TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401

5N 157B Lookout Place

JUN 15 1990

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of the Application of	)	Docket No. 50-390
Tennessee Valley Authority	)	

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - SUPPLEMENTAL INFORMATION ON WBN CABLE ISSUES

Reference: 1. Cable Issues Corrective Action Program (CAP) Plan, submitted to NRC by TVA's letter dated June 27, 1989

2. Supplemental Information on WBN Cable Issues - Ampacity and Large Low Voltage Power Cables in Standard Conduit Bodies, submitted to NRC by TVA's letter dated June 15, 1990

On May 22, 1990, TVA presented the status of the WBN cable issues to NRC in a meeting held at the Region II offices in Atlanta, Georgia. At the conclusion of the meeting, TVA committed to provide NRC with supplemental information on several presentation topics. This is the third of three letters providing this information. Enclosures 1 through 5 contain supplemental explanations and clarifications relating to Cable Proximity to Hot Pipes; Cable Splices; Silicone Rubber Insulated Cables; Cable Drop in Vertical Tray and Conduit; and Cable Bend Radius issues. Enclosure 6 contains the commitments made in this submittal.

TVA requests a meeting with NRC in July 1990 in order to identify any remaining issues and to assure that NRC has sufficient information to complete its review of the Cable Issues CAP Plan. R. J. Stevens of my staff will be contacting the appropriate NRC personnel to arrange such a meeting. If there are any questions, please contact him at (615) 365-8650.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. N. Shell
for E. G. Wallace, Manager
Nuclear Licensing and
Regulatory Affairs

Enclosures
cc: See page 2

A001 1/1

U.S. Nuclear Regulatory Commission

JUN 15 1990

cc (Enclosures):
NRC Resident Inspector
Watts Bar Nuclear Plant
P.O. Box 700
Spring City, Tennessee 37381

Mr. Peter S. Tam
U.S. Nuclear Regulatory Commission
Mailstop 13H3
Washington, D.C. 20555

Mr. B. A. Wilson, Chief
of TVA Projects
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

ENCLOSURE 1
SILICONE RUBBER INSULATED CABLES

This information is provided as supplemental information to that contained in Section 4.1.1 of the Cable Issues CAP Plan submitted by TVA to NRC on June 27, 1989.

Background

To resolve the cable support in vertical conduit issue at Sequoyah Nuclear Plant (SQN), high-potential withstand testing of silicone rubber cable was performed and several failures were experienced. Analysis of these failures revealed that they were not the result of inadequate support. Instead, it was noted that the damage location and structure was consistent with some type of impact mechanism. Laboratory testing by TVA[1] indicated that silicone rubber insulation was more susceptible to this type of damage than other insulation systems. Neither vendor literature nor TVA installation specifications dictated any special handling or installation measures to ensure that such damage did not occur. Inspection of the failed SQN cables revealed that "impacts" had resulted in reduced insulation wall thicknesses.

In order to ensure that cables which experienced these reductions would perform their intended function, TVA initiated simulated loss of coolant accident (LOCA) tests[2] at Wyle Laboratories in Huntsville, Alabama. These tests were performed on aged cables with intentionally reduced insulation thickness to simulate an impact condition. The results were acceptable and provided a limited qualified life of 10 years. To confirm the qualification of the as-installed SQN and WBN cable for its full 40-year life, TVA and the NRC agreed to additional testing of Anaconda and Rockbestos cables removed from WBN. It should be noted that all silicone rubber insulated cables which failed the above high potential withstand test at SQN were manufactured by American Insulated Wire (AIW). AIW silicone rubber insulated cables have not been and will not be used in Class 1E circuits at WBN and accordingly were not included in further testing.

Method of Resolution

The total population of conduits containing safety related circuits located inside containment at WBN was screened to find those in 10 CFR 50.49 Category A or B service containing silicone rubber insulated cables which were subjected to "worst-case pulls" as defined below.

Five such circuits were identified for both Anaconda and Rockbestos silicone rubber cables. Given the rather large population of cables manufactured by Rockbestos in Unit 1 of WBN (approximately 400), that unit was considered as representative of both units at SQN and WBN. Given fewer circuits at WBN containing silicone rubber cables manufactured by Anaconda, worst-case installations were determined using both units as the initial family. As discussed below, these latter specimens were to be used to represent SQN only. The remaining steps in the identification and removal process were as follows:

---

1. Singleton Materials Engineering Laboratory Test Report SME-MET-87-043, entitled "Sequoyah Nuclear Plant, Impact Testing of AIW Cable."
2. Report No. 17905-1, entitled "Qualification Test Program for Silicone Rubber Cables with Reduced Insulation Thicknesses for use in Tennessee Valley Authority's Sequoyah Nuclear Plant, Unit 2."

ENCLOSURE 1
SILICONE RUBBER INSULATED CABLES

- Construction specifications[3] were used to establish the maximum length of cable allowed for a given conduit size that could be pulled without performing sidewall bearing pressure calculations. All cables having circuit lengths less than those defined by the construction specifications were eliminated from the selection process.

- Walkdowns were then performed to eliminate cables installed in conduits which had less than two 90 degree condulets in the run.

- The final selection was based on the severity of the pulls as a function of sidewall bearing pressure. For the purposes of this evaluation, "C" condulets were not considered pull points.

Cables thus identified were removed and sent to Wyle Laboratories for environmental testing[4]. In order to qualify the as-installed cables both at SQN and WBN, certain specimens were designated as representing "SQN" and the remaining specimens were designated as "WBN." Both sets of specimens were aged according to the respective plants' environmental conditions. The specimens were then exposed to a simulated LOCA environment (including steam/chemical spray), which enveloped both SQN and WBN requirements, while energized. After completion of the accident simulation, the cables were subjected to a mandrel rebend and high potential withstand test for margin assessment.

Results

All cables removed from WBN and designated as "SQN" specimens (Rockbestos and Anaconda) successfully passed the tests. The 40-year specimens designated to represent WBN (Rockbestos only) experienced low insulation resistance (IR) values when measured following insertion of the specimen tray in the LOCA chamber. At TVA's request, the chamber was opened and the tray containing the 40-year specimens were removed.

Investigation revealed that the low IR values were the result of exposing the specimens to excessive radiation due to an improper determination of the beta contribution. Accordingly, revised calculations[5] were issued in May 1989. Utilizing these revised calculations, it has been established that in order to simulate worst-case WBN accident conditions, cables must receive a total dose of 150 MRADS to account for the normal 40-year gamma dose, the beta and gamma accident dose and the 10-percent margin of accident radiation[6]. The Rockbestos specimens removed from WBN (and originally designated as "SQN") received 156 MRADS. Based on the foregoing analysis, TVA concludes that the tests results of the "SQN" specimens are applicable to WBN.

3. General Construction Specification (G-38), "Installing Insulated Cables Up to 15,000 Volts," Tables F1 (power) and F2 (control).
4. Per IEEE 383/323.
5. Calculation No. WBNTSR-015, "Dose to Cables Inside the Containment."
6. Per IEEE 323-1974.

ENCLOSURE 1
SILICONE RUBBER INSULATED CABLES

Since Anaconda silicone rubber cables are not used in 10 CFR 50.49 circuits for WBN Unit 1, no further evaluation of cables by this manufacturer is required. A copy of the Wyle Laboratories test report[7] is enclosed.

Conclusion

In summary, TVA has completed it's WBN program of environmental qualification testing of cables removed from "worst-case" conduits. The successful performance of the cables during these tests demonstrates that the installation methods for silicone rubber cables were adequate to have prevented significant impact-induced damage. The cables, as aged to conditions enveloping WBN requirements, demonstrated an ability to perform their intended safety function following the rigors of installation and removal.

7. Report No. 18056-1, "Qualification Test Program for Silicone-Rubber Insulated Cables For Use In Tennessee Valley Authority's Sequoyah and Watts Bar Nuclear Plants."

ENCLOSURE 2
CABLE SUPPORT IN VERTICAL TRAY AND CONDUIT

This information is provided as supplemental information to that contained in Sections 4.1.3 and 4.1.4 of the Cable Issues CAP Plan submitted by TVA to NRC on June 27, 1989.

Background

Cables in long vertical conduits and cable trays may be inadequately supported, which could potentially cause unacceptable cable insulation degradation. The root cause of this deficiency is the failure by TVA to include industry standard support requirements in design and installation documents. TVA has revised construction specifications[1] to ensure compliance with National Electric Code (NEC)[2] requirements, with respect to vertical drops in conduit and cable tray.

Method of Resolution

Drawing reviews and calculations have been performed to find those families of trays[3/4] and conduits[4/5/6] containing safety-related cables wherein the potential exists that adequate support was not provided to meet the requirements of the NEC[2]. Walkdowns[7/8/9] are being employed to obtain exact configurations. Where the length of the vertical drop exceeds 25 percent of the support spacing stipulated in the NEC and a discrete support is not present, TVA is confirming that a method of equal effectiveness exists (as permitted by the code). TVA's analysis[4] includes consideration for the degrading mechanisms that could result from the drop and takes into consideration the inherent support provided by the raceway system (sweeps, horizontal sections above a drop, etc.).

Where adequate support is found to be lacking, the necessary design changes and field modifications will be undertaken to bring the subject cables into compliance.

Evaluation of Mechanism:

Inadequate support of safety-related cables in vertical raceways is of concern due to the potential degradation of the insulation system. To evaluate that impact, the influence of the unsupported load must be reviewed with respect to the cable and any connected equipment at the top of the drop. These effects fall into four major categories.

---

1. General Construction Specification (G-38), "Installing Insulated Cables Up to 15,000 Volts."
2. Article 300-19, National Electric Code (1987)
3. Calculation WBPEVAR8907010, "Selection of Class IE Vertical Trays for the Vertical Support in Vertical Tray Walkdown."
4. Calculation WBPEVAR9005001, "Analysis of Effect of Vertical Cable Runs on Acceptability of Installed Cables."
5. Calculation WBPEVAR8912010, "Class IE Cable Support in Vertical Conduit - Screening, Evaluation, and Disposition."
6. Calculation WBPEVAR8905049, "Silicone Rubber Insulated Cable - Support in Vertical Conduit - Critical Case Evaluation."
7. Walkdown Procedure WP-47, "Walkdown of Cable Support in Vertical Conduit."
8. Walkdown WD-006, "Cable Support in Vertical Conduit."
9. Walkdown TI-94.04, "Cable Support in Vertical Tray Walkdown."

ENCLOSURE 2
CABLE SUPPORT IN VERTICAL TRAY AND CONDUIT

The first is the impact of the unsupported weight on the copper conductors and the potential for such a load to stretch the copper. Using standard formulas for the allowable working load on the conductors, maximum permissible vertical drops were established for each cable size in conduit as a function of its weight per foot. A similar approach was utilized for cables in tray except that consideration was given for the additional weight imposed due to the presence of the fire retardant coating, Vimasco.

The second issue is the concern for pullout of conductors from crimped lugs at terminations. The loading data developed above was used and compared with industry lug pullout values.

The third concern was for the potential cutting action of tie wraps used to secure cables in trays. TVA's analysis[4] concluded that degradation to the cable, beyond cosmetic indentation of the jacket, was not feasible provided that the cables were restrained so as to prohibit significant longitudinal movement. This aspect is discussed further in the results section.

The final issue of concern was the potential development of excessive static sidewall bearing pressure at existing support points for drops in excess of code allowables. TVA's evaluation gave consideration to the geometry of the transition points (conduit and tray sweeps, conduit bushings, condulets, tray siderails and covers, etc.) and the pressures which would result at each. A 'stacking factor' was developed to conservatively account for the presence of multiple cables at the same transition. The resulting pressures are then compared with acceptance criteria adopted by TVA based on tests performed by the Okonite Cable Corporation[10]. Single conductor No. 12 AWG EPR insulated cables were energized and brought to 90°C. Weights were applied to a 1/4-inch diameter steel rod laid across the cable. A series of curves were developed reflecting the relationship of weight applied and time-to-failure. Okonite concluded that a 20-pound load thus applied would not lead to premature failure. For conservatism, TVA has utilized an equivalent 10-pound loading to develop its criteria. Using this latter value, an allowable static sidewall bearing pressure of 342 PSI has been established. The results of these tests are regarded as applicable to TVA's EPR and cross-linked polyethylene (XLPE) cables. Both materials are thermoset in nature with the EPR being the softer of the two.

10. Attachment C to Reference 2.

ENCLOSURE 2
CABLE SUPPORT IN VERTICAL TRAY AND CONDUIT

Additional conservatisms are applied for polyethylene insulated cables which are used in control applications outside of primary containment. Acceptance criteria for silicone rubber cable, which is softer than EPR, was based on the successful Sequoyah Nuclear Plant (SQN) testing.

Results

Vertical Tray:

TVA has performed a review of the safety-related tray system required for Unit 1 operation and has identified eighty-eight vertical segments of a length greater than that permitted by the NEC for their respective cable sizes.

Walkdowns have been performed to obtain exact configurations and to identify cables which exit those segments. Those walkdowns revealed that the segments were generally coated with Vimasco fire retardant cable coating, and that the cables therein were secured to the trays with ties. Numerous ties were observed to exist, though the specific number could not be determined due to the presence of the Vimasco. Likewise, spacing of the ties on the individual cables could not be confirmed, but estimates, based on the total quantity observed, indicated that spacing does not exceed 10 feet.

Analysis showed that the installed configurations were adequate with respect to conductor loading, lug pullout, and static sidewall bearing pressure. A further review was performed to ensure that the horizontal run at the top of the drop provided the necessary restraint to prevent cable movement. In order to quantify this restraining force, a conservative value for the "effective coefficient of friction" was determined. A value of 1.5 was considered appropriate for these horizontal segments of tray since cables, or bundles of cables, are frequently secured by tie wraps and since the cables and rungs are coated with Vimasco (this latter material cures with strong, though undefined, structural and adhesive properties). The "effective coefficient of friction" was then utilized with conventional pulling force equations to identify the horizontal lengths required to provide the necessary restraint. All cables were found to be adequately restrained.

Many of the segments were observed to include firestops in either the horizontal or vertical segments that further inhibit movement or provide support, respectively.

A separate evaluation[2] was performed of cables exiting the vertical segments. Several installations were identified as requiring support to provide assurance that long-term degradation will not occur at the bearing point (i.e., tray cover).

ENCLOSURE 2
CABLE SUPPORT IN VERTICAL TRAY AND CONDUIT

Vertical Conduit:

Conduits containing Class 1E, silicone rubber insulated cables were identified and walked down to find those conduits that exceeded NEC limitations. A total of 35 were initially identified; however, to date the cables in 6 of these conduits have been reworked as a result of other issues. Of the remaining conduits, 5 are bounded by the successful SQN insitu testing and will be supported to NEC requirements without further review.

