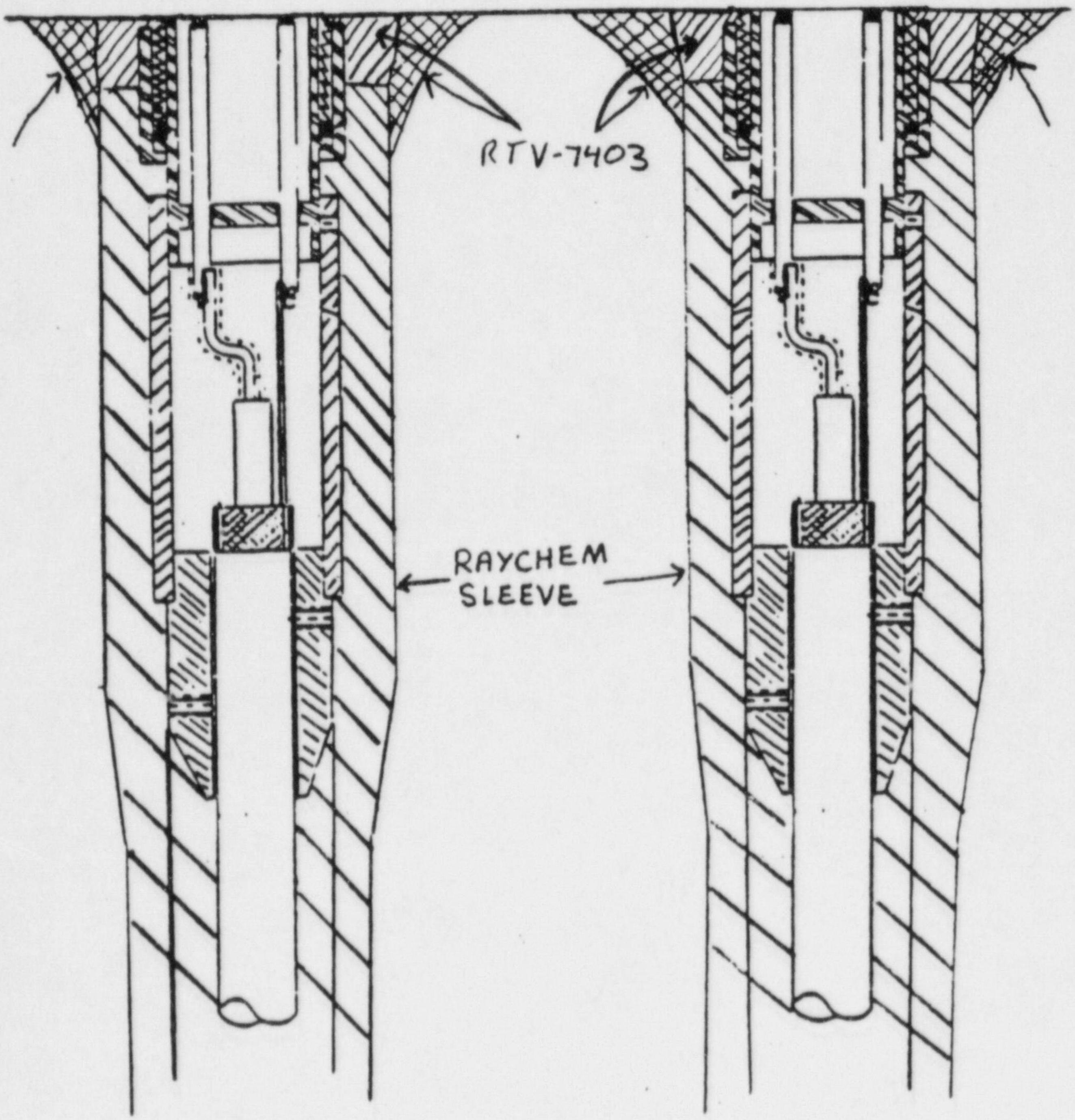
Copies of a review done by RG&E to address the "hardening and powdering" of cable anomally were given to the inspector. RG&E concluded as a result of this review that the cause of failure was misapplication by Victoreen of certain materials in the fabrication of the connections at both the detector and penetration ends of the coaxial cable. RG&E designed connection systems based on extensive experience with the sleeving materials and qualification test programs independent of Victoreen. RG&E considers that the existing design is completely qualified to function during all design basis events.

ROCHESTER GAS AND ELECTRIC CORPORATION

42-33

ENG. DEPT.	STATION:	DATE:	PAGE OF
JOB:		MADE BY:	CK:

HIGH RANGE DETECTOR



CABLE TERMINATION ASSY.