In accordance with Section 4.1.3 of the WBN Cable Issues CAP, the silicone rubber insulated cables in the remaining conduits which were not bounded by SQN testing were either to be tested and supported or replaced. The purpose of those tests was to confirm that unacceptable degradation had not occurred at the support point as a result of the excess bearing pressure. However, based on TVA's SQN experience, it is expected that some cables may not be resting on the subject condulet or bushing (or only bearing lightly) due to support provided by RTV seals or conduit offsets in the vertical drop. In these cases, the cables will be considered suitable for service, and a support added to ensure long-term integrity since the degrading mechanism is not present. TVA will consider that sufficient evidence exists that the degrading mechanism is absent if the cables can be lifted off of the support point with one hand. Where cables are under pressure at the support point, TVA will either confirm their integrity by test prior to supporting them or the cables will be replaced.

Conduits containing safety-related cables required for Unit 1, with other than silicone rubber insulation, were screened to identify those (approximately 2700) that potentially exceed the vertical drop limits of the NEC.

Walkdowns are ongoing to first confirm the presence of the conservatively assumed vertical drop. Where the code allowable has been exceeded, the type of support component (condulet, sweep, crimped lug, etc.) will be identified. Acceptance criteria has been developed for cables in conduits, using similar methodology to that described above for trays. Consideration was given to conductor loading, lug pullout, sidewall pressure and cable restraint. When evaluating the restraining force provided by a horizontal run at the top of the drop, an "effective coefficient of friction" of 0.6 was applied. This number is considered conservative for dry cables in conduit, with additional unquantifiable restraint provided by dried pulling lubricant and the presence of fire or pressure seals.

Cables in those conduits not meeting the acceptance criteria will be supported or reworked.

ENCLOSURE 2
CABLE SUPPORT IN VERTICAL TRAY AND CONDUIT

Remaining Activities:

- For safety related cable trays, confirm the presence of cable ties or Vimasco on all cables in the horizontal tray segments above the vertical drop.

- Provide supports, as required, for the cables that enter/exit vertical tray segments.

- Complete inspections and supporting of the silicone rubber cables in conduit. Perform testing or replace cables where appropriate.

- Complete walkdowns, analysis, and required modifications to the other Class 1E cables in conduit.

- Evaluate the impact (static and seismic) of the excess vertical drop on connected equipment.

- Revise design and construction procedures to ensure that all potential transition/support points have been addressed.

Conclusions

TVA has completed development of a set of criteria to assess the adequacy of cables in a variety of vertical drop configurations. Implementation of this criteria and the consequent corrective actions will ensure that the cables are adequately supported to ensure performance of their safety function.

ENCLOSURE 3
CABLE PROXIMITY TO HOT PIPE

This information is provided as supplemental information to that contained in Section 4.1.5 of the Cable Issues CAP Plan submitted by TVA to NRC on June 27, 1989.

Background

In April of 1986, TVA's Sequoyah Nuclear Plant (SQN) identified a condition in their main steam valve vaults where cable degradation occurred due to heat from nearby main steam piping (550°F). SQN's problems resulted from failure to replace insulation after maintenance. In June of 1986 stemming from an incident at the San Onofre Nuclear Station, the Nuclear Regulatory Commission (NRC) issued an information notice[1] which highlighted failures of electrical cables exposed to uninsulated thermally hot pipes (400°F).

Method of Resolution

Piping systems exist throughout the plant which operate at various process temperatures. Since this issue is related to long-term cable degradation, only those piping systems continuously in use, such as normal operation or long-term accident operation, need be considered.

Based on the experience at Sequoyah and San Onofre, only very hot pipes (greater than 400°F) pose a significant risk to cables. In these cases, cable was found to be charred and in some cases to the point of electrical insulation failure. For WBN, calculations and screening criteria have been developed to encompass pipes operating above 250°F.

Per WBN design criteria[2], piping in excess of 135°F shall be insulated in areas where personnel access is required. Since this criteria does not require all piping in this temperature range to be insulated, TVA will perform walkdowns to examine piping and raceway proximity. Corrective action will be taken as necessary to insulate piping and to resolve any potentially unacceptable interactions. TVA will perform calculations to document that the sizing process utilized for cables in conduits includes sufficient conservatism to account for those cables in close proximity to pipes between max normal ambient temperature and 135°F.

For pipes operating above 250°F, preliminary calculations have been performed to establish a screening criteria for use on existing installations and as a guide for future installations. The criteria creates an envelope outside of which no cables are endangered from hot pipes. Some key aspects are:

- power cables were analyzed for worst-case configuration in either conduit or trays

1. IE Information Notice No. 86-49, "Age/Environment Induced Electrical Cable Failure," June 16, 1986
2. Design Criteria WB-DC-40-1, "Insulation" (B26 880714 023)

ENCLOSURE 3
CABLE PROXIMITY TO HOT PIPE

- 36-inch pipe was assumed to carry 650°F process fluid and insulated with calcium silicate (calcium silicate was used since it has a worst-case emissivity for radiation calculations)

- minimum thermal insulation thickness was assumed according to design specifications

- both natural convection and radiation heat transfer was assumed (forced ventilation flow which breaks up plumes and increases heat transfer was not considered)

- single point heat sources were assumed

- piping less than 2" in diameter was not regarded as a heat source of sufficient magnitude to warrant further consideration

The calculations were performed for several different pipe and cable raceway orientations - horizontal, vertical, parallel, and nonparallel. Based on these orientations and the above considerations, typical separation criteria were determined to be: 1.5 pipe and insulation diameters above the hot pipe, 6 inches beside, and 6 inches below for parallel configurations; and 6 inches above, 6 inches beside, and 6 inches below for nonparallel configurations. Other configurations are included in the calculation.

A walkdown procedure[3] was developed using the criteria to identify potentially unacceptable raceway/"hot" pipe interactions. When minimum screen was not met, actual plant configurations were used for evaluation of the interaction.

To prevent recurrence of similar installation deficiencies, TVA has incorporated the separation criteria into construction specifications[4] for use on all future conduit installations in the vicinity of piping in excess of 250°F. Following completion of the above calculations, similar criteria will be incorporated for conduit separation from piping between 135°F and 250°F and for cable trays.

In addition to the above evaluations, TVA will review maintenance practices and procedures to address the removal and replacement of thermal insulation during operation and ensure proper controls are in place to protect Class 1E cables by restoring the required insulation on hot pipe.

<u>Results</u>

Walkdowns of piping above 250°F are complete and the evaluation of the approximately 470 screening interactions is progressing. Each of the cases is being evaluated to determine if corrective action is required. These evaluations will be documented in the calculations establishing the screening criteria.

3. Walkdown Procedure, WD-011, "Walkdown of Hot Pipes and Components in Proximity to Electrical Raceways" (B26 900406 078)
4. TVA General Construction Specification, SRN-G-40-34, Section 3.2.1.11, Installing Electrical Conduit Systems and Conduit Boxes" (B26 900312 416)

ENCLOSURE 3
CABLE PROXIMITY TO HOT PIPE

Conclusions

TVA has developed and is implementing an resolution plan which, at completion, will ensure that hot pipe interactions are corrected and that Class 1E electrical cables will maintain their ability to perform their intended safety function.

ENCLOSURE 4
CABLE BEND RADIUS

This information is provided as supplemental information to that contained in Section 4.1.7 of the Cable Issues CAP Plan submitted by TVA to NRC on June 27, 1989.

Background

As a result of internal TVA reviews and NRC inspection findings, potential programmatic bend radius violations and concerns have been identified. The reviews and findings indicated that TVA engineering standards lacked a documented basis for deviations from industry bend radius standards and that installations existed where bends were in violation of the relaxed TVA standards.

Method of Resolution

In order to properly assess the significance of the subject deficiencies, TVA has embarked upon a program of testing and analysis with the following salient points:

- Definition of degradation mechanisms resulting from the less than code defined bend radii and the consequent impact on performance.

- Testing to establish the point of onset for the degrading mechanism.

- Definition of an inspection/acceptance criteria based on the above findings and conclusions with consideration for the cables normal and accident service conditions.

- Initiation of long-term plan comprised of testing, monitoring, and analysis to further validate conclusions drawn above.

An overview of each of the efforts is provided below:

1. Design Standard DS-E12.1.5, Revision 3, "Minimum Radius for Field Installation Insulated Cables Rated 15,000 Volts and Less."

ENCLOSURE 4
CABLE BEND RADIUS

Evaluation of Mechanism:

Excess bending of safety-related cable is of concern due to the potential impact on performance. To evaluate that impact, influence of the bend must be reviewed with respect to the constituent components of the various cable constructions. For the bend radius violations under consideration, the effects fall into two major categories. The first is the permanent mechanical deformation of critical cable components (i.e., conductor or tape shield) while the latter is the impact of the supplemental elongation imparted to the primary insulation as a consequence of the tight bend. Each of these categories was reviewed for low- and medium-voltage cable types so that subsequent analysis would account for all known phenomena.

For medium-voltage cables, three mechanisms were judged to be of potential concern. First, bends beyond that permitted by industry standards resulted in an additional elongating stress to the insulation system. Since cable life is generally defined in terms of retention of elongation, such an additional prestress may be viewed as a potential reduction in life. The stress developed which is above that generated by a standard bend may be readily determined by calculation. Such calculation may then be utilized to assess impact to the cable's life.

Second, overbending may result in interfacial disruptions of a medium-voltage cable's stress control layers. These layers (strand shield, insulation, and insulation shield) must remain in intimate contact to ensure proper stress distribution and provide protection against corona inception. Additionally, the helically wound copper tape shield must not become so deformed as to potentially pinch or gouge the insulation and insulation shield. Such action would again result in the increased likelihood of corona degradation. Should corona discharges persist, deterioration will progress with age. Therefore, tests undertaken by TVA included direct evaluation of both tape shield and interfacial integrity.

The third consideration was for conductor deformation resulting from the bend. Concern existed that such deformation might result in a residual radial stress on the insulation system. Therefore, TVA's tests considered conductor integrity for both overbent specimens and retrained overbent specimens.

For low-voltage cables, no such interfacial concerns existed. Due to their reduced dielectric stress levels, no risk of corona initiation exists, and consequently, the stress control layers, such as used on medium-voltage cables, are absent. However, the issues of additional elongating stress and conductor deformation are applicable and have been included in TVA's evaluation.

ENCLOSURE 4
CABLE BEND RADIUS

While the above discussion addresses the significant factors associated with single conductor cable bends, TVA recognizes that an additional influence is present in multiconductor cables. For these latter designs, tight bends result in a flattening of the overall jacket such that the cables' cross section becomes oval rather than circular. In such a bend, stress are imparted to the individual conductors from the jacket, other conductors and drain wires. The magnitude of such forces is influenced by the specific construction of the cable (size and number of conductors, presence of drain wires, tightness of the core, type of filler material, etc.). Evaluation of these forces for the variety of cables employed at WBN was beyond the scope of the subject tests. Bend radius factors for multiconductor cables were developed by alternate means specifically to eliminate these supplemental stresses. This is described below in the "Development of Inspection/ Acceptance Criteria" section of this enclosure.

Testing to Establish "Lower Bound":

In order to assess the parameters discussed above, tests[2] were initiated by TVA at its Central Laboratories Services Department (CLSD) in Chattanooga. These evaluations, which are type test in nature, were conducted in accordance with CLSD's quality assurance program. The tests consisted of the bending of single conductor cables, ranging in size from 16 AWG to 500 MCM, on specially constructed forms ranging in size from the ICEA allowable down to the point at which some significant deformation occurred or to the minimum practical bend. The "lower bound" for such a specimen was tentatively regarded as the radius (expressed in multiples of cable diameters) at which deformation occurred plus one cable diameter (1X) or the minimum practical bend, if no deformation was noted. An additional specimen was then bent to this "lower bound" and then retrained to a larger radius (typically the ICEA radius). This step was intended to demonstrate that the nonelastic components (conductor, tape shield, etc.) would not deform during the retraining. If shield integrity was still present (no separation, no gouging or pinching, etc.) and excessive conductor deformation (i.e., birdcaging) had not occurred, the "lower bound" value was confirmed.

Accordingly, the lower bound for low-voltage cables 10 AWG and smaller was set at a bend radius factor of one. The lower bound for low-voltage cables 8 AWG and larger was established at two. For medium voltage, the lower bound was determined to be four.

2. CLSD Report 90-1014, Revision 0, "Test to Document Cable Bend Radius Damage."

ENCLOSURE 4
CABLE BEND RADIUS

Development of Inspection/Acceptance Criteria:

Having thus defined the mechanisms of concern and having established lower bound values for bends of single conductor cable, a review was initiated to correlate this information with industry standards, vendor letters, voltage and current loading requirements, cable construction, and environmental parameters. The purpose of this ongoing review is to establish acceptable bend radius factors for use at WBN. Preliminary results are summarized in Table 1. Several comments regarding the table are warranted:

- Class 1E 10 CFR 50.49 cables located inside of primary containment and the main steam valve vault will comply with industry standard bend radius factors. This is in recognition of the severity of the accident environmental transient in these areas. Cables found to be bent below the lower bound will be replaced as discussed in Table I.

- Medium-voltage Class 1E cables required to support Unit 1 operation will be inspected to ensure at least an 8 times bend radius factor. None of these cables are located in primary containment or the valve vault. Environmental transients in the remainder of the plant are significantly lower with respect to both magnitude and duration. ICEA recommends a 12 times factor for training such cable; however, the 8 times factor can be shown to produce only about 2 percent elongating stress, which is negligible when contrasted with material capabilities.

  Cables which were above the lower bound (4 times) but less than 8 times will receive a high-potential withstand test at maintenance levels[3] prior to Unit 1 startup. Cables found to be bent below the lower bound will be replaced as discussed in Table I.

- Low-voltage single conductor power cables in 10 CFR 50.49 service but installed in areas <u>other than</u> the primary containment and the main steam valve vault will be accepted "as-is," provided that they are not bent below the lower bound. Cables found to be bent below the lower bound will be replaced as discussed in Table I. However, as a result of the additional elongating stress from the tight bend, TVA has performed a review of its environmental records to assess the impact of this stress on the cables' life.

---

3. Institute of Electrical and Electronics Engineers (IEEE) 400-1980, "Guide For Making High-Direct-Voltage Tests on Power Cable Systems in The Field."

ENCLOSURE 4
CABLE BEND RADIUS

This review conservatively assumes a linear decrease of elongation from the cables' new condition to its end of life at 40 years for standard ICEA bends. Within this analysis, the pre-LOCA "end-of-life" has been assumed as 60 percent retained elongation, conservatively above the 40 percent chosen by most vendors. In order to account for the stress (above that generated for a standard bend) resulting from the tight bend, the additional elongation is subtracted from the minimum permissible elongation for a new cable. The "life" curve is replotted and the new 60 percent retained elongation crossing point determines the revised qualified life. Figure I gives a typical example of such an analysis for cables insulated with Type II EPR[4]. As can be seen, power cables in this category bent to 2X or 1X would have their qualified life reduced to approximately 32 and 22 years, respectively.

- Low-voltage single conductor cables which are in 10 CFR 50.49 control applications and are located outside of the primary containment and the main steam valve vault may be accepted "as-is" without a reduction in qualified life. Cables found to be bent below the lower bound will be replaced as discussed in Table I. Control cables are generally accepted to operate at or near ambient temperature because of the minimal current loading within this voltage level. Elimination of this factor significantly reduces concerns for this age-related phenomenon. Figure II is a typical plot for EPR Type II when used in control applications. Assuming values of 1.1 eV for activation energy and 60°C for conductor temperature results in a "qualified life" of in excess of 900 years for this 90°C material. Reducing the initial elongation by the differential stress imposed by the tight bend is shown to be of no effect for the plant's 40-year life.

- Low-voltage multiconductor power, control, and signal cables which are in 10 CFR 50.49 service outside of primary containment and the main steam valve vault and multiconductor power cables which are not in 10 CFR 50.49 circuits but are in containment or the valve vault may be retrained and used without reduction in life provided they are not bent to less than the lower bound for their individual conductors. Cables found to be bent below the lower bound will be replaced as discussed in Table I. The training radius factor applied to this family gives consideration to both the size and number of individual conductors[5]. Restricting the bends in this manner limits the forces produced between the constituent components of a multiconductor cable. By eliminating this issue of concern, the 10 CFR 50.49 cables may now be regarded as qualified for their full life since the smallest bend allowable per this bulletin is 4X the diameter of a single conductor. This value corresponds to ICEA guidance.

---

4. As defined in ICEA S-68-516, "Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy."
5. Table I, column B of Rockbestos Technical Bulletin No. 28, "Bending Radii and Installation Practices"

ENCLOSURE 4
CABLE BEND RADIUS

- Low-voltage Class 1E single conductor power cables in non-10 CFR 50.49 service inside of containment or the main steam valve vault will be accepted "as-is" provided that they are not bent less than the lower bound. Cables found to be bent below the lower bound will be replaced as discussed in Table I. Since these cables have no accident service requirements, the pre-LOCA end-of-life criteria previously discussed is not applicable. However, a typical "projected life" analysis is, as shown in Figure III, indicates a minimum of 40-year service for bends at the lower bound and above.

- As noted in TVA's letter to NRC[6], all 10 CFR 50.49 and Regulatory Guide (RG) 1.97 single-jacketed coax cable in harsh environment is being replaced. The new double-jacketed cable will be installed to meet ICEA requirements.

- The remaining cables will be used "as-is." The remaining cables either are not exposed to accident service conditions or are not required to mitigate the consequences of such an accident. As such, the margins associated with the remaining cables exceed even those described above.

The above analysis is being documented in a TVA calculation. In addition, where the analysis indicates that a cable's qualified life is limited to less than 40 years, WBN EQ binders will be revised to track these limitations.

Long-Term Program:

In order to ensure that the mechanisms pertinent to cable performance under small bend radius conditions have been fully identified and properly evaluated, TVA will perform additional tests and/or analysis.

Such actions have not been fully extablished at this time. TVA will submit details regarding this effort to NRC. The program will include as a minimum the following activities:

1. Verification of Lower Bound - TVA will engage the services of an independent laboratory to provide verification of the tests performed[2] at CLSD to evaluate the lower bound.

2. Evaluation of the Effects of Overbending - TVA will provide details of the tests and/or analysis to be performed to further validate the use of bend factors shown in Table I. These efforts will include considerations, as appropriate, for any age-related consequences of such bends on both normal and accident service.

6. Electrical Cable Damage-Assessment and Resolution Plan, Dated December 20, 1989.

ENCLOSURE 4
CABLE BEND RADIUS

3. Cable Condition Monitoring - TVA will also provide details of a cable monitoring and trending program for WBN. The program will invoke a combination of meggering, high-potential testing and visual inspection to ensure the continued integrity of cables in safety-related systems. Consideration will be given for cables which are trained to bend radius factors that are less than those established by the ICEA.

<u>Results</u>

Inspections using the above criteria have just commenced. TVA will provide NRC with the results of these inspections as part of Cable Issues CAP closure.

<u>Conclusions</u>

As a result of the actions undertaken and planned by TVA, including testing, field inspection, and rework; 10 CFR 50.49 cables inside containment and main steam valve vaults will meet industry standard bend radius criteria. For the remaining cable population, TVA will utilize less restrictive bend radius criteria with corresponding adjustment of qualified life, where appropriate. Through ongoing testing and analysis, TVA will provide independent confirmation of the foregoing evaluations.

TABLE I

CABLE BEND RADIUS SUMMARY
SCOPE: CLASS IE CABLES

<table>
<tr><th></th><th></th><th>MV PWR</th><th>1/C LV PWR</th><th>M/C LV PWR</th><th>1/C CONTROL</th><th>M/C CONTROL</th><th>SIGNAL</th><th>COAX</th></tr>
<tr><td rowspan="2">50.49</td><td>I/C or MSVV</td><td>N/A</td><td>(B)</td><td>(B)</td><td>(B)</td><td>(B)</td><td>(B)</td><td>(H)</td></tr>
<tr><td>Other Harsh</td><td>(A)</td><td>(D)</td><td>(C)</td><td>(E)</td><td>(C)</td><td>(C)</td><td>(H)</td></tr>
<tr><td rowspan="2">Non 50.49</td><td>I/C or MSVV</td><td>N/A</td><td>(F)</td><td>(C)</td><td rowspan="2">(G)</td><td rowspan="2">(G)</td><td rowspan="2">(G)</td><td rowspan="2">(H,G)</td></tr>
<tr><td>Other Harsh</td><td>(A)</td><td>(G)</td><td>(G)</td></tr>
<tr><td colspan="2">1E MILD</td><td>(A)</td><td>(G)</td><td>(G)</td><td>(G)</td><td>(G)</td><td>(G)</td><td>(G)</td></tr>
</table>

(A) $<$ LB REPLACE*
$\geq$ LB RETRAIN $\geq$ 8X

(B) $<$ LB REPLACE*
$\geq$ LB RETRAIN to ICEA

(C) $<$ LB FOR 1/C REPLACE*
$\geq$ LB 1/C RETRAIN TO ROCKBESTOS TECHNICAL BULLETIN NO. 28

(D) $<$ LB REPLACE*
$\geq$ LB USE-AS-IS WITH REDUCED QUALIFIED LIFE

(E) $<$ LB REPLACE*
$\geq$ LB USE-AS-IS BASED ON MARGIN ANALYSIS AND LONG TERM PROGRAMS

(F) $<$ LB REPLACE*
$\geq$ LB USE-AS-IS BASED ON PROJECT LIFE

(G) USE-AS-IS BASED ON MARGIN ANALYSIS AND LONG-TERM PROGRAMS

(H) 10 CFR 50.49 AND RG 1.97 TO BE REPLACED IN HARSH AREAS

*REPLACE – In some cases the entire cable will not be replaced. Where possible, only the portion of the cable where the training radius is less than acceptable will be replaced. For example, cables or portions of cable reworked or replaced under the new site cable installation procedures may be excluded from the reinspection/rework design change notices.

TABLE DEFINITIONS:

LB	– LOWER BOUND
1/C	– SINGLE CONDUCTOR CABLE
M/C	– MULTICONDUCTOR CABLE
I/C	– INSIDE CONTAINMENT
MSVV	– MAIN STEAM VALVE VAULT
LV PWR	– LOW VOLTAGE POWER

ENCLOSURE 5
CABLE SPLICES

This information is provided is supplemental information to that contained in Section 4.1.8 of the Cable Issues CAP Plan submitted by TVA to NRC on June 27, 1989.

Background

Beginning in 1984, various cable splicing deficiencies were identified at Watts Bar Nuclear Plant (WBN) through condition adverse to quality reports (CAQRs), employee concerns, and Nuclear Regulatory Commission (NRC) inspections. The deficiencies were predominately related to the application of Raychem type N heat shrinkable tubing and kits, but also included TVA's ability to confirm that all Class 1E splices were identified.

In addition, CAQR WBP 890567 has been initiated which identified unqualified vendor splices used to extend pigtails on the Conax primary containment penetrations.

Method of Resolution

As a result of the above findings at WBN, it was determined that insufficient data existed to confirm that the installed splices conformed with the configurations and materials tested by the vendor for adverse or accident environments, and to confirm that all Class 1E splices had been identified.

Therefore, TVA has undertaken a program to ensure adequacy which consists of the following actions:

- TVA's standard drawing series[1], which details installation procedures, has been updated to properly detail splice and termination requirements.
- Revisions to construction specifications[2] and site implementing procedures[3] to include these requirements have been completed.
- Craft and construction field engineering training sessions have been instituted to ensure that ongoing work is performed in accordance with TVA and Raychem splicing instructions.

---

1. Design Standard Drawing Series, SD-E12.5, "Cable Connectors and Fittings"
2. General Construction Specification G-38, "Installing Insulated Cables Rated Up To 15,000 Volts."
3. WBN-CPI-8.1.8-E-100-A, "Termination, Splicing, and Repair of Low and Medium Voltage Cable"; Maintenance Instruction MI-57.14, "Guidelines for Splicing and Terminating Low Voltage (0-600 Volt) and Medium Voltage (601-15,000 Volt) Cables"; Maintenance Instruction MI-57.99.7, "Application of Raychem Material."

ENCLOSURE 5
CABLE SPLICES

- A comprehensive splice list for all Class 1E cables required for Unit 1 safe shutdown has been developed. This list was based upon extensive reviews of existing splice documentation and walkdown records. In addition, the data collected during ongoing construction activities such as cable inspection and replacement during pullby resolution activities, bend radius inspections, ampacity replacements, and flex conduit rework will record splices which where not previously documented. These additional splices will be evaluated and reworked as necessary to ensure that they meet qualification requirements.

- Based on the above list and using the updated procedures, all splices for 10 CFR 50.49 cables located in harsh environments and all intermediate splices for Class 1E cables in mild environments which are susceptible to moisture intrusion from flood, line break, or sprinkler system activation are being replaced. The scope of this effort will result in the replacement of approximately 26,000 termination and mid-run splices on approximately 1800 cables.

- Vendor splices provided as part of a 10 CFR 50.49 component (e.g., motors, panels) are qualified as an assembly, and the vendor documentation will address the qualification of that assembly and is included in the project EQ binder for that assembly.

Conclusion

Implementation of the above program of splice identification and replacement, coupled with the recurrence control actions specified will ensure compliance to tested configurations and splice functionality during all required postulated environmental service conditions.

ENCLOSURE 6
LIST OF COMMITMENTS

Silicone Rubber Insulated Cables:

1. TVA will not use American Insulated Wire (AIW) silicone rubber insulated cables in Class 1E circuits at Watts Bar.

Cable Support in Vertical Tray and Conduit:

1. Through the evaluations, walkdowns, and modifications described in Enclosure 2 of this document, TVA will demonstrate for WBN Unit 1 the adequacy of safety-related cables with respect to cable support in vertical tray and conduit.

2. TVA will revise design and construction procedures to include support requirements for all potential transition/support points for vertical cable drops.

Cable Proximity to Hot Pipe:

1. Through the evaluations, calculations, walkdowns, and modifications described in Enclosure 3 of this document, TVA will demonstrate for WBN Unit 1 the adequacy of safety-related cables with respect to cable proximity to hot pipes.

2. TVA will review maintenance practices and procedures to address the removal of thermal insulation operation and ensure proper controls are in place to protect Class 1E cables by restoring the required insulation of hot pipe.

3. TVA will perform a review of design input documents which establish separation criteria for cable trays and will revise as necessary to include adequate separation requirements.

Bend Radius:

1. Through the analysis, evaluations, walkdowns, and modifications described in Enclosure 4 of this document, TVA will demonstrate for WBN Unit 1 that Class 1E cables are adequate for startup with respect to cable bend radius.

ENCLOSURE 6
LIST OF COMMITMENTS

Bend Radius (continued):

2. TVA will provide NRC with the details of the long-term test and analysis program described in Enclosure 4 prior to WBN Unit 1 startup. Through this program, TVA will demonstrate that the mechanisms pertinent to cable performance under small bend radius conditions have been identified and evaluated.

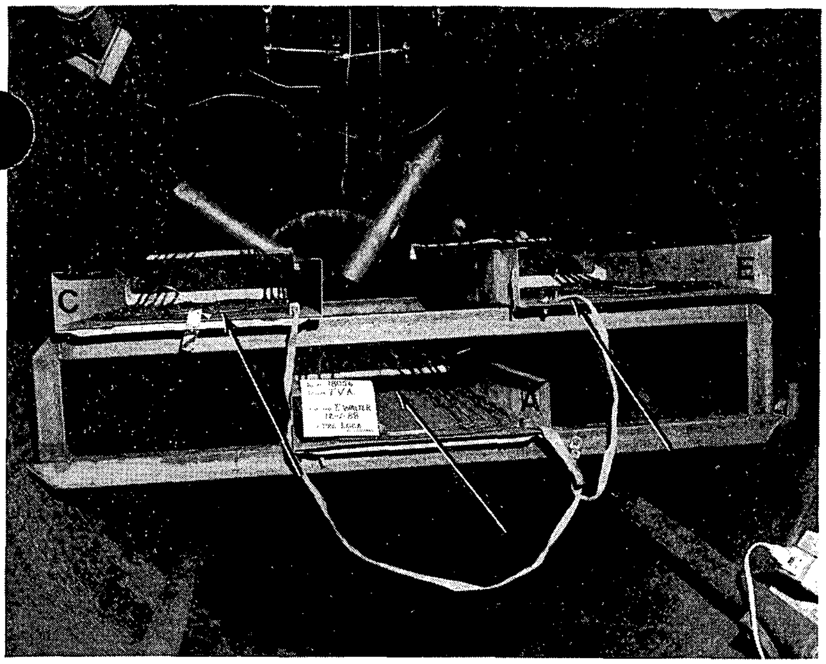
Cable Splices:

1. TVA will analyze or rework any previously unidentified Class 1E splices, identified during ongoing construction activities.