FIGURE 3

Figure IV-3

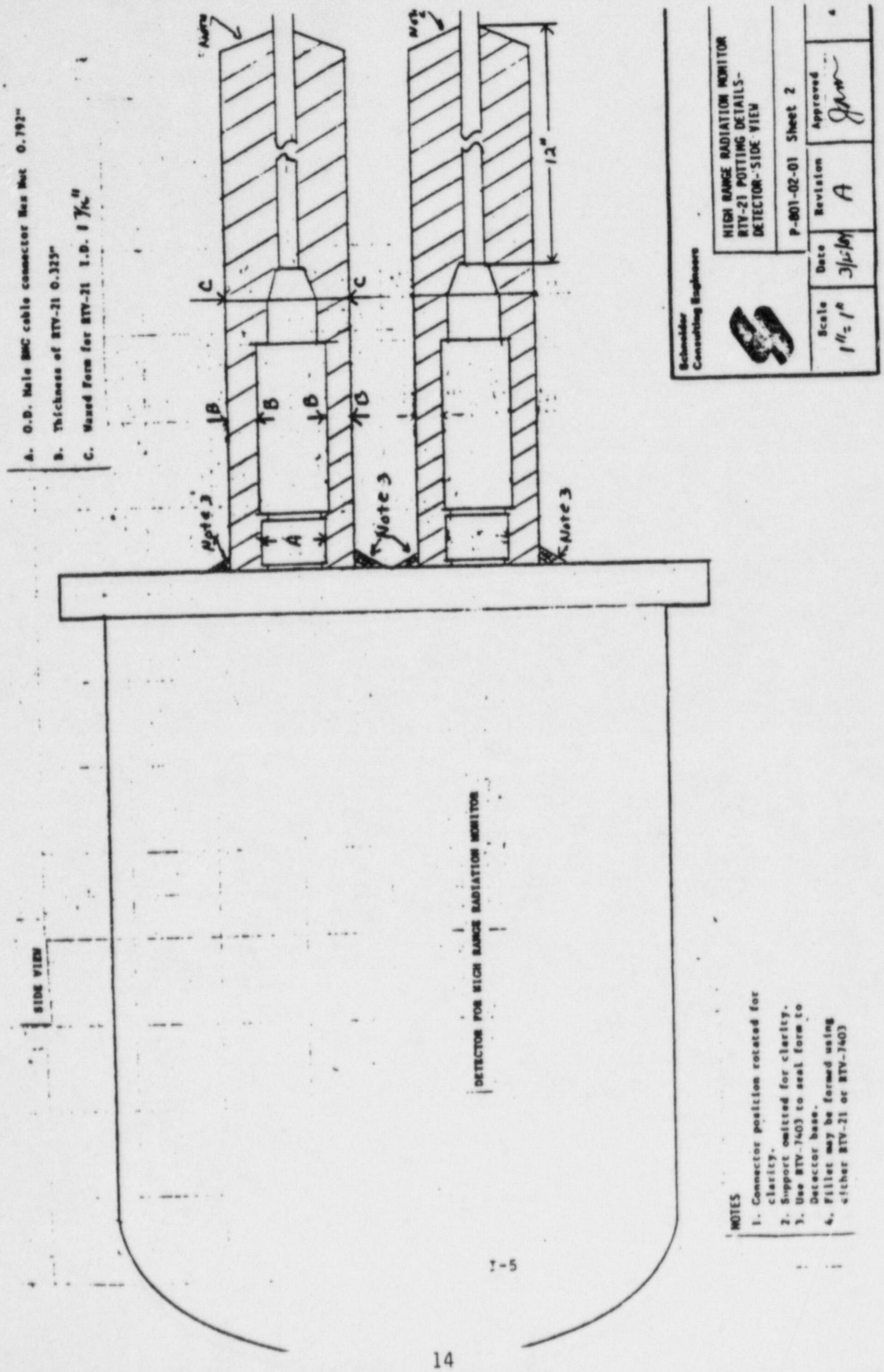
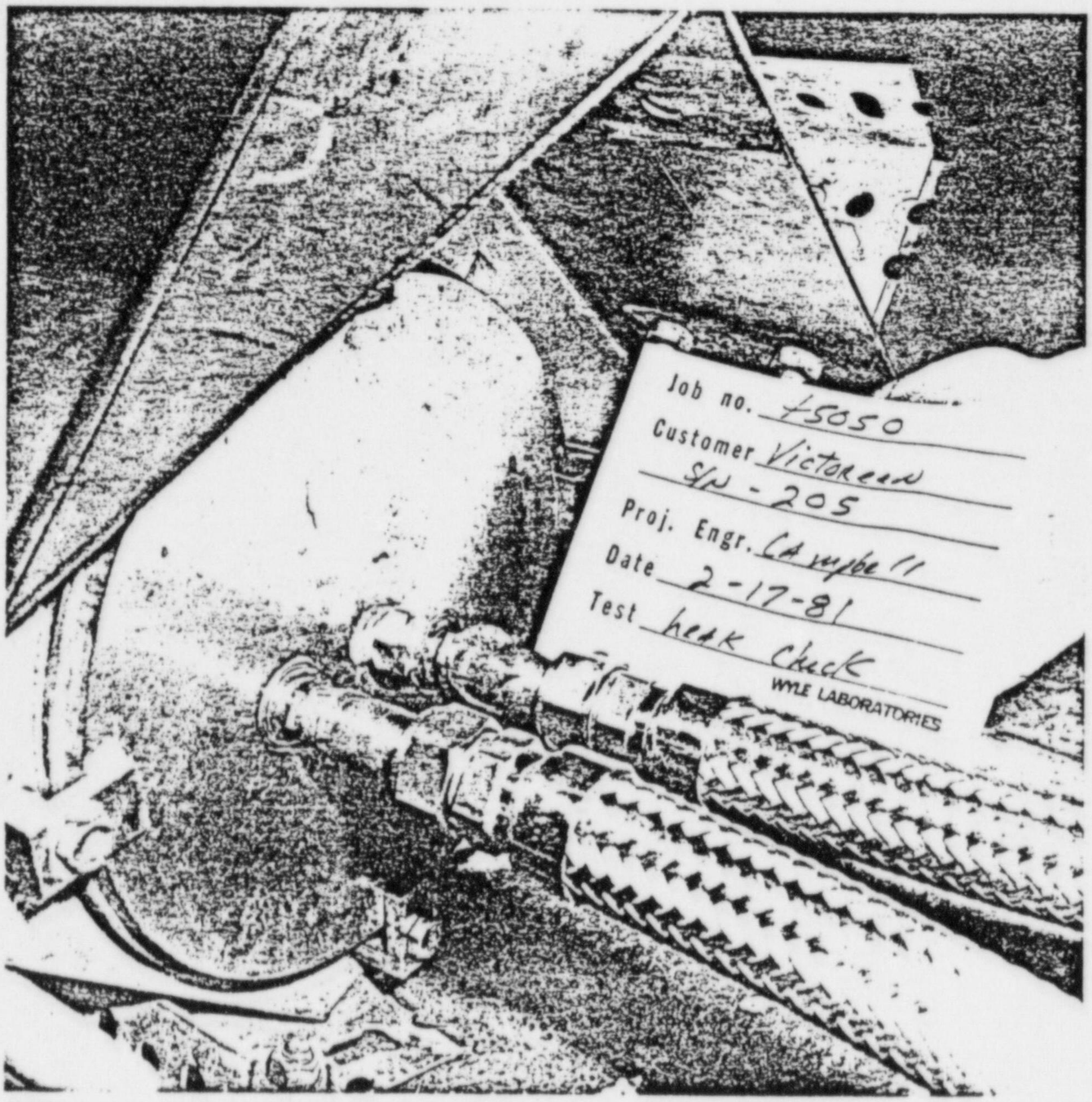


Figure I-1 (Continued)

ATTACHMENT 10 TO ENCLOSURE 1



PHOTOGRAPH VI-24

LEAK-CHECKING SPECIMENS
PRE-LOCA #9

ENCLOSURE 2

PVC CABLE

NRC "POTENTIAL ENFORCEMENT" CONCERN

Similarity between tested and installed cables was not definitively estabished.

RG&E RESPONSE

In EEQ Package #44, RG&E provided an analysis (Reference 3.b.2 - Attachment 1) which compared the electrical and physical applications and dimensions, and the anticipated "harsh" environment, of the PVC cables tested by Report 45307-1 (Reference 3.b.1 of EEQ Package #44), to those installed at Ginna. This comparison did not address the identity of the molecular structure of the two PVC specimens. PVC is a basic material, and is named so for its chemical composition. Manufacturers may add different plasticizers and additives, but it was considered that the variation in basic properties was minimal, relative to RG&E's needs (see attachment #2, Figure 3-1 from EPRI NP-2129 and Section 7.2.3.2 of EPRI NP-1558). Since the Wyle test supported qualification of the PVC cable for instrumentation, it was determined from a review of references that differences in plasticizers or additives in RG&E's PVC cable would not cause a significant difference in properties which would lead to a failure in its uses at Ginna, which have less demanding performance requirements (see item 2 below for a comparison of performance requirements).

The comparison in 3.b.2 also demonstrated that <u>all</u> of the parameters and applications of the tested cable were much more severe than those for the cable installed at Ginna. Thus, although no specific manufacturer was identified for the tested cable, the safety margin was (and is) significant enough that RG&E had reasonable assurance of the qualification of this cable, in accordance with 10CFR50.49. Paragraph (f)(3) of 10CFR50.49 designates one of the qualification methods to be "experience with identical or similar equipment under similar conditions with a supporting analysis to show that the equipment to be qualified is acceptable". Nonetheless, RG&E did perform a confirmatory qualification test of the cable actually installed at Ginna. The test was successfully completed during the week of the NRC inspection. The qualification plan, test results, and the cable sample itself were available for review by the NRC during the inspection. This test provided additional confirmation that the PVC cable installed at Ginna is capable of performing its required safety functions.

A detailed comparison between the application at Ginna, and the qualification test results, is as follows:

1. The tested cables were 2/C #16 AWG and 4/C #16 AWG with PVC insulation and jacket. Based on IPCEA S-61-402, (Thermoplastic-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy), these cables would have 30 mils of PVC insulation. The smallest PVC insulated Coleman cable used in containment by RG&E is 1/C #14 AWG. Gilbert Associates, Inc. Specification SP-5315 was used to provide the technial requirements for the purchase of this cable at RG&E. This requires the cables to meet the requirements of IPCEA-S-61-402 for PVC insulation and jacket requirements. For #14 AWG cable the thickness is 45 mils. This is 50% thicker than 30 mils and would provide a substantial increase in insulation resistance (IR) for an application where a very low IR is acceptable.

2. The tested cables were for use in instrumentation circuits, where IR is important in terms of instrument accuracy. At Ginna, the PVC cable is used only for indication and control applications (position indication for the Namco limit switches used for the pressurizer PORVs, and operation of the solenoid for hot leg sampling valve 955). Leakage currents can be significantly higher for RG&E's applications than for the instrumentation circuits, and still meet the necessary performance requirements.

   For the PORV limit switch circuit there is a resistor in series with the indicating light which drops the circuit voltage from 130 volts to 30 volts across the indicating light. The indicating light for the valve's actual position (open (red) or closed (green)) would be on and bright. If leakage occurred, this light would remain bright, since the insulation resistance would be shunted by the closed limit switch contact. The only possible confusion could arise on the limit switch circuit which indicates the position the valve is <u>not</u> in. For a "false" indication to occur, the cable leakage resistance would have to shunt an open limit switch. As noted in the calculations, (Attachment 3), using the results of Test Report 45307-1, the "false" indication would only be 1/7 the illumination of the "true" indication. Using the results of the new Acton test (not in the EEQ Package #44 at the time of the inspection), the "false" indication would be 1/10 of the illumination of the "true" indication. It is not considered that there would be any operator confusion at these levels.

   Also, since the only safety function of the PORVs in Ginna's Emergency Procedures is to close or remain closed, operator action for any potentially open indication would be to close the valves, assuring the safety function.

For sampling solenoid valve 955, the supply voltage is 130 VDC with a 3 amp fuse in the circuit. Conservatively assuming the valve draws 0.5 amps when energized, this would allow 2.5 amps for leakage. The insulation resistance of the cable would have to be 52 ohms to pass 2.5 amps. Conservatively assuming the installed cable is 400 feet long, this is equivalent to only 2.08×10^3 ohms per foot of cable (see Attachment 4 for calculation).

3. The tested PVC cable was directly exposed to the accident environment effects. At Ginna, all of the PVC cable in a 10CFR50.49 application is completely routed in conduit. Therefore, additional physical protection is provided in the Ginna Station applications.

4. The pressure, temperature, and radiation profile for the tested speciment was comparable to that required following a major loss of coolant accident. In the Ginna applications, the "harsh" environments during which the equipment connected to these cables would be used would be less severe.

   a. Pressurizer PORV Position Indication - This position indication is needed to determine if the PORVs, which relieve to pressurizer relief tank, are open. This information is provided, which could allow the operator to terminate the event (close the valves) prior to a "harsh" environment. If he failed to immediately close the valves, the eventual containment atmospheric conditions resulting from a 4" hot leg break (the diameter of the PORV nozzle) would be much less than the 60 psig and 286°F conditions to which the cable was tested at Wyle.

   b. Reactor Coolant System Hot Leg Sampling - The sampling valve 955 is part of the post-accident sampling system. Its purpose is to sample reactor coolant in the hot leg, per the provisions of NUREG-0737. In the event of an accident releasing major steam and radiation to containment (e.g., large break LOCA), little reactor coolant remains in the hot legs for reliable sampling. Sump sampling, using sampling valves 10023 and 10024, which do not have PVC cable insulation in their control cables, would provide this sampling function. For a steam line break, little radiation would be released, and the temperature and pressure transient would be short (less than 60 seconds above 280°F, per Figures 6.2-4 and 6.2-6 of the Ginna UFSAR). An excellent measure of temperature qualification for this particular cable was demonstrated during the IPCEA Section 3.8 testing (168 hours at 250°F), which was provided in EEQ Package #44, Reference 3.b.7 (see Attachment 5).

All of the above information was available at the time of the 10CFR50.49 inspection. Only the level of explanation has been expanded. The time available during the inspection week did not permit such a detailed level of review of all of RG&E's auditable information.

Using the information provided in Package #44 at the time of the inspection, RG&E considers that environmental qualification for the applications required at Ginna Station were suitably demonstrated, as required by 10CFR50.49. No "potential enforcement item" relative to the PVC cable is considered warranted.

In addition to the information available at the time of the inspection, RG&E has performed a PVC similarity analysis (see Attachment 5), documenting RG&E's previous assertions that "PVC is PVC". This analysis validates the simpler, but correct similarity assertion previously provided by RG&E, as documented in Package #44 at the time of the audit.

ATTACHMENT 1 TO ENCLOSURE 2 362

Rochester Gas and Electric Corporation

Inter-Office Correspondence

March 16, 1986

SUBJECT: Qualification of PVC Cable in Ginna Containment Applications

TO: G. W. Daniels

I have reviewed CP&L's qualification test report for PVC Cable, Wyle Report 45307-1, dated 12/31/81, for applicability to the PVC cable used for EEQ equipment in the Ginna containment. The Ginna cable is required to meet the qualification requirements of the DOR Guidelines, which allows a combination of test and analysis to substantiate qualification.

The environmental test conditions generally envelope the Ginna design basis environment conditions, with the exception of the initial ramp (see attached curve, as well as Figures VI-2 and VI-3 of the Wyle Report). This is acceptable, since there is substantial margin in the duration of high environmental conditions. Furthermore, the PVC applications at Ginna are for the hot leg sample valve and the pressurizer PORV position indication. Neither of these functions are necessary following a large break LOCA, which is the accident resulting in the rapid pressure and temperature increase in containment. A large break LOCA would empty the bulk of the RCS, including the hot leg, such that hot leg sampling would not be necessary. The pressurizer PORV position indication is necessary only for an incident such as inadvertent PORV actuation, which would have environmental conditions substantially lower than the design basis values. Thus, it is considered that the CP&L/Wyle report environmental conditions adequately envelope the Ginna Station PVC cable applications.