QUALIFICATION TEST PROGRAM
FOR
SILICONE RUBBER INSULATED CABLES
FOR USE IN
TENNESSEE VALLEY AUTHORITY'S
SEQUOYAH AND WATTS BAR
NUCLEAR PLANTS

For

Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902



NEQ

Nuclear Environmental Qualification

Test Report

REPORT NO. 18056-1

WYLE JOB NO. 18056

CUSTOMER P. O. NO. TV-73743A

PAGE i OF 291 PAGE REPORT

DATE January 27, 1989

SPECIFICATION (S) See References in Paragraph 5.0 of this Summary Section

1.0 CUSTOMER Tennessee Valley Authority (TVA)

ADDRESS 400 West Summit Hill Drive, Knoxville, Tennessee 37902

2.0 TEST SPECIMEN Silicone Rubber Insulated Cables P/N KS-500 and P/N CC-2193 Nuclesil

3.0 MANUFACTURER Rockbestos and Anaconda-Continental, repsectively

4.0 SUMMARY

Silicone Rubber Insulated Cables, as described and noted in Paragraph 6.0, were subjected to a Qualification Program to verify their ability to maintain loads during an Accident Simulation as specified by TVA. The Qualification Program described herein represents installations at the Tennessee Valley Authority's Sequoyah and Watts Bar Nuclear Plants.

The Qualification Test Program was performed to satisfy the intent of IEEE Standards 323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," and 383-1974, "Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations."

STATE OF ALABAMA } ss. Alabama Professional
COUNTY OF MADISON } Engineer Reg. No. 7948

Frederick M. Sittason, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

Frederick M Sittason

SUBSCRIBED and sworn to before me this 10th day of February 19 89

Carolyn Hill Cunningham

Notary Public in and for the State of Alabama at large.

My Commission expires June 4, 19 89

PREPARED BY Robert T. Walter 02-10-89
R. T. Walter

APPROVED BY F. R. Johnson 2/10/89
F. R. Johnson

WYLE Q. A. G.W. Hight 2-13-89
G. W. Hight

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
HUNTSVILLE, ALABAMA

4.0 SUMMARY (Continued)

The Qualification Program was performed on two independent manufacturer's types of silicone rubber insulated cables. A description of the test specimens is presented in Paragraph 6.0 of this Section. This report contains the following sections:

- Section I - Specimen Identification, Preparation, and Baseline Functional Test
- Section II - Normal Radiation Exposure and Post-Radiation Functional Test
- Section III - Thermal Aging and Post-Thermal Aging Functional Test
- Section IV - Accident Radiation Exposure and Post-Radiation Functional Test
- Section V - Accident Simulation and Post-Test Functional Test
- Section VI - Voltage Withstand Test and Post-Test Inspection
- Section VII - Wyle Laboratories' Qualification Plan No. 18057-00, Revision A

The test program was conducted in the sequence indicated by Section I through VI above and in accordance with Wyle Laboratories' Qualification Plan 18057-00, Revision A, which is contained in Section VII.

Four anomalies occurred during the test program. Details of the anomalies are included in the appropriate sections of this report and are briefly described below.

Notice of Anomaly No.	Date of Anomaly	Section	Description
1	11-03-88	III	Cable Trays A, C, and E were exposed to an over-temperature condition in the initial thermal aging period. During the thermal aging chamber temperature startup, the chamber temperature was inadvertently allowed to increase in excess of the temperature tolerance acceptance criteria. The out-of-specification temperature was determined to have been approximately 5.6 deg C above the required temperature of 112°C, for a period of less than 5 minutes. The short period of specimen exposure to the out-of-specification temperature was considered to have no effect upon the qualification program for the silicone rubber insulated cables.

4.0 SUMMARY (Continued)

Notice of Anomaly No.	Date of Anomaly	Section	Description
2	12-03-88	V	Low resistance values recorded for Cable Tray C were documented during the pre-test wet insulation resistance measurements. The test chamber was drained of water and insulation resistance measurements were repeated at certain intervals. At the Customer's request, Cable Tray C was removed from the Accident Chamber and discontinued from the test program. The pre-test wet insulation resistance measurements were repeated on the test specimens of Cable Trays A and E, and testing was continued.
3	12-28-88	V	Power supply line voltage fluctuations and power losses resulted in test specimen out-of-specification conditions. A conservative estimate of 5 hours 30 minutes was added to the test profile at the post-DBE aging temperature of 150°F (+9, -0 deg F). The test specimens remained powered during the additional test period.
4	12-09-88	V	Out-of-specification PH levels existed for the chemical spray solution during the Accident Simulation. The high PH level (0.15 above tolerance) occurred for approximately the last 2 hours of the required chemical spray test. The short period of chemical spray at the high PH level was considered not to have a detrimental effect upon the test specimens' performance.

The test specimens were subjected to normal radiation exposure, thermal aging, and accident radiation exposure. The 40-year test specimens specified for Sequoyah Nuclear Plant demonstrated the capability to maintain specified voltage and current during the specified Design Basis Event (LOCA Simulation). It is therefore judged that the Sequoyah Nuclear Plant 40-year silicone rubber insulated cables, described and noted in Paragraph 6.0 of this section, met the acceptance criteria requirements of Wyle Laboratories' Qualification Plan (WLQP) 18057-00, Revision A.

5.0 **REFERENCES**

5.1 IEEE Standard 323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."

5.2 IEEE Standard 383-1974, "Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations."

5.3 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," U. S. Nuclear Regulatory Commission, 1973.

5.4 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," U. S. Nuclear Regulatory Commission, January 21, 1983.

5.5 TVA Contract No. TV-73743A.

5.6 Wyle Laboratories' (Eastern Operations) Quality Assurance Program Manual, dated June, 1988.

5.7 Wyle Laboratories' Qualification Plan No. 18057-00, Revision A.

6.0 **TEST SPECIMEN DESCRIPTION**

Descriptions of the cable specimens are as follows:

Specimen No.	Manufacturer	P/N	Cable No.	Cable Size	Cable Tray
RWC-S-A.40	Rockbestos	KS-500	1-3V-62-4450A/CBBN	14 AWG	A*
RWC-S-B.40	Rockbestos	KS-500	1-3V-43-9841B/5SVN	14 AWG	A*
RWC-S-C.40	Rockbestos	KS-500	1-3V-67-3111B	14 AWG	A*
RWC-S-D.40	Rockbestos	KS-500	1-3V-67-3091A/9DG	14 AWG	A*
RWC-S-E.40	Rockbestos	KS-500	1-3V-62-2811B/6D1	14 AWG	A*
RWC-S-A.15	Rockbestos	KS-500	1-3V-62-4450A/CBB3	14 AWG	B
RWC-S-B.15	Rockbestos	KS-500	1-3V-43-9841B/5SVG	14 AWG	B
RWC-S-C.15	Rockbestos	KS-500	1-3V-67-3111B/9DR	14 AWG	B
RWC-S-D.15	Rockbestos	KS-500	1-3V-67-3091A/9DR	14 AWG	B
RWC-S-E.15	Rockbestos	KS-500	1-3V-62-2811B/6DG	14 AWG	B
RWC-W-A.40	Rockbestos	KS-500	1-3V-62-4450A/CBB8	14 AWG	C
RWC-W-B.40	Rockbestos	KS-500	1-3V-43-9841B/5SVR	14 AWG	C
RWC-W-C.40	Rockbestos	KS-500	1-3V-67-3111B/9DX	14 AWG	C
RWC-W-D.40	Rockbestos	KS-500	1-3V-67-3091A/9DX	14 AWG	C
RWC-W-E.40	Rockbestos	KS-500	1-3V-62-2811B/6DR	14 AWG	C
RWC-W-A.15	Rockbestos	KS-500	1-3V-62-4450A/CBB9	14 AWG	D
RWC-W-B.15	Rockbestos	KS-500	1-3V-43-9841B/5SV1	14 AWG	D
RWC-W-C.15	Rockbestos	KS-500	1-3V-67-3111B/9DY	14 AWG	D
RWC-W-D.15	Rockbestos	KS-500	1-3V-67-3091A/9DY	14 AWG	D
RWC-W-E.15	Rockbestos	KS-500	1-3V-62-2811B/6DC1	14 AWG	D

6.0 TEST SPECIMEN DESCRIPTION (Continued)

Specimen No.	Manufacturer	P/N	Cable No.	Cable Size	Cable Tray
ANA-S-A.40	Anaconda	CC-2193	1-3V-30-1362B/VFL11	12 AWG	E*
ANA-S-B.40	Anaconda	CC-2193	1-3V-31-7168A/VBL1	14 AWG	E*
ANA-S-C.40	Anaconda	CC-2193	2-3V-30-1362B/VFL3	12 AWG	E*
ANA-S-D.40	Anaconda	CC-2193	2-3PL-30-4830A/A27AC3	14 AWG	E*
ANA-S-E.40	Anaconda	CC-2193	2-4V-70-2855B/T1	12 AWG	E*
ANA-S-A.15	Anaconda	CC-2193	1-3V-30-1362B/VFL3	12 AWG	F
ANA-S-B.15	Anaconda	CC-2193	1-3V-31-7168A/VBLN	14 AWG	F
ANA-S-C.15	Anaconda	CC-2193	2-3V-30-1362B/VFLN	12 AWG	F
ANA-S-D.15	Anaconda	CC-2193	2-3PL-30-4830A/A27AA1	14 AWG	F
ANA-S-E.15	Anaconda	CC-2193	2-4V-70-2855B/T2	12 AWG	F

*Test specimens completed the test program including the Accident Simulation.

7.0 QUALITY ASSURANCE

All work performed on the test program was done in accordance with Wyle Laboratories' Quality Assurance Program, which complies with the requirements of 10 CFR 50 Appendix B, ANSI N45.2, and the "daughter" standards. Defects are reportable in accordance with the requirements of 10 CFR Part 21.

8.0 TEST EQUIPMENT AND INSTRUMENTATION

All instrumentation, measuring, and test equipment used in the performance of this test program were calibrated in accordance with Wyle Laboratories' Quality Assurance Program which complies with the requirements of Military Specification MIL-STD-45662A. Standards used in performing all calibrations are traceable to the National Institute of Standards and Technology by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented as auditable.

SECTION I

SPECIMEN IDENTIFICATION, PREPARATION, AND BASELINE FUNCTIONAL TEST

1.0 **REQUIREMENTS**

1.1 **Specimen Identification**

The specimens shall be subjected to an inspection for the purpose of identification and documentation. The inspection shall be performed as specified in Paragraph 3.1 of Section VII.

1.2 **Specimen Preparation and Baseline Functional Test**

The test specimens, as provided by Tennessee Valley Authority (TVA), shall be mounted in open cable trays as specified in Paragraph 3.2 of Section VII. Upon completion of specimen preparation, the test specimens shall be subjected to the Baseline Functional Tests described in Paragraph 3.3 of Section VII.

2.0 **PROCEDURES**

2.1 **Specimen Identification**

A visual inspection of the test specimens was conducted upon receipt at Wyle Laboratories. This inspection was performed in order to document manufacturer and identification numbers of the specimens to be tested and any noticeable damage. In addition, all specimens were tagged with metal "Test Specimen" tags to facilitate their identification during the test program. The results of the identification inspections were recorded on the "Test Specimen Inspection" forms in the appendices of this Section.

2.2 **Test Specimen Preparation**

The test specimens were removed from the TVA shipping enclosure and separated according to manufacturer type. During test specimen removal and preparation, air sampling was conducted in a secured area. The air sampling was performed to determine if excessive levels of asbestos fibers existed during specimen preparation. Results of the air samples indicated that the asbestos fiber level was within safety requirements. The test specimens were placed in open cable trays 18 inches wide and 5 feet long. Rockbestos (RWC) and Anaconda-Continental (ANA) test specimens were placed in Cable Trays A through F as delineated in the following table.

2.0 **PROCEDURES (Continued)**

2.2 **Test Specimen Preparation (Continued)**

Cable Tray Designation	Specimen No.	Plant/Age Designation	Wire Size
A	RWC-S-A.40 RWC-S-B.40 RWC-S-C.40 RWC-S-D.40 RWC-S-E.40	Sequoyah 40-Year	14 AWG (All)
B	RWC-S-A.15 RWC-S-B.15 RWC-S-C.15 RWC-S-D.15 RWC-S-E.15	Sequoyah 15-Year	14 AWG (All)
C	RWC-W-A.40 RWC-W-B.40 RWC-W-C.40 RWC-W-D.40 RWC-W-E.40	Watts Bar 40-Year	14 AWG (All)
D	RWC-W-A.15 RWC-W-B.15 RWC-W-C.15 RWC-W-D.15 RWC-W-E.15	Watts Bar 15-Year	14 AWG (All)
E	ANA-S-A.40 ANA-S-B.40 ANA-S-C.40 ANA-S-D.40 ANA-S-E.40	Sequoyah 40-Year	12 AWG 14 AWG 12 AWG 14 AWG 12 AWG
F	ANA-S-A.15 ANA-S-B.15 ANA-S-C.15 ANA-S-D.15 ANA-S-E.15	Sequoyah 15-Year	12 AWG 14 AWG 12 AWG 14 AWG 12 AWG

Each test specimen was mounted to its respective cable tray such that both lead ends were positioned at one end of the tray. The lead ends of the test specimens were prepared for connection to test equipment, during functional tests, and elevated approximately four inches from the bottom of the cable tray. The specimens were positioned on each cable tray with a minimum 1/2-inch spacing between specimen cables and with an individual bend radius greater than the minimum as specified in Paragraph 3.2 of Section VII.

A small length of Rockbestos (RWC) cable was mounted to the center of Cable Tray A. An equal length of Anaconda-Continental (ANA) cable was mounted to the center of Cable Tray E. The small lengths of cable were intended for use by TVA personnel and the lead ends were not prepared for Functional Tests. The test specimens and small cable lengths were secured to the cable trays with Tefzel cable ties.

2.0 **PROCEDURES (Continued)**

2.2 **Test Specimen Preparation (Continued)**

Upon completion of specimen preparation, the cable specimens were photographed as mounted in their respective cable trays.

2.3 **Baseline Functional Test**

2.3.1 Visual Inspection

The test specimens were subjected to a visual inspection prior to initiation of the wet insulation resistance measurements. All observations noted during the visual inspection were recorded.

2.3.2 Wet Insulation Resistance Measurements

The test specimens as mounted in the cable trays were immersed in tap water with both leads of each specimen suspended out of the water. Insulation resistance measurements were taken of each cable specimen by applying 500 VDC for 1 minute prior to reading the resistance value between conductor and ground (the cable tray). All insulation resistance measurements were recorded for information only.

3.0 **RESULTS**

The test specimens were subjected to the specimen identification, preparation, and Baseline Functional Tests of Paragraph 2.0 and met the requirements of Paragraph 1.0. Observations recorded during the Baseline Functional Test visual inspection are presented below.

During the visual inspection it was noted that some of the cable specimens exhibited varying degrees of an ash discoloration on the asbestos jacket material. This discoloration of the jacket material did not seem to be attributable to a particular plant/age designation or manufacturer. Cable specimens that did not exhibit this discoloration were noted to maintain a dark black tone.

The data recorded during this phase of the test program is presented in Appendices I through IV of this Section as noted below.