The CP&L cables tested were 2/C and 4/C #16 AWG, compared to the 1/C #14, 4/C #12, and 10/C #12 AWG cable used for Ginna Station applications. This is considered acceptable since the CP&L cable is of smaller gauge, and thus, generally has a thinner insulation system. Also, all Ginna Station PVC cable EEQ applications are totally run in conduit or are located in splice boxes, providing additional protection from post-LOCA effects.

Based on review of the CP&L/Wyle test report, and a comparison of the CP&L cables with the Ginna cables and applications, it is considered that reasonable assurance exists that the Ginna cables are environmentally qualified for their anticipated post accident service, in accordance with the DOR Guidelines.

George J. Wrobel

George J. Wrobel

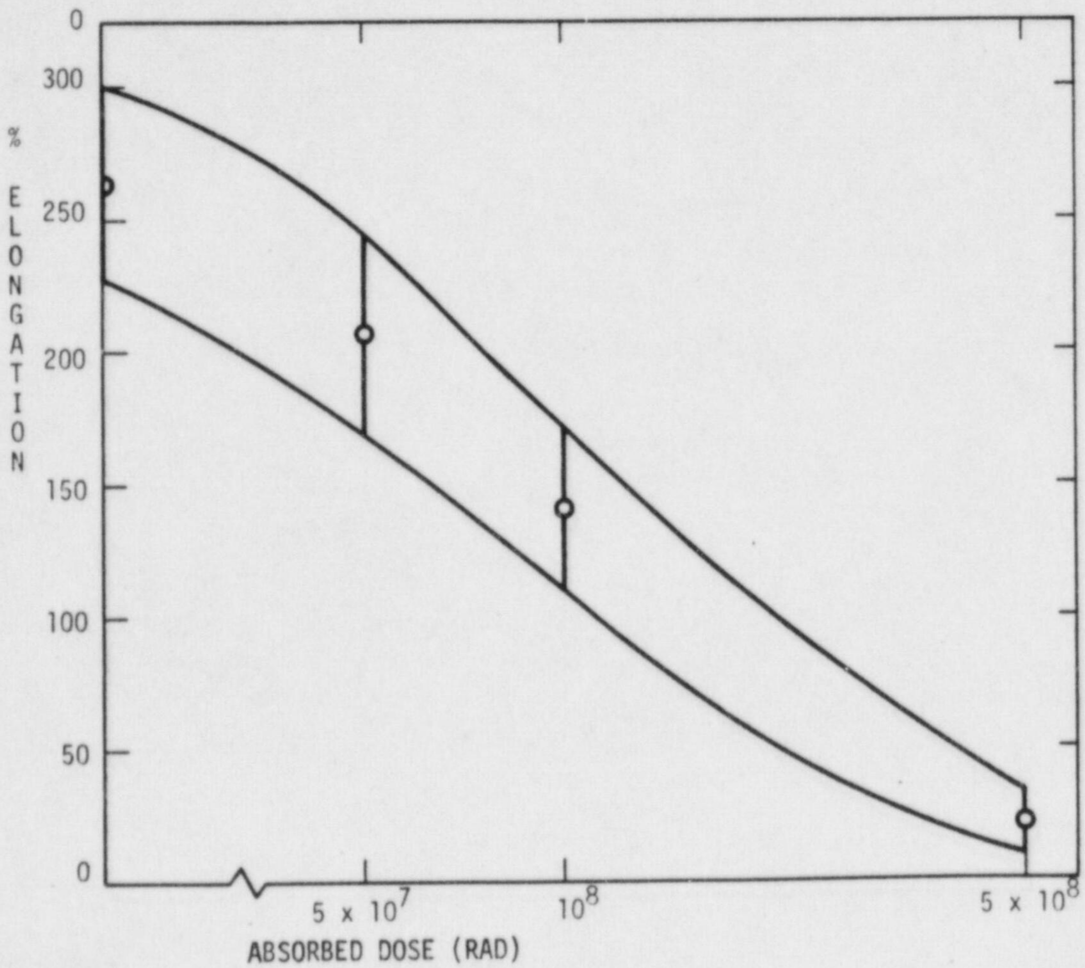
Attachment

xc: P. Wilkens
G. Daniels
R. Baker
C. Edgar

ATTACHMENT 2 TO ENCLOSURE 2

Figure 3-1 FROM EPRI NP-2129

"SIMILAR" PVC CABLES IRRADIATED AT 20-40°C



Data for cables from 38 manufacturers

(From Reference 50)

EPRI NP-1558

full motor tests might become unnecessary for prediction of thermal life of motors. In the new tests, a unique method was to be employed for achieving heating of the motors by armature rotation reversals rather than by heating ovens or by being put under load. The evaluation would begin by performing insulation and surge tests, followed by thermal aging by the above procedure, and a bench period away from service with a "wet humidity test." Four insulation systems, three of which had been in service and one proposed, would be included in the evaluation. A motor would be considered to have failed if it were unable to reverse, or if it could not pass the 600-V breakdown tests. Since the tests had just started at the time of this report, no results were available.

7.2.3 Electrical Cables and Wires

7.2.3.1 Apparatus and Procedures for Testing of Cables

Reports on studies of the aging of insulated power cables have disclosed some information on apparatus and the methods of handling cable samples.

In a study of the aging mechanism of 1-kV, plastic-insulated cables, Maršál and Slaninka *(144)* carried out tests in an underground cable channel 1.6 m wide, 2.1 m high and 50 m long. For each test combination, two parallel cable lengths of 46 m were arranged in horizontal trays in the same plane with 1-cm separation between cables and then connected to an electrical supply system. The installation conditions were considered typical of those used in industrial distribution systems. However, because of the considerable air exchange which might accelerate the thermo-oxidative process and the transport of plasticizers and products of thermal degradation away from the cable, the conditions were more severe than normal with buried cables. Thus the experimental conditions seemed to correspond closely to the more unfavorable service condition.

Blodgett and Fisher *(903)* investigated the effect of gamma irradiation on thin-walled cable coverings, using 10-feet-long wire samples which were coiled on a 2-ft-diameter cardboard drum. The drum rotated at 3 rev/min in air at temperatures ranging from 30° to 40°C. Related experiments were done with wire sets wrapped around a beaker for exposure to radiation in air and water.

Considerably more detail was provided by Paulson and Carfagno *(996)* in a report on apparatus and procedures for qualification of Class 1E electric cable. Many of the procedures and much of the apparatus are applicable to the testing of Class 1E equipment other than electric cable.

The cable specimens were arranged for testing either by placing coiled specimens of appropriate length on perforated metal trays in a test vessel or (preferably) by wrapping the specimens around metal mandrels consisting of stainless steel rods in a cylindrical array. These may be oriented either vertically or horizontally during the thermal aging, irradiation and exposure to steam/chemical-spray environments (simulating LOCA conditions). The advantages and disadvantages of different specimen arrangements were discussed and recommendations made for further development of the test apparatus and procedures.

The stresses applied to the cables included thermal aging, gamma irradiation and exposure to chemical spray solutions, particularly those of boric acid buffered with sodium hydroxide. Thermal aging was generally accomplished by heating the cable in a forced-convection oven in a specified time/temperature cycle. A modification, practiced to a lesser extent, but possibly receiving renewed interest, consisted of maintaining high relative humidity in the oven during accelerated thermal aging.

The aging test may be carried out in a sequential or in a simultaneous manner. In this latter procedure, the cables may be thermally pre-aged before being subjected to supplemental thermal aging combined with gamma radiation aging, or they may be subjected to one combined thermal/radiation exposure only.

Most of the coil irradiation made use of a source consisting of cobalt-60 pencils in a radiation hot cell, with the tests usually conducted in air at ambient temperature and atmospheric pressure.

Since a number of nuclear power plants have been in operation for more than 10 years, samples of cables which have been aged for long periods of time under ambient conditions might possibly become available, and these could be used as "benchmarks" for comparison with accelerated aging studies. This aspect has been considered by Gillen, Salazar and Frank *(616)*, who suggested guidelines for collecting information on prior history and implementation of a test program comparing new cables and cable material identical to those obtained from power plants.

7.2.3.2 Aging of PVC Cables

A study of the aging mechanism of 1-kV, PVC-insulated and sheathed cables was reported by Maršál and Slaninka *(144)*. The test program, which covered a period of about two years, aimed at:

- Establishing the life characteristics of the cables under simulated service conditions
- Obtaining information on the nature of the aging process
- Locating the critical quantities of the change(s) related to the degree of deterioration of the cable.

The complex degradative mechanism of the PVC-based, multicomponent mixtures was assumed to involve:

- Diffusion of oxygen into the cable
- Loss of plasticizer from the insulation and the sheath by vaporization to the surroundings
- Polymer degradation by dehydrochlorination, chain scission and crosslinking reactions.

The overall effect of these processes was a significant change of important electrical and mechanical properties. Electrical properties, such as loss factor and volume resistivity, were measured for the cable as a whole and separately for the insulation. Mechanical properties (e.g., tensile strength and elongation) were measured on samples taken from the cable sheaths and insulation at regular time intervals. Sampling included excision from specified locations of the cross-section of the cable, thus allowing some comments on the most sensitive areas of the construction.

Measurements of modulus under torsional stress were performed on cable sheath samples taken during aging to monitor possible changes of the glass transition temperature, which would be indicative of progress loss of plasticizer or changes in the molecular structure.

Conclusions drawn from the measurements of the electrical properties indicated no significant changes in loss factor during tests at 70° and 90°C; however, after aging at 120°C, changes in loss factor were very marked and irregular. These changes were considered to offer a better criterion for estimating the degree of deterioration than insulation resistance. There was no evidence of the influence of voltage on the aging mechanism.

Data on the mechanical properties during tests of the insulation and sheath at 90°, 110°, and 120°C showed an increase in tensile strength and a decrease in the elongation of the PVC compounds. Only the final stage of aging was marked by a decrease in tensile strength. As might be expected, the rate of these changes increased with temperature.

The glass transition temperature which increases steadily during the early phase of the test and then leveled off, appeared to be a useful indicator of the state of the PVC compound. The trend of the physical properties, in general, could be logically explained in terms of the postulated phases in the degradative mechanism such as gelatination, loss of plasticizer, cross-linking, and scission of macromolecules.

Tensile strength might serve as a useful criterion. The decrease of the tensile strength in the ultimate phase of the degradation process demonstrated that scission reactions began to prevail over cross-linking, thus marking advanced degradation of the material.

Elongation was considered the most significant and regularly changing property and, therefore, the most sensitive indicator of the degree of deterioration. A decrease to about 50% of the original value, accompanied by occurrence of breakdowns and crack formation, seemed to indicate the endpoint of the service life of the product.

The relationship found between elongation and time was

$$t_c^n = \frac{\lambda_o - \lambda_c}{\lambda_1}$$

where

$n = 3$

$t_c =$ time to failure

λ_c = critical value of elongation

λ_0, λ_1 = constants determined for the material and construction, approximated by trial and error (see Table 7-24).

Table 7-24
Constants of Elongation vs. Time Relation for PVC
(Simplified from Ref. **144**, p. 221)

Temp, °C	Constants for the Sheath		Constants for the Insulation	
	λ_0	λ_1	λ_0	λ_1
90	400	5.0×10^{-7}	400	3.5×10^{-7}
110	390	2.3×10^{-5}	400	1.5×10^{-5}
120	400	1.65×10^{-4}	400	9.76×10^{-4}

The Arrhenius Model appears to be valid for the data shown in Figure 7-16 which gives estimated times to failure (days) versus temperature. Extrapolation would show that at a conductor temperature of 65°C (with about 50°C on the sheath) the time corresponding to 1% failures is about 8000 days, or 21 years. The authors pointed out that this assumes continuous operation of 24 hours per day; if the cable is loaded for 8 or 16 hours per day, the life given above would be multiplied by a factor of 3 or 1.5, respectively.

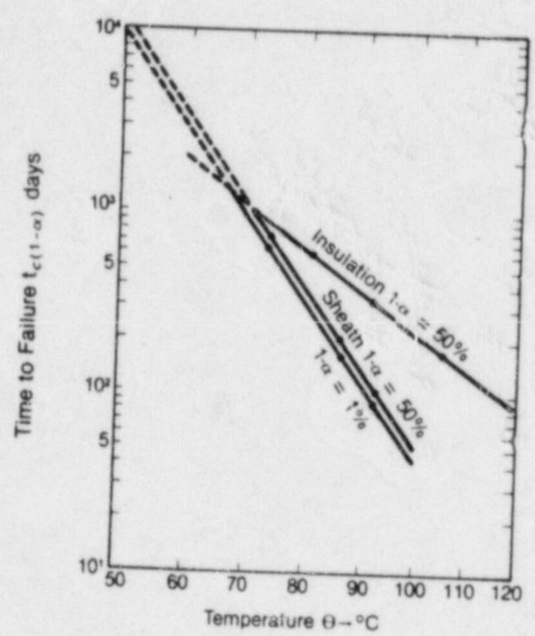


Figure 7-31.
Estimated Times to Failure $t_{c(1-\alpha)}$
vs. Temperature Θ – Calculated from Eqn. 3a,b in Ref. 144.
(From Ref. **144**, p. 222)