- Appendix I contains the Test Specimen Inspection Sheets.
- Appendix II contains Photographs I-1 through I-12 which show the specimens mounted to the open cable tray.
- Appendix III contains the Data Sheet generated during Baseline Functional Tests.
- Appendix IV contains the Instrumentation Equipment Sheet generated for the Baseline Functional Tests.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX I

TEST SPECIMEN INSPECTION SHEETS

THIS PAGE INTENTIONALLY LEFT BLANK

TEST SPECIMEN INSPECTION

CUSTOMER TENNESSEE VALLEY AUTHORITY
JOB NO. 18056
SPECIFICATION WLQP 18057-00
DATE 10-24-88

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
1.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-$-A-40 *	YES	YES	YES
	INSULATED CABLE		CBBN			
	14 AWG		1-3V-62-4450A			
2.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-$-B-40 *	YES	YES	YES
	INSULATED CABLE		5$VN			
	14 AWG		1-3V-43-9841B			
3.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-$-C-40 *	YES	YES	YES
	INSULATED CABLE					
	14 AWG		1-3V-67-3111B			
4.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-$-D-40 *	YES	YES	YES
	INSULATED CABLE		9DG			
	14 AWG		1-3V-67-3091-A			
5.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-$-E-40 *	YES	YES	YES
	INSULATED CABLE		6D1			
	14 AWG		1-3V-62-2811B			
6.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-$-A-15 **	YES	YES	YES
	INSULATED CABLE		CBB3			
	14 AWG		1-3V-62-4450-A			
7.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-$-B-15 **	YES	YES	YES
	INSULATED CABLE		5$VG			
	14 AWG		1-3V-43-9841B			
			X RTW			

NOTES: * CABLE TRAY A
** CABLE TRAY B
ITEM 3.0 WAS NOT TAGGED "9DG" AS SPECIFIED

Specimen Failed NONE
Specimen Passed ALL
NOA Written NONE

Inspected By [signature] Date: 10-24-88
Witness N/A Date:
Sheet No. 1 of 5
Approved [signature] 01-24-89

TEST SPECIMEN INSPECTION

CUSTOMER Tennessee Valley Authority

JOB NO. 18056

SPECIFICATION WLQP 18057-00

DATE 10-24-88

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
8.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-S-C-15 **	YES	YES	YES
	INSULATED CABLE		9DR			
	14 AWG		1-3V-67-3111B			
9.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-S-D-15 **	YES	YES	YES
	INSULATED CABLE		9DR			
	14 AWG		1-3V-67-3091A			
10.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-S-E-15 **	YES	YES	YES
	INSULATED CABLE		6DG			
	14 AWG		1-3V-62-2811B			
11.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-A-40 ***	YES	YES	YES
	INSULATED CABLE		CBB8			
	14 AWG		1-3V-62-4450A			
12.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-B-40 ***	YES	YES	YES
	INSULATED CABLE		5SVR			
	14 AWG		1-3V-43-9841B			
13.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-C-40 ***	YES	YES	YES
	INSULATED CABLE		9DX			
	14 AWG		1-3V-67-3111B			
14.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-D-40 ***	YES	YES	YES
	INSULATED CABLE		9DX			
	14 AWG		1-3V-67-3091A			

NOTES: ** CABLE TRAY B

*** CABLE TRAY C

Specimen Failed NONE
Specimen Passed ALL
NOA Written NONE

Inspected By [signature] Date: 10-24-88
Witness N/A Date:
Sheet No. 2 of 5
Approved [signature] 01-24-89

TEST SPECIMEN INSPECTION

CUSTOMER TENNESSEE VALLEY AUTHORITY
JOB NO. 18056
SPECIFICATION WLQP 18057-00
DATE 10-24-88

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
15.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-E-40 ***	YES	YES	YES
	INSULATED CABLE		6DR			
~~16.0~~ RTW	14 AWG		1-3V-62-2811B			
16.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-A-15 ****	YES	YES	YES
	INSULATED CABLE		CB89			
	14 AWG		1-3V-62-4450-A			
17.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-B-15 ****	YES	YES	YES
	INSULATED CABLE		5SV1			
	14 AWG		1-3V-43-9841B			
18.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-C-15 ****	YES	YES	YES
	INSULATED CABLE		9DY			
	14 AWG		1-3V-67-3111B			
19.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-D-15 ****	YES	YES	YES
	INSULATED CABLE		9DY			
	14 AWG		1-3V-67-3091A			
20.0	1/C SILICONE RUBBER	ROCKBESTOS	RWC-W-E-15 ****	YES	YES	YES
	INSULATED CABLE		6DC1			
	14 AWG		1-3V-62-2811B			
21.0	1/C SILICONE RUBBER	~~ROCKBESTOS~~ RTW	ANA-S-A-40 *****	YES	YES	YES
	INSULATED CABLE	ANACONDA	VFL11			
	12 AWG		1-3V-30-1362-B			

NOTES: *** CABLE TRAY C
**** CABLE TRAY D
***** CABLE TRAY E

Specimen Failed NONE
Specimen Passed ALL
NOA Written NONE

Inspected By [signature] Date: 10-24-88
Witness N/A Date:
Sheet No. 3 of 5
Approved [signature] 01-24-89

TEST SPECIMEN INSPECTION

CUSTOMER Tennessee Valley Authority

JOB NO. 18056

SPECIFICATION WLQP 18057-00

DATE 10-24-88

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
22.0	1/C SILICONE INSULATED	ANACONDA	ANA-$-B-40 *****	YES	YES	YES
	CABLE		VBLI			
	14 AWG		1-3V-31-7168A			
23.0	1/C SILICONE RUBBER	ANACONDA	ANA-$-C-40 *****	YES	YES	YES
	INSULATED CABLE		VFL3			
	12 AWG		2-3V-30-1362-B			
24.0	1/C SILICONE RUBBER	ANACONDA	ANA-$-D-40 *****	YES	YES	YES
	INSULATED CABLE		AZ7AC3			
	14 AWG		2-3PL-30-4830-A			
25.0	1/C SILICONE RUBBER	ANACONDA	ANA-$-E-40 *****	YES	YES	YES
	INSULATED CABLE		TI			
	12 AWG		2-4V-70-2855-B			
26.0	1/C SILICONE RUBBER	ANACONDA	ANA-$-A-15 ******	YES	YES	YES
	INSULATED CABLE		VFL3			
	12 AWG		1-3V-30-1362-B			
27.0	1/C SILICONE RUBBER	ANACONDA	ANA-$-B-15 ******	YES	YES	YES
	INSULATED CABLE		VBLN			
	14 AWG		1-3V-31-7168-A			
28.0	1/C SILICONE RUBBER	ANACONDA	ANA-$-C-15 ******	YES	YES	YES
	INSULATED CABLE		VFLN			
	12 AWG		2-3V-30-1362-B			

NOTES: ***** CABLE TRAY E

****** CABLE TRAY F

Specimen Failed NONE

Specimen Passed ALL

NOA Written NONE

Inspected By [signature] Date: 10-24-88

Witness N/A Date:

Sheet No. 4 of 5

Approved [signature] 01-24-89

TEST SPECIMEN INSPECTION

CUSTOMER Tennessee Valley Authority
JOB NO. 18056
SPECIFICATION WLQP 18057-00
DATE 10-24-88

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
29.0	1/C SILICONE RUBBER	ANACONDA	ANA-S-D-15 ******	YES	YES	YES
	INSULATED CABLE		A27AA1			
	14 AWG		2-3PL-30-4830-A			
30.0	1/C SILICONE RUBBER	ANACONDA	ANA-S-E-15 ******	YES	YES	YES
	INSULATED CABLE		T2			
	12 AWG		2-4V-70-2855-B			

NOTES: ****** CABLE TRAY F

Specimen Failed NONE
Specimen Passed ALL
NOA Written NONE

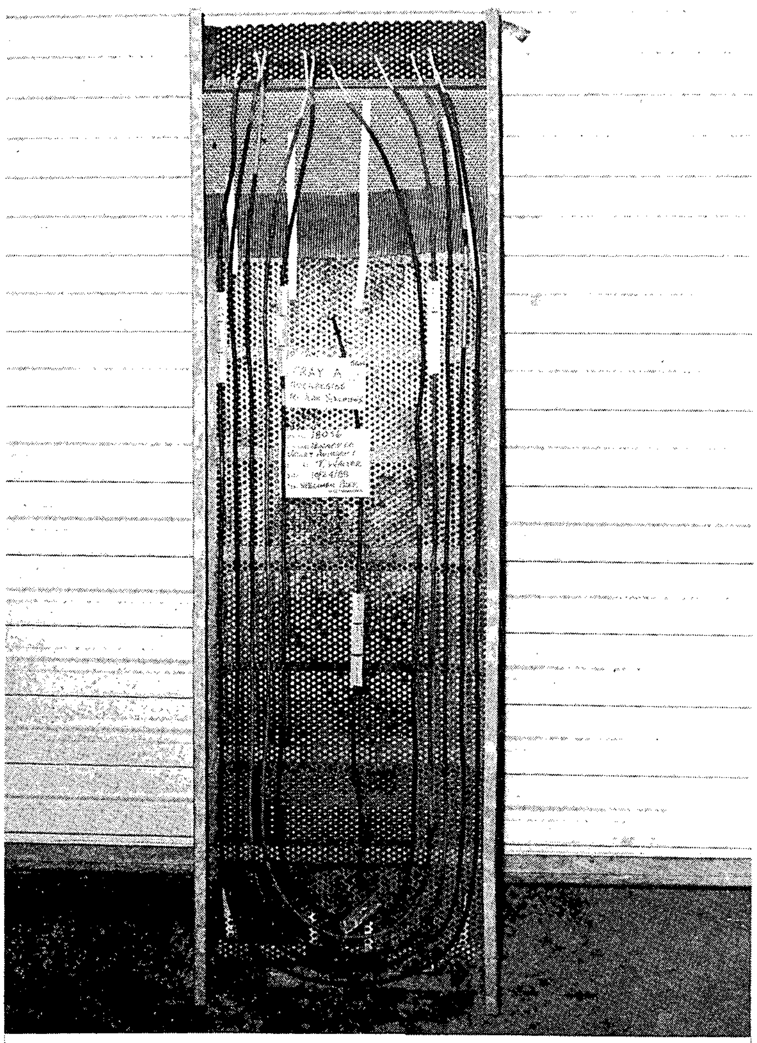
Inspected By Robert [signature] Date: 10-24-88
Witness N/A Date:
Sheet No. 5 of 5
Approved [signature] 01-24-89

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX II

PHOTOGRAPHS

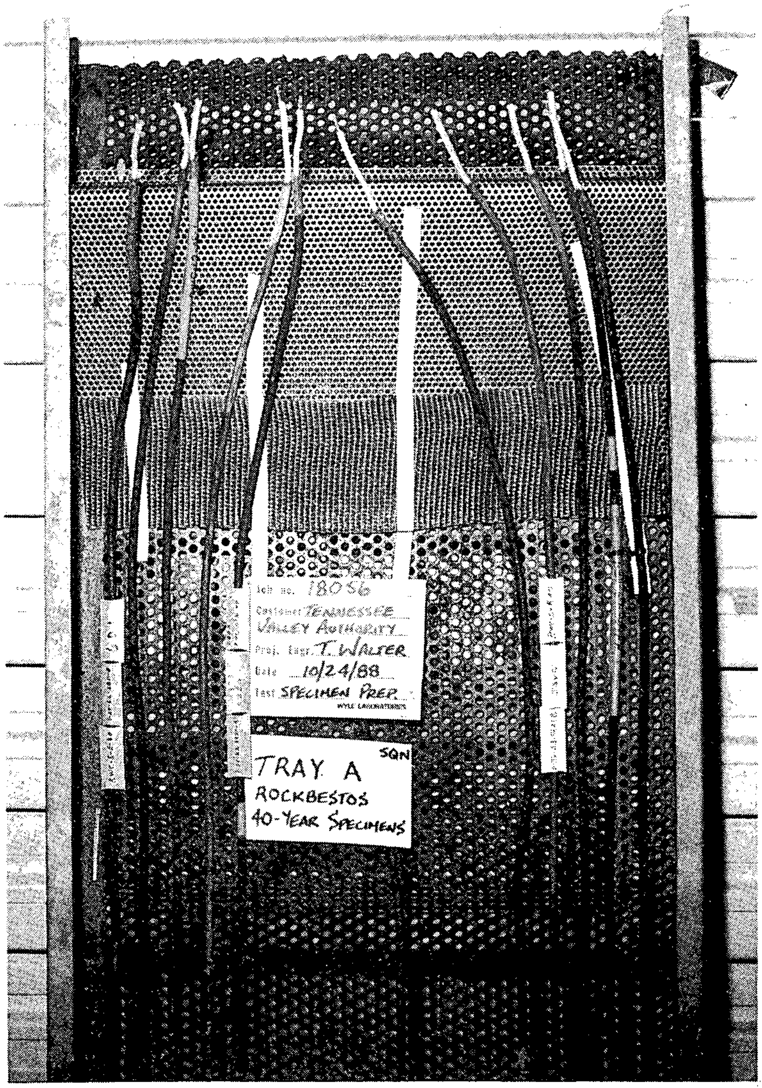
THIS PAGE INTENTIONALLY LEFT BLANK



PHOTOGRAPH I-1

SPECIMEN PREPARATION

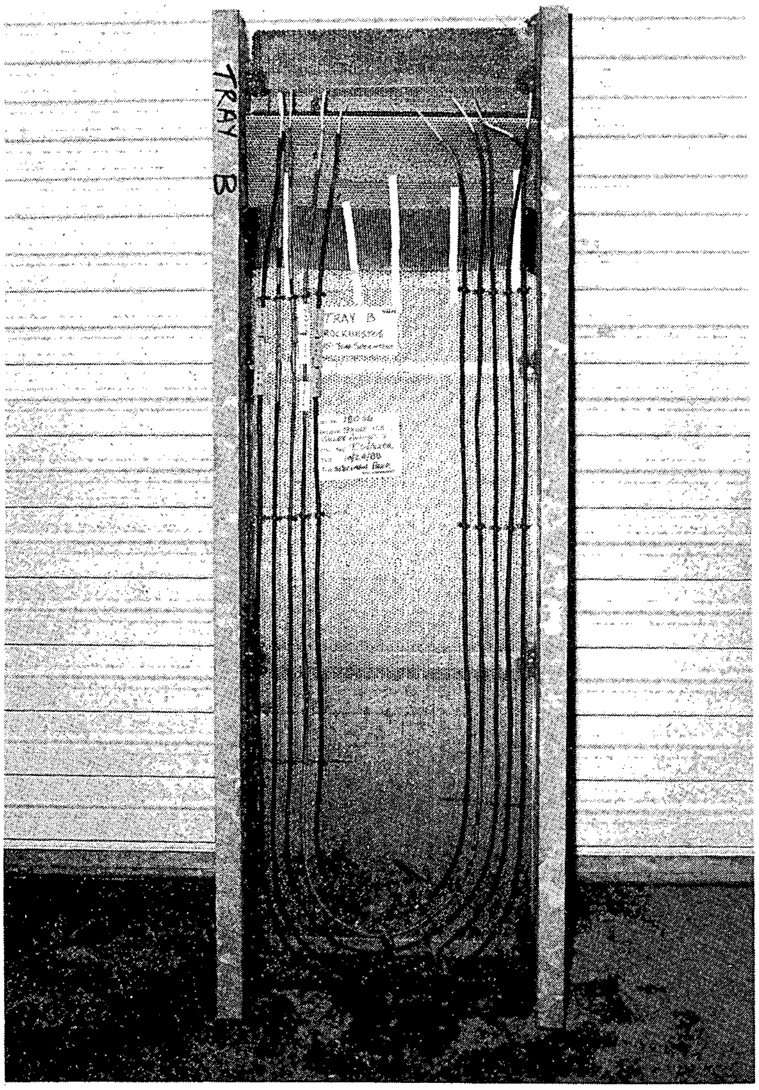
CABLE TRAY A WITH ROCKBESTOS 40-YEAR SPECIMENS, DESIGNATED FOR SEQUOYAH, MOUNTED TO PERFORATED STEEL BOTTOM