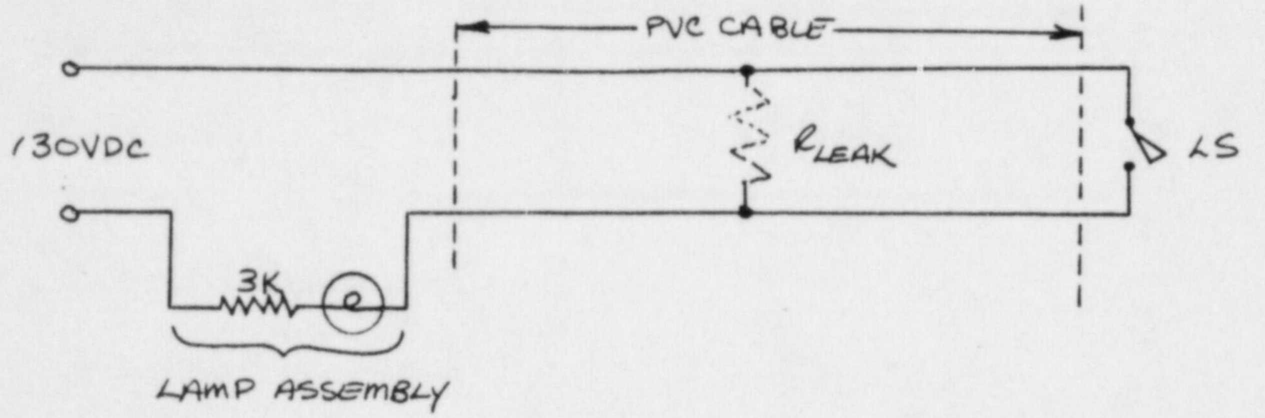
ATTACHMENT 3 TO
ENCLOSURE 2

ROCHESTER GAS AND ELECTRIC CORPORATION

42-33

ENG. DEPT.	STATION: GINNA	DATE: 3-3-87	PAGE 1 OF 3
JOB: 10 CFR 50.49 COMPLIANCE		MADE BY: DPS	CK:

LIMIT SWITCH CIRCUIT



NORMAL BULB VOLTAGE = 30 VOLTS
$I_{NORMAL} = 130-30/3000 = 0.033$ AMPS
} WITH LIMIT SWITCH CLOSED

CONSERVATIVELY, FOR 1/4 ILLUMINATION $I = 1/2 I_{NORMAL}$
AND $V = 1/2 V_{NORMAL}$

$\therefore$ UNDER ACCIDENT CONDITIONS WITH LIMIT SWITCH OPEN
$I = 0.033/2 = 0.0167$ AMPS
$V = 30/2 = 15$ VOLTS

$\therefore$ $E = IR$

$(130-15) = (0.0167)(3000 + R_{LEAK})$

$R_{LEAK} = 3886$ OHMS (FOR WHOLE CABLE, CONDUCTOR TO CONDUCTOR

400' OF CABLE IS ASSUMED

$1/R_T = 1/R_1 + 1/R_2 + \cdots\cdots 1/R_{400}$

$1/3886 = 400/R_{LEAK/FT}$

$R_{LEAK/FOOT} = \underline{\underline{1.554 \times 10^6 \text{ OHMS PER FOOT}}}$
(CONDUCTOR TO CONDUCTOR)

(FOR 1/4 ILLUMINATION)
OR 25%

(CONTINUED)

ENG. DEPT.	STATION: GINNA	DATE: 3-3-87	PAGE 2 OF 3
JOB: 10 CFR 50.49 COMPLIANCE		MADE BY: DPS	CK:

LIMIT SWITCH CIRCUIT

TEST REPORT 45307-1 (WYLE),
GIVES LEAKAGE AS 0.5×10^6 OHMS PER 2.5 FEET
(CONDUCTOR TO GROUND)

$R_{LEAK/FOOT} = (0.5 \times 10^6)(2.5) = 1.25 \times 10^6$ OHMS PER FOOT
$= 2.5 \times 10^6$ OHMS PER FOOT
(CONDUCTOR TO CONDUCTOR)

$1/R_T = 400/1.25 \times 10^6$

$R_T = 3125$ OHMS (CONDUCTOR TO GROUND)

$\therefore R_T = (3125)(2) = 6250$ OHMS (WHOLE CABLE, COND. TO COND.)

THEREFORE, NEW CIRCUIT CURRENT WOULD BE:

$$\frac{3000+6250}{3000+3886} = \frac{0.0167}{I}$$

$I = 0.012$ AMPS

NEW ILLUMINATION WOULD BE:

$$\left(\frac{0.012}{0.0333}\right)^2 = 0.139 \approx \underline{\underline{1/7 \text{ ILLUMINATION}}}$$

OR APPROX. 14%

(CONTINUED)

ENG. DEPT.	STATION: GINNA	DATE: 3-3-87	PAGE 3 OF 3
JOB: 10 CFR 50.49 COMPLIANCE		MADE BY: DPS	CK:

LIMIT SWITCH CIRCUIT

TEST REPORT 22775-87 (ACTON)
GIVES LEAKAGE AS 1.55mA (CONDUCTOR TO CONDUCTOR)
AT 500 VDC FOR APPROX. 10' OF CABLE

$R = 500/1.55 \times 10^{-3} = 3.23 \times 10^5$ OHMS PER 10 FEET

$R_{LEAK/FOOT} = (3.23 \times 10^5)(10) = 3.23 \times 10^6$ OHMS PER FOOT (CONDUCTOR TO CONDUCTOR)

$1/R_T = 400/3.23 \times 10^6$

$R_T = 8065$ OHMS (FOR WHOLE CABLE, COND. TO COND.)

THEREFORE, NEW CIRCUIT CURRENT WOULD BE:

$$\frac{3000+8065}{3000+3886} = \frac{0.0167}{I}$$

$I = 0.010$ AMPS

NEW ILLUMINATION WOULD BE:

$$\left(\frac{0.010}{0.0333}\right)^2 = 0.097 \approx \underline{\underline{1/10 \text{ ILLUMINATION}}}$$

OR APPROX. 10%

SUMMARY

OHMS/FOOT LEAKAGE (CONDUCTOR TO CONDUCTOR)	% ILLUMINATION	REF.
1.554×10^6	≈ 25%	BASE
2.5×10^6	≈ 14%	45307-1
3.23×10^6	≈ 10%	22775-87

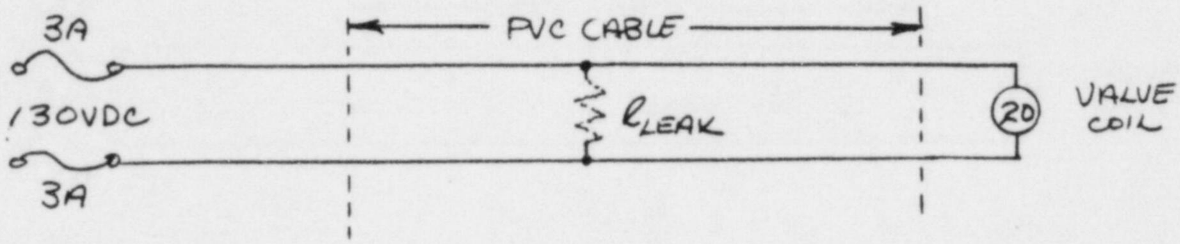
ATTACHMENT 4 TO ENCLOSURE 2

ROCHESTER GAS AND ELECTRIC CORPORATION

42.33

ENG. DEPT.	STATION: GINNA	DATE: 3-3-87	PAGE 1 OF 1
JOB: 10 CFR 50.49 COMPLIANCE		MADE BY: DPS	CK:

VALVE CIRCUIT



ASSUME COIL CURRENT = 0.5 AMPS

R_{LEAK} MUST PASS 3-0.5 = 2.5 AMPS TO OPEN FUSE

$R_{LEAK} = 130/2.5 = 52$ OHMS, CONDUCTOR TO CONDUCTOR, FOR WHOLE CABLE

$1/R_T = 1/R_1 + 1/R_2 + \cdots 1/R_{400}$

$1/52 = 400/R_{LEAK/FOOT}$

$R_{LEAK/FOOT} = \underline{\underline{2.08 \times 10^3 \text{ OHMS/FOOT}}}$, CONDUCTOR TO CONDUCTOR

FROM LIMIT SWITCH ANALYSIS:

WYLE REPORT LEAKAGE ⇒ $\underline{\underline{2.5 \times 10^6 \text{ OHMS/FOOT}}}$

ACTON REPORT LEAKAGE ⇒ $\underline{\underline{3.23 \times 10^6 \text{ OHMS/FOOT}}}$

BOTH CONDUCTOR TO CONDUCTOR

Attachment 5 to Enclosure 2

SIMILARITY

OF

PVC INSULATED, PVC JACKETED

CABLES

FOR

ROCHESTER GAS AND ELECTRIC
GINNA NUCLEAR STATION

1.0 PURPOSE

The purpose of this report is to establish the similarity of General PVC insulated, PVC Jacketed Cable installed at the Ginna Nuclear Station to the Continental PVC/PVC Cable tested by Carolina Power and Light Co.

2.0 SIMILARITY OF PERFORMANCE CHARACTERISTICS

IPCEA Standard S-61-402

The cables covered by this report were purchased in accordance with Ginna Cable Specification SP-5315 which, in turn, requires compliance with IPCEA Standard S-61-402, paragraph 3.7 or 3.8 which states that the PVC insulation shall meet the following physical and aging requirements:

For 60c Rated Cable

Physical Requirements	
Tensile Strength, minimum psi	1500
Elongation at rupture, minimum, percent	100
Aging Requirements	
After air oven test at 100c for 168 hours	
Tensile strength, and elongation minimum, percentage of unaged value	65
After oil immersion at 70c for 168 hours	
Tensile strength and elongation, minimum, percentage of unaged value	85
Heat Distortion, 121c, maximum, percentage of unaged value	50
Heat Shock, 121c	No Cracks
Cold Bend, -10c	No Cracks

For 75c Rated Cable

Physical Requirements	
Tensile Strength, minimum psi	2000
Elongation at rupture, minimum, percent	150
Aging Requirements	
After air oven test at 100c for 168 hours	
Tensile strength, and elongation, minimum, percentage of unaged value	

Maximum	120
Minimum	80
After oil immersion at 70c for 4 hours	
Tensile strength and elongation, minimum percentage of unaged value	85
Heat distortion, 121c, maximum, percentage of unaged value	25
Heat Shock, 121c	No Cracks
Cold Bend, -30c	No Cracks

The cable tested as discussed in Section 5.0 was manufactured by Continental Wire and Cable Company and was certified to IPCEA standards. The cable had 30 mils of PVC insulation and 15 mils of PVC jacket, based on conversation with the purchasing agents.

3.0 CABLE MATERIALS

All of the cables of interest in this report have polyvinyl chloride insulation and a polyvinyl chloride jacket. The cables also have a Mylar shield, the purpose of which is to eliminate extraneous electrostatic signals and/or noise from external sources in order to insure a "clean" signal. This shield is not of interest when comparing PVC properties.

4.0 MATERIAL COMPOSITION SIMILARITY

BP Performance Polymers, Incorporated (Reichold), a supplier to the PVC cable market, has stated that a compound formulation which would meet IPCEA specifications would be a premium performance product that would typically be purchased as a finished product from a high quality supplier and it would not be compounded by a cable vendor. The cable vendor might add a coloring agent. BP has only one such compound, their Bland 8100.

From the above information, it can be judged that the performance requirements of IPCEA greatly limit the range of formulation variations which can be allowed and still have the resultant compound meet the applicable specifications. Most additives increase the cost of a compound and therefore are controlled to a minimum quantity which produces the desired effects. The following section discusses the use and effects of various types of additives. The discussion is based on information in "Modern Plastics Encyclopedia" and from "Polyvinyl Chloride", Harold A. Sarvetnick, R.E. Krieger Publishing Company, Huntington, NY (1977).

Antioxidants/Stabilizers are used to inhibit oxidative degradation during processing and life. Normally, Barium/lead soaps would be used. If too little were used, the cable would not pass the IPCEA aging requirements.

Colorants PVC insulation is usually black which is obtained with carbon black. See the discussion of carbon black under UV stabilizers below. BP has stated that the colorants would not affect the properties.

External Lubricants are used to prevent the compound from sticking to the extrusion dies during processing. Since it is applied to the outer surface of the insulation it does not affect that long or short term performance of the cable.

Fillers/Extenders There must be a controlled balance between the amount of filler and plasticizer to obtain the necessary physical and electrical properties. Therefore the IPCEA serve as a functional control on the composition of the cable.

Fire Retardants PVC is inherently flame retardant resin. However, the plasticizers are known to be flammable. Flame retardants always increase the cost and reduce physical properties or processability, therefore their use kept to an absolute minimum necessary to meet the required specifications. Normally antimony oxide is used in combination with the PVC resin to render the plasticizers flame retardant.

Plasticizers are added to PVC cable compounds to improve processability and to impart flexibility to the extruded insulation. Trialkyl trimellitates are used, sometimes with some diundecyl phthalate or ditridecyl phthalate. Again, the IPCEA serves as a functional control on the composition of the cable.

UV Stabilizers are not needed for the insulation in a jacketed cable. However, carbon black which is frequently added as a colorant is also an excellent UV stabilizer. Less than 3% would be suitable for outdoor exposure. If too much carbon black were used, the physical properties would not meet the IPCEA specifications.

Heat Stabilizers The main function of a heat stabilizer is to prevent discoloration during processing. Generally, the level of degradation which occurs during processing does not materially affect other physical properties. Discoloration begins with a loss of less than 0.1% HCI. After the processing operation, the requirement for heat stabilizer no longer exists for most applications. Exceptions are special cases where the product may be subjected to heat, e.g., electrical insulation and film or sheet which may be heat sealed or thermoformed.

Lead compounds are used almost exclusively in electrical applications since these materials and lead chloride which may be formed are insoluble and nonhygroscopic. Lead carbonate is a commonly used general purpose stabilizer. One of the best for high temperature applications is dibasic lead phthalate. Lead sulfrate and dibasic lead phosphite are also important. Lead stearate may serve the dual role of stabilizer and lubricant.

Adding heat stabilizers to PVC cable insulation results in improved long and short term thermal aging characteristics for the cable materials. A comparison of RG&E's thermal rating for the PVC cable and the tested cable established identity of this characteristic (75°C max).

Unused Additives The following additives are not used in PVC extruded cables for IPCEA or military specification cables: antiblock or slip agents, antistatic agents, biodegradable additives, blowing agents, cross-linking agents, impact modifiers, internal lubricants or photodegradable additives.

5.0 LOCA TESTING

Carolina Power Cable Testing (45307-1)

RG&E EEQ Package #44 contains the report which documents testing on six samples of PVC/PVC two and four conductor instrumentation cables that were removed from the H.B. Robinson Nuclear Power Generating Station after ten years of service. The cables were subjected to a radiation exposure of a minimum of 1.65 x 10^7 rads and up to 30 years additional equivalent aging. The cables were then subjected to a double transient 30-day accident test with chemical spray from the second transient onward.

The temperature peaked at 290F and was above 280F for essentially the entire three hours of the first ramp, and above 285F for essentially the three hours of the second ramp. The pressure peaked at 67 psig during the first ramp and was above 60 psig during most of the first ramp, and above 50 psig for most of the second ramp. During the next 21 hours the temperature averaged about 220F and the pressure was about 15 psig. During the remaining 29 days the temperature averaged 152F and the pressure averaged 5 psig. The cables were conducting 24 mA at 48 VDC during this accident testing.

These conditions envelope the required "harsh" environmental conditions at Ginna Station.

6.0 CONCLUSIONS OF SIMILARITY ANALYSIS

The discussion in Section 2.0 has shown that PVC insulated cables manufactured to IPCEA specifications are required to meet certain minimum performance requirements after high temperature exposure. The discussion in Section 4.0 has shown that the relatively minor compositional changes from manufacturer to manufacturer will have no appreciable effect of the performance of PVC/PVC insulated cables under accident conditions of the Ginna plant. It is therefore judged that the test results on the tested cables apply to the PVC/PVC cables in the Ginna plant and that these cables are qualified to perform their Class 1E accident functions.

ENCLOSURE 3

COLEMAN CABLE
(PACKAGE #13)

NRC "POTENTIAL ENFORCEMENT" CONCERN

The Coleman cable was not demonstrated to be qualified for use in instrumentation circuits, based on Package #13 qualification data at the time of the inspection.

RG&E RESPONSE

The Coleman silicone-rubber cable is considered qualified for both control and instrumentation applications, based on the information in Package #13 at the time of the inspection (and previously). The only deficiency identified during the recent 10CFR50.49 inspection was that insulation resistance was not measured and recorded during the FRC testing (Reference 3.b.1 of Package #13). The cables did withstand all the environmental conditions imposed during the LOCA testing, with significant margin (note that the test peak conditions were 132 psig and 365°F, vs. the required Ginna peaks of 60 psig and 286°F). Based on this test, there was nothing to indicate that the cable would not have been acceptable.

Reference 3.b.5 of Package #13 provides certification, for the silicone rubber cable, to IPCEA S-19-81 which demonstrates and documents that the cable met the industry accepted criteria prevalent at that time. The certification also shows that the insulation resistance of the cable, after IPCEA testing which included 168 hours of aging at 392°F, was greater than 10^{9} ohms. Since high temperature was considered to have the most severe impact on insulation resistance during the LOCA/steam line break, the IPCEA test results were considered sufficient to demonstrate acceptable performance criteria for instrumentation circuits.

During the 1978 FRC test, documented in EEQ Package #13 as Reference 3.b.1, the insulation resistance of the tested samples was monitored and the lowest reading reported, after irradiation and after steam/chemical spray testing, for insulation resistance. In each case the insulation resistance measured showed little significant change from that certified in the IPCEA Standard (8×10^{12} ohms post irradiation and 1.5×10^{8} ohms post steam/chemical spray). These data indicate that significant degradation did not occur during testing. Additional evidence of qualification was provided by the successful demonstration of its capability to pass a high voltage (1500 V) withstand test following the LOCA test. The results of this test are presented in the FRC test report which indicates that the highest leakage current observed was 2.5 mA at 1500 V. At rated current and voltage, as in the actual application of this cable, the leakage current, if any, would be substantially less. Typical Ginna ratings are 75 V at 10-50 mA.

If significant degradation had occurred during testing, the circuit breaker would have tripped thereby failing the circuit. One specimen out of seven was observed to have low IR (6 x 10^4 ohms) reading after steam and spray testing (this anomaly was discussed and dispositioned in Section 7.b of EEQ-1 Package #13, and was due to the potting method used to seal the cable in the test chamber).

This qualification information was reviewed by FRC during the 1982 Environmental Qualification Review (see Attachment 1) culminating with FRC TER C5257-454, with the conclusion that this cable was qualified for its application, except for radiation and qualified life. These two differences were addressed by RG&E in subsequent communications with FRC and the NRC (EEQ Package #15 References 3.b.4 for the qualified life calculation, and Reference 3.b.8 for the radiation qualification information). These documents were in the RG&E Package #13 file at the time of the NRC inspection.

Based on RG&E's review of the test report and other qualification documentation such as the IPCEA tests, as well as the FRC/NRC review as detailed in the FRC TER C5257-454, and RG&E's disposition of the TER open items, RG&E considered the cable to be fully qualified, as required by 10CFR50.49, for both instrumentation and control applications, and did not consider additional testing to be a necessity, and certainly not a priority item.

In 1985, RG&E decided to perform additional confirmatory testing of various cable and connection samples being used at Ginna Station (such as small bend radius Raychem sleeves, and sleeves with less than 2" overlap). It was decided at that time to also test a sample of the Coleman cable, and measure leakage currents during the LOCA conditions. This would further confirm that the cables met all performance requirements for their application and thus enhance RG&E's documentation. Various delays kept the test from being completed until the week of the NRC inspection. The testing was successful in that it confirmed that leakage currents were not significant during the LOCA. The cable specimen, test plan, and test results were available to the NRC staff for review and inspection on Wednesday through Friday of the inspection week. The maximum leakage current was 16 A at 500V for the 10 foot sample. In a 75 V, 10-50 mA instrument loop with 400 feet of cable, the leakage current would be 1.0 A. This would cause an insignificant error. The results of this testing further confirmed that the evaluations and judgements used to accept the qualification of this cable for all applications at Ginna was justified.

Based on the information provided in Package #13 at the time of the inspection, RG&E believes that reasonable assurance was demonstrated to show that the cable was qualified to perform its safety functions, and that the additional testing was confirmatory in nature. Therefore, RG&E does not believe that a "potential enforcement" finding is warranted for this item.