PHOTOGRAPH I-2

SPECIMEN PREPARATION

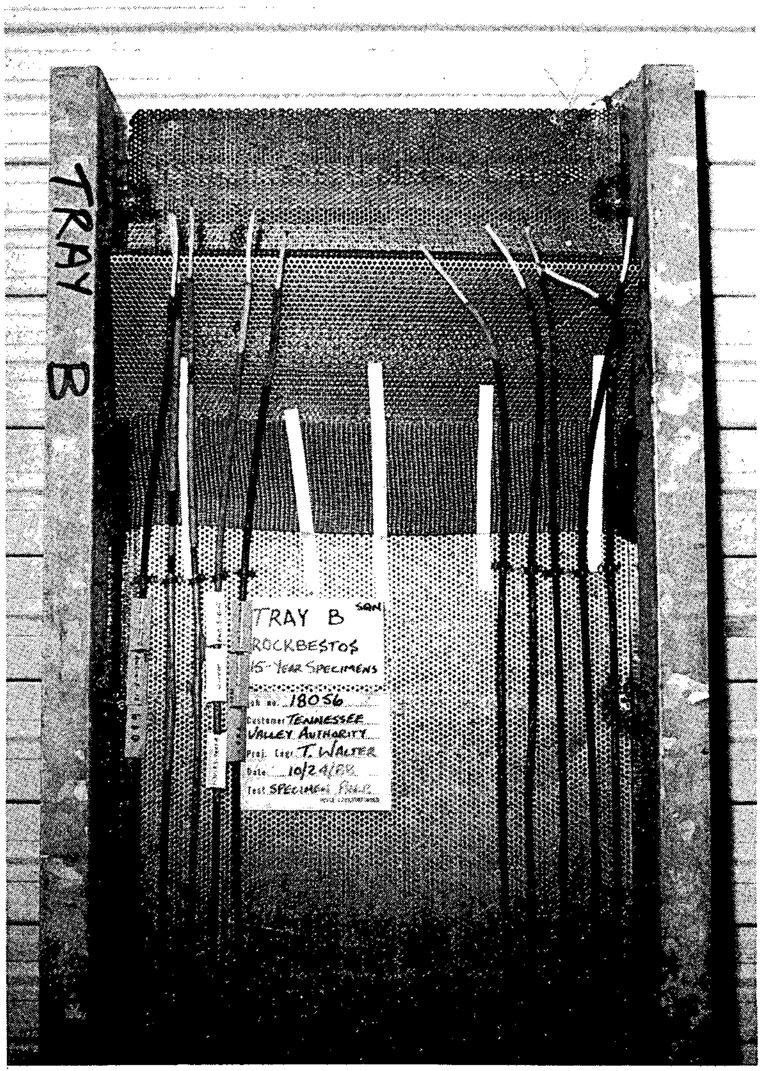
CABLE TRAY A WITH PREPARED CABLE SPECIMEN LEAD ENDS AND IDENTIFICATION TAGS AS PROVIDED BY TENNESSEE VALLEY AUTHORITY (TVA)



PHOTOGRAPH I-3

SPECIMEN PREPARATION

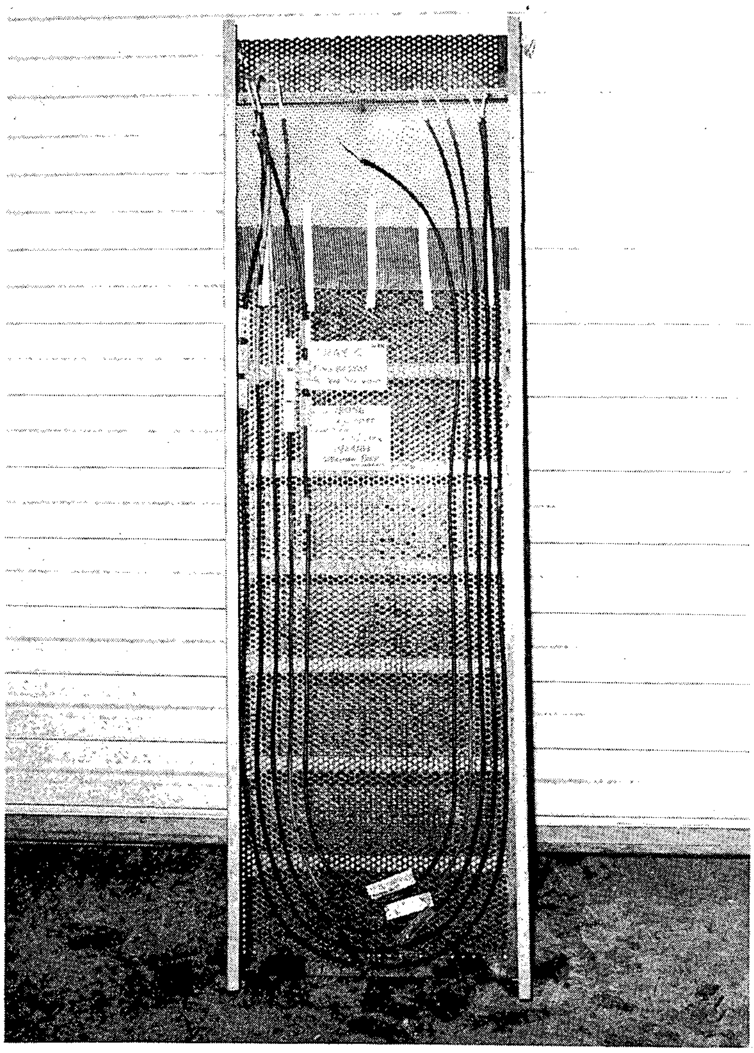
CABLE TRAY B WITH ROCKBESTOS 15-YEAR SPECIMENS, DESIGNATED FOR SEQUOYAH, MOUNTED TO PERFORATED STEEL BOTTOM



PHOTOGRAPH I-4

SPECIMEN PREPARATION

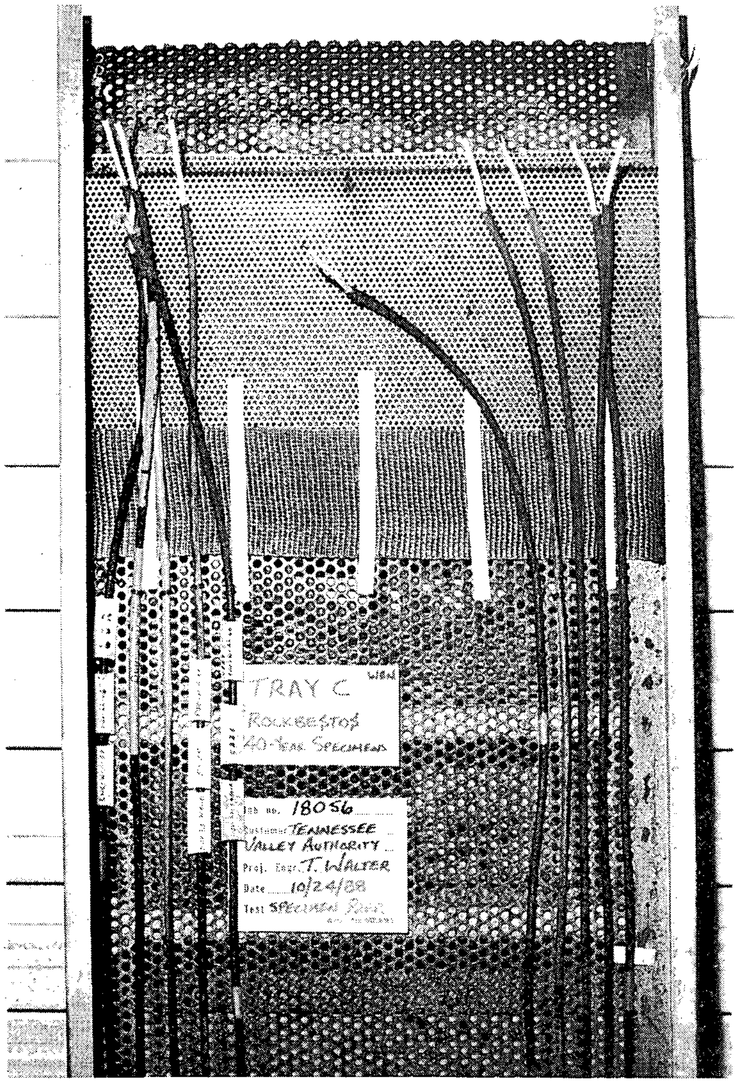
CABLE TRAY B WITH PREPARED CABLE SPECIMEN LEAD ENDS AND IDENTIFICATION TAGS AS PROVIDED BY TENNESSEE VALLEY AUTHORITY (TVA)



PHOTOGRAPH I-5

SPECIMEN PREPARATION

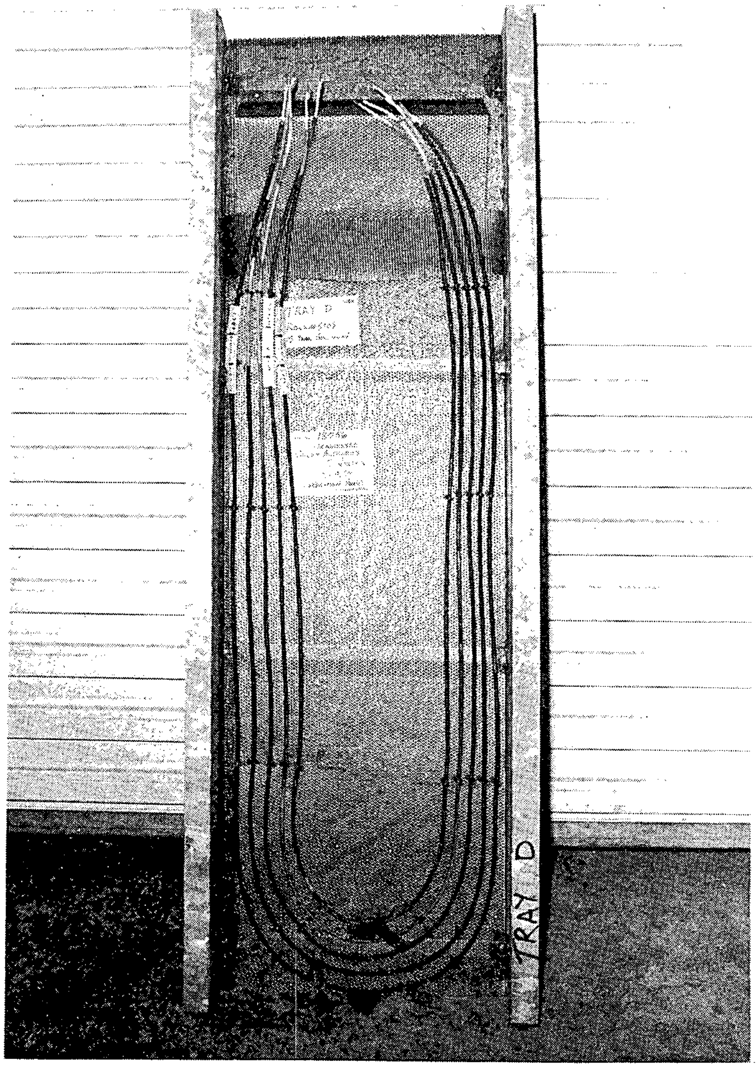
CABLE TRAY C WITH ROCKBESTOS 40-YEAR SPECIMENS, DESIGNATED FOR WATTS BAR, MOUNTED TO PERFORATED STEEL BOTTOM



PHOTOGRAPH I-6

SPECIMEN PREPARATION

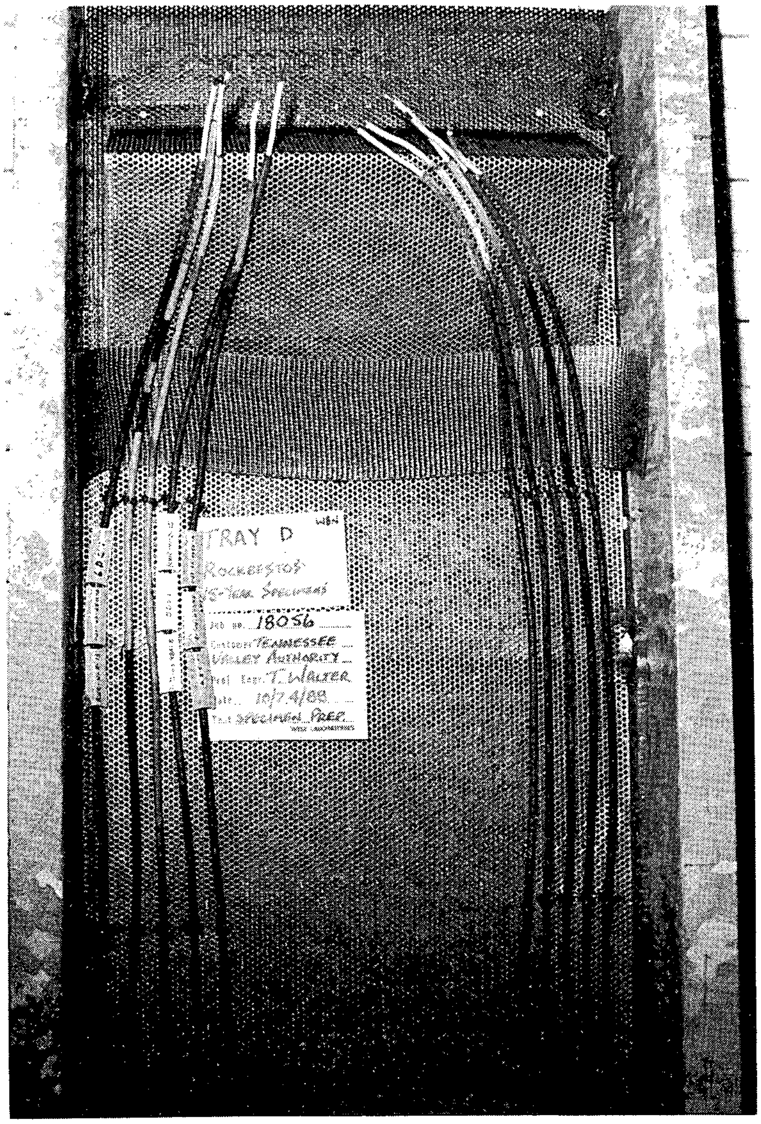
CABLE TRAY C WITH PREPARED CABLE SPECIMEN LEAD ENDS AND IDENTIFICATION TAGS AS PROVIDED BY TENNESSEE VALLEY AUTHORITY (TVA)



PHOTOGRAPH I-7

SPECIMEN PREPARATION

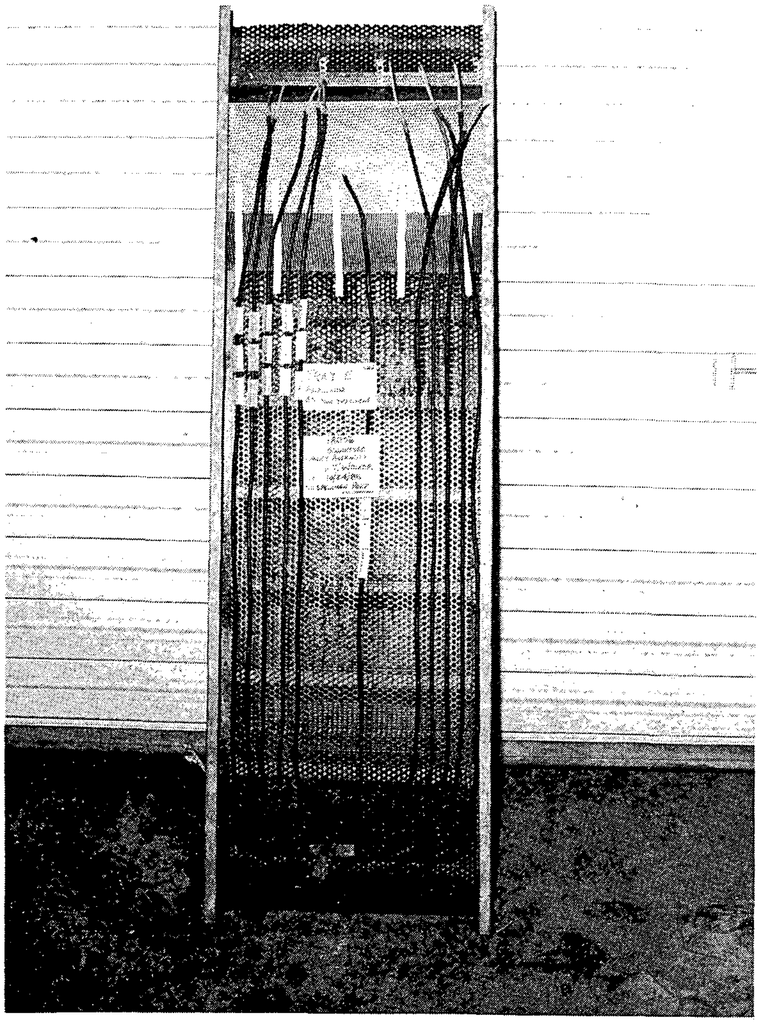
CABLE TRAY D WITH ROCKBESTOS 15-YEAR SPECIMENS, DESIGNATED FOR WATTS BAR, MOUNTED TO PERFORATED STEEL BOTTOM



PHOTOGRAPH I-8

SPECIMEN PREPARATION

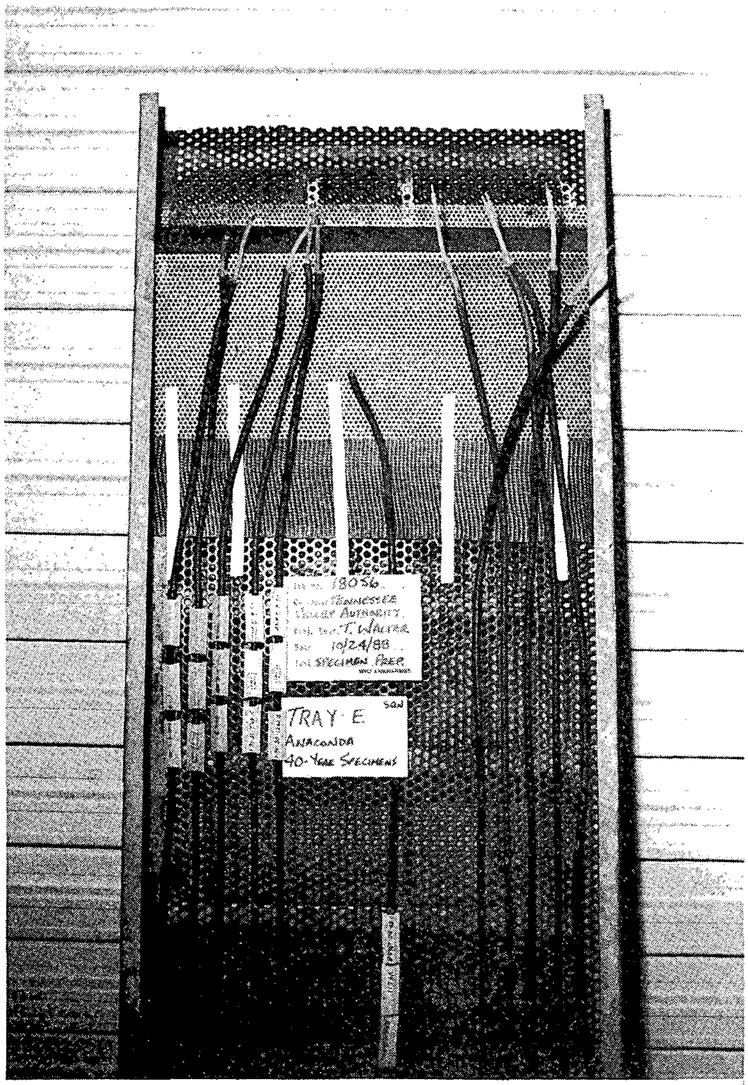
CABLE TRAY D WITH PREPARED CABLE SPECIMEN LEAD ENDS AND IDENTIFICATION TAGS AS PROVIDED BY TENNESSEE VALLEY AUTHORITY (TVA)



PHOTOGRAPH I-9

SPECIMEN PREPARATION

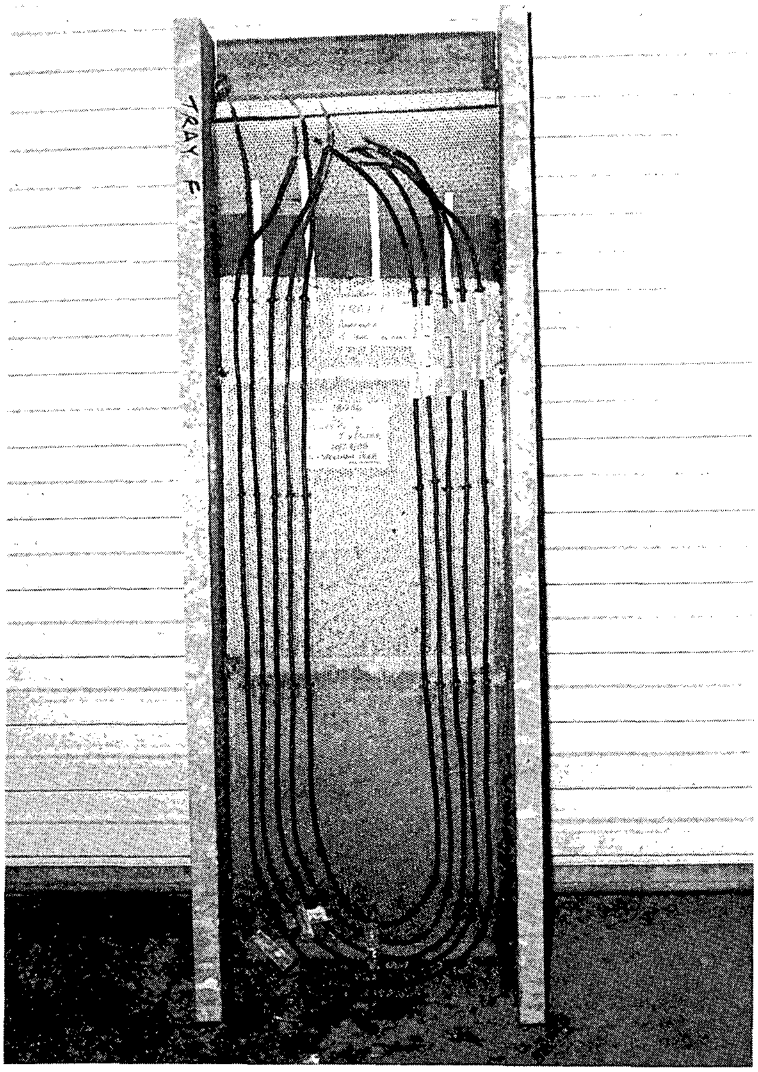
CABLE TRAY E WITH ANACONDA-CONTINENTAL 40-YEAR SPECIMENS, DESIGNATED FOR SEQUOYAH, MOUNTED TO PERFORATED STEEL BOTTOM



PHOTOGRAPH I-10

SPECIMEN PREPARATION

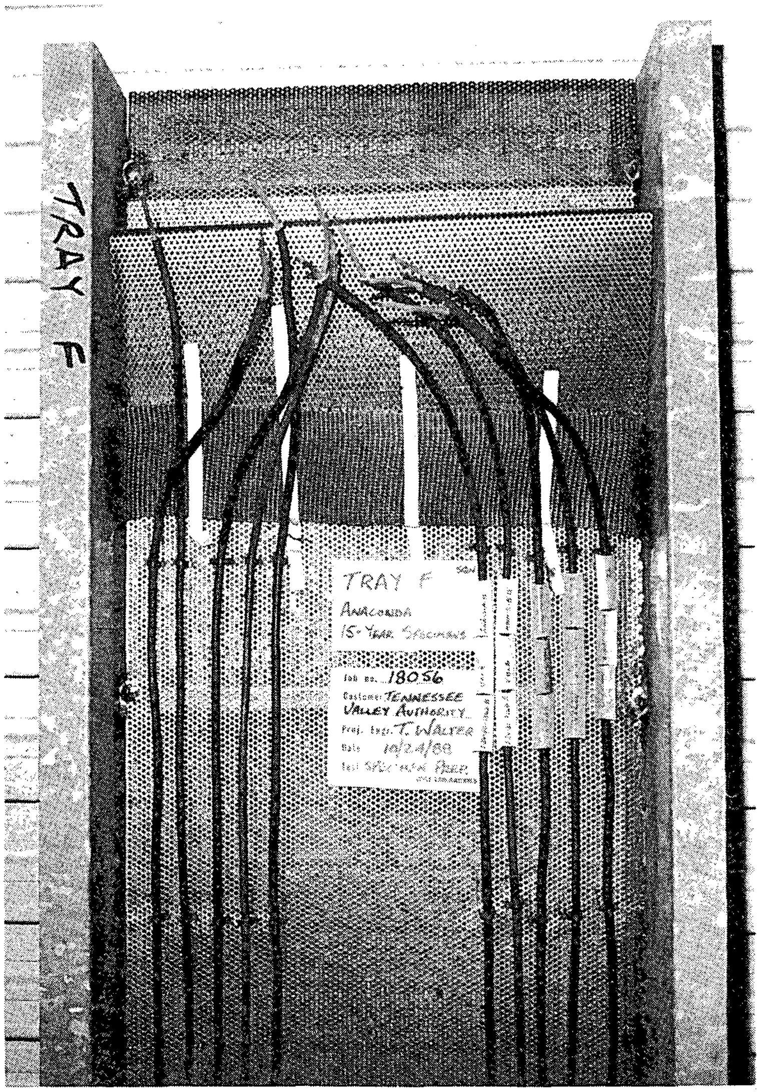
CABLE TRAY E WITH PREPARED CABLE SPECIMEN LEAD ENDS AND IDENTIFICATION TAGS AS PROVIDED BY TENNESSEE VALLEY AUTHORITY (TVA)



PHOTOGRAPH I-11

SPECIMEN PREPARATION

CABLE TRAY F WITH ANACONDA-CONTINENTAL 15-YEAR SPECIMENS, DESIGNATED FOR SEQUOYAH, MOUNTED TO PERFORATED STEEL BOTTOM



PHOTOGRAPH I-12

SPECIMEN PREPARATION

CABLE TRAY F WITH PREPARED CABLE SPECIMEN LEAD ENDS AND IDENTIFICATION TAGS AS PROVIDED BY TENNESSEE VALLEY AUTHORITY (TVA)

APPENDIX III

DATA SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

DATA SHEET

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables

WYLE LABORATORIES

Part No.: Various
Amb. Temp.: 70°F
Job No.: 18056
Spec.: WLOP 18057-00
Photo: No
Report No.: 18056-1
Para.: 3.3.2
Test Med.: ~~Air~~ WATER
Start Date: 10-24-88
S/N: Listed
Specimen Temp.: Ambient
GSI: N/A

Test Title: BASELINE Functional Test

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	1.9×10^{12} Ω	RWC-W-A.15	3.5×10^{12} Ω
RWC-S-B.40	7.3×10^{12} Ω	RWC-W-B.15	1.0×10^{13} Ω
RWC-S-C.40	7.6×10^{12} Ω	RWC-W-C.15	7.2×10^{12} Ω
RWC-S-D.40	6.6×10^{12} Ω	RWC-W-D.15	7.4×10^{12} Ω
RWC-S-E.40	2.2×10^{12} Ω	RWC-W-E.15	4.0×10^{11} Ω
RWC-S-A.15	2.8×10^{12} Ω	ANA-S-A.40	1.5×10^{10} Ω
RWC-S-B.15	7.8×10^{12} Ω	ANA-S-B.40	4.5×10^{10} Ω
RWC-S-C.15	7.6×10^{12} Ω	ANA-S-C.40	7.5×10^{9} Ω
RWC-S-D.15	7.2×10^{12} Ω	ANA-S-D.40	1.5×10^{10} Ω
RWC-S-E.15	4.0×10^{12} Ω	ANA-S-E.40	4.0×10^{9} Ω
RWC-W-A.40	3.0×10^{12} Ω	ANA-S-A.15	8.0×10^{10} Ω
RWC-W-B.40	7.4×10^{12} Ω	ANA-S-B.15	8.4×10^{10} Ω
RWC-W-C.40	1.1×10^{12} Ω	ANA-S-C.15	6.2×10^{9} Ω
RWC-W-D.40	1.0×10^{12} Ω	ANA-S-D.15	1.6×10^{10} Ω
RWC-W-E.40	4.0×10^{12} Ω	ANA-S-E.15	2.8×10^{9} Ω

Tested By: D. Compton Date: 10/24/88
Witness: N/A Date:
Sheet No. 1 of 1
Approved: Robert T. Walls 10-31-88

Notice of Anomaly: NONE

Wyle Form WH 614A, Rev. APR '84

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX IV

INSTRUMENTATION EQUIPMENT SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

INSTRUMENTATION EQUIPMENT SHEET

DATE: 10/21/88
TECHNICIAN: D. COMPTON

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: ACOUSTICS
TYPE TEST: IR

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	MEG MTR	GENERAL RADIO	1864	657113180	011898	50K-50TOHM	2-5%RANGE	10/13/88	04/11/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 10-21-88

CHECKED & RECEIVED BY Robert [illegible] Watts 10-21-88

Q.A. T R Hamilton 10-21-88 (Wyle 9 A)

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION II

NORMAL RADIATION EXPOSURE AND POST-RADIATION FUNCTIONAL TEST

1.0 REQUIREMENTS

1.1 **Normal Radiation Exposure**

The test specimens shall be subjected to the normal radiation exposure as specified in Paragraph 3.4 of Section VII.

1.2 **Post-Radiation Functional Test**

The test specimens shall be subjected to a Functional Test upon completion of radiation exposure. The Functional Test shall be performed as specified in Paragraph 3.5 of Section VII.

2.0 PROCEDURES

2.1 **Normal Radiation Exposure**

The test specimens were subjected to the normal irradiation at Georgia Institute of Technology's Neely Nuclear Research Center. Each test specimen cable tray was subjected to a Total Integrated Dose (TID) depending upon plant and/or age designation. The TID to each of the cable trays was as described below:

Cable Tray Designation	Plant/Age Designation	Specimen Manufacturer	Cumulative TID (rads)
A	Sequoyah 40-year	RWC	8.07E7
B	Sequoyah 15-year	RWC	3.04E7
C	Watts Bar 40-year	RWC	8.03E7
D	Watts Bar 15-year	RWC	3.07E7
E	Sequoyah 40-year	ANA	2.07E7
F	Sequoyah 15-year	ANA	7.63E6

Upon completion of irradiation, the test specimens were returned to Wyle Laboratories' Test Facility for completion of testing.

2.0 **PROCEDURES (Continued)**

2.2 **Post-Radiation Functional Test**

Upon completion of irradiation, the test specimens were subjected to a Post-Radiation Functional Test. The Functional Test was performed as described in Paragraph 2.3, Section I, of this report.

3.0 **RESULTS**

The test specimens were subjected to the Normal Radiation Exposure and Post-Radiation Functional Tests of Paragraph 2.0 and met the requirements of Paragraph 1.0. Photographs of the test specimens mounted in the cable trays were taken upon receipt at Wyle Laboratories. Observations recorded during the Post-Radiation Functional Test Visual Inspection are presented in the following paragraphs.

During the visual inspection it was noted that, in general, the test specimens were in good condition and showed no indication of damage or severe degradation. The Tefzel cable ties were intact and were maintaining specimen cable position on the cable trays. The test specimens separated from the metal surface of the cable tray(s) in some areas between the specimen cable ties. This "flexing" of the test specimens can be attributed to the normal radiation exposure that the specimens received, and to the natural coiling nature of the cables. Visual inspections for each individual cable tray are presented in the following paragraphs.

Cable Tray A was noted to have silicone insulation on the lead ends of Test Specimens A and E that was much darker in apperance than the remaining test specimens on the tray. The asbestos braided jacket material on Test Specimen E was found to be fraying at the lead ends. All of the test specimens on this tray exhibited an ash coloring on their jacket material. The test specimens, as mounted in the cable tray, had lost some flexibility.

Cable Tray B was noted to have ash coloring on the jacket material on all of the test specimens, with Test Specimen D being the least apparent. The test specimens, as mounted in the cable tray, had lost some flexibility. All of the test specimens were noted to have curved at the lead ends in the elevated portion of the cable tray.

Cable Tray C was noted to have darkened silicone insulation at the lead ends of Test Specimens A and E, as described previously for Cable Tray A. The asbestos braided jacket material on Test Specimens A and E was found to be fraying at the lead ends. All of the test specimens on this tray exhibited an ash coloring on the jacket material with Test Specimens D and E being the least apparent. Test specimen flexibility was as described previously for Cable Tray A .

3.0 RESULTS (Continued)

Cable Tray D was noted to have ash coloring on the jacket material on all of the test specimens, with Test Specimens D and E being the least apparent. The asbestos braided jacket material on Test Specimen E was found to be fraying at one lead end. The test specimen lead ends were noted to have curved in the elevated portion of the cable tray. The test specimens had lost some flexibility.

Cable Tray E was noted to have ash coloring on the jacket material on all of the test specimens, with Test Specimen A being the least apparent. The asbestos braided jacket material on Test Specimens B through E was found to be fraying at the lead ends. Test specimen flexibility was as described previously for Cable Tray A.

Cable Tray F was noted to have ash coloring on the jacket material of Test Specimens B through E. The asbestos braided jacket material on Test Specimens C and E were found to be fraying at the lead ends. The test specimen lead ends were noted to have curved in the elevated portion of the cable tray. The test specimens had lost some flexibility.

The data recorded during this phase of the test program is presented in Appendices I through IV, of this Section, as noted below:

- Appendix I contains a Letter of Certification indicating dose rates, exposure time and cumulative total dose on the test specimens.
- Appendix II contains Photographs II-1 through II-8 which show the test specimens during the Post-Radiation Visual Inspection and Functional Test.
- Appendix III contains the Data Sheet generated during the Post-Radiation Functional Tests.
- Appendix IV contains the Instrumentation Equipment Sheet generated for the Post-Radiation Functional Tests.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX I

LETTER OF CERTIFICATION FOR THE IRRADIATION EXPOSURE

THIS PAGE INTENTIONALLY LEFT BLANK

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425

(404) 894-3600

January 3, 1989

Wyle Laboratories
7800 Governors Drive
Huntsville, Alabama 35807-5101

Attention: Mr. Dave McGuiness

Reference: 4-5739-S
851039

Gentlemen:

The items covered by the above number have been irradiated in accordance with quality assurance requirements using Cobalt 60 (gamma energies 1.173 Mev, 1.331 Mev) to the total dose requested.

We ceritfy the specifics of the irradiation as follows:

Irradiation Period: Interval between 1556 on 10/25/88 and 1510 on 11/01/88 as shown on the enclosed Gamma Irradiation Log Sheets

Dose Rate: Up to 1.0 E6Rads/hr (Air Equivalent); maximum error plus or minus 4%

Total Dose:

Tray A	8.07 E7	Rads/~~hr~~ (Air Equivalent);	ETW 01-17-89
B	3.04 E7	"	
C	8.03 E7	"	
D	3.07 E7	"	
E	2.07 E7	"	
F	7.63 E6	"	

maximum error plus or minus 5%

Dosimetry: Keithley Model 485Autoranging Picoammeterwith LND Model 52160 ionization chamber. Calibration against NIST (formerly NBS) traceable Cobalt-60.

Calculations, a sketch and/or photographs of the arrangement are enclosed. Please let us know if any additional information is needed.

Yours truly,

R. N. Macdonald

Dr. R.N. Macdonald
Associate Director

RNM:jlr

Enclosures

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425

(404) 894-3600

D O S E   R A T E   D E T E R M I N A T I O N

Using Ionization Probe: LND Model 52160, S/N 88-35
Electrometer: Keithley Model 485, S/N 375586

Client: Wyle Labs
PO Number:4-5739-S
NNRC Ref: 851039

Date: 10/25/88
Time: 16:00

Description	Rding 1	Rding 2	Rding 3	Rding 4	Average	Dose Rate
	Electrometer Reading x 1E-6 Amps					
TRAY A	1.19700	1.21800	1.50700	1.42800	1.33750	6.39E+05
TRAY B	0.71230	0.74070	0.79090	0.74790	0.74795	3.56E+05
TRAY C	1.30400	1.23400	1.30900	1.20300	1.26250	6.03E+05
TRAY D	0.60130	0.63570	0.63280	0.57060	0.61010	2.90E+05
TRAY E	0.42540	0.45710	0.46520	0.41700	0.44117	2.09E+05
TRAY F	0.37830	0.42480	0.42610	0.35570	0.39622	1.88E+05

Dose Rate (R/Hr) = 4.791e11*Electrometer Reading (Amps) - 1367

Performed by: [signature]
Dixon F. Parker

Reviewed by: R.N. Macdonald
Date: 1/3/89

Georgia Institute of Technology
NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425
(404) 894-360

DOSE RATE DETERMINATION

Using Ionization Probe: LND Model 52160, S/N 88-35
Electrometer: Keithley Model 485, S/N 375586

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Ref: 851039

Date: 10/27/88
Time: 15:00

Description	Electrometer Reading x 1E-6 Amps Rding 1	Rding 2	Rding 3	Rding 4	Average	Dose Rate
TRAY A	0.93350	1.12100	1.14100	0.96010	1.03890	4.96E+05
TRAY B	0.23060	0.26450	0.26480	0.23490	0.24870	1.17E+05
TRAY C	0.86860	1.11600	1.05500	0.97540	1.00375	4.79E+05
TRAY D	0.24130	0.28470	0.28790	0.28330	0.27430	1.30E+05
TRAY E	0.11570	0.12590	0.12880	0.12130	0.12292	5.75E+04

Dose Rate (R/Hr) = 4.791e11*Electrometer Reading (Amps) - 1367

Performed by: [signature] Dixon F. Parker

Reviewed by: R. N. Macdonald
Date: 1/3/89

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425

(404) 894-3600

DOSE RATE DETERMINATION

Using Ionization Probe: LND Model 52160, S/N 88-35
Electrometer: Keithley Model 485, S/N 375586

Client: Wyle Labs
PO Number:4-5739-S
NNRC Ref: 850139

Date: 10/28/88
Time: 16:00

Description	Electrometer Reading x 1E-6 Amps Rding 1	Rding 2	Rding 3	Rding 4	Average	Dose Rate
TRAY A	1.06700	1.26400	1.27800	1.05200	1.16525	5.56E+05
TRAY B	0.24640	0.27430	0.28100	0.23940	0.26027	1.23E+05
TRAY C	0.89370	0.98310	0.92880	0.80530	0.90272	4.31E+05
TRAY D	0.24850	0.28110	0.26850	0.29530	0.27335	1.29E+05
TRAY E	0.11300	0.12220	0.11690	0.10910	0.11530	5.38E+04

Dose Rate (R/Hr) = 4.791e11*Electrometer Reading (Amps) - 1367

Performed by: Dixon F. Parker

Reviewed by: R.N. Macdonald

Date: 1/3/89

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425

(404) 894-3600

DOSE RATE DETERMINATION

Using Ionization Probe: LND Model 52160, S/N 88-35
Electrometer: Keithley Model 485, S/N 375586

Client: Wyle Labs
PO Number:4-5739-S
NNRC Ref: 851039

Date: 10/31/88
Time: 09:30

Description	Electrometer Reading x 1E-6 Amps Rding 1	Rding 2	Rding 3	Rding 4	Average	Dose Rate
TRAY A	1.74500	1.73700	1.91700	2.02800	1.85675	8.88E+05
TRAY B	0.44740	0.50170	0.48740	0.42230	0.46470	2.21E+05
TRAY C	1.48000	1.46700	1.64000	1.57800	1.54125	7.37E+05
TRAY D	0.47550	0.50960	0.47930	0.44750	0.47797	2.27E+05
TRAY E	0.19940	0.21730	0.21520	0.19750	0.20735	9.79E+04

Dose Rate (R/Hr) = 4.791e11*Electrometer Reading (Amps) - 1367

Performed by: Dixon F. Parker

Reviewed by: R. N. Macdonald

Date: 1/3/89

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425

(404) 894-3600

DOSE RATE DETERMINATION

Using Ionization Probe: LND Model 52160, S/N 88-35
Electrometer: Keithley Model 485, S/N 375586

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Ref: 851039

Date: 10/31/88
Time: 1700

Description	Electrometer Reading x 1E-6 Amps Rding 1	Rding 2	Rding 3	Rding 4	Average	Dose Rate
TRAY B	0.33200	0.35670	0.32620	0.29770	0.32815	1.55E+05
TRAY C	1.54900	1.51200	1.46400	1.44600	1.49275	7.13E+05
TRAY D	0.48060	0.50420	0.53230	0.49290	0.50250	2.39E+05
TRAY E	0.92790	0.99900	0.90750	0.86740	0.92545	4.42E+05

Dose Rate (R/Hr) = 4.791e11*Electrometer Reading (Amps) - 1367

Performed by: Dixon F. Parker

Reviewed by: R. N. Macdonald

Date: 1/3/89

Georgia Institute of Technology
NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425
(404) 894-360

DOSE RATE DETERMINATION

Using Ionization Probe: LND Model 52160, S/N 88-35
Electrometer: Keithley Model 485, S/N 375586

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Ref: 851039

Date: 11/1/88
Time: 11:00

Description	Electrometer Reading x 1E-6 Amps Rding 1	Rding 2	Rding 3	Rding 4	Average	Dose Rate
TRAY B	0.61550	0.61780	0.61810	0.57720	0.60715	2.89E+05
TRAY D	1.14300	1.20300	1.15700	1.09400	1.14925	5.49E+05

Dose Rate (R/Hr) = 4.791e11*Electrometer Reading (Amps) - 1367

Performed by: [signature]
Dixon F. Parker

Reviewed by: R.N. Macdonald
Date: 1/3/89

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425

(404) 894-3600

GAMMA IRRADIATION LOG

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Reference: 851039

Item: Cable Tray A
Total Dose: 8.00E+07
Dose Rate: 1.00E+06

Irradiation Time Start	Irradiation Time Stop	Elapsed hours	Dose Rate Rad/hr	Dose Rads	Total Dose Rads
10/25/88 15:56	10/27/88 08:30	40.56	6.39E+05	2.59E+07	2.59E+07
10/27/88 14:50	10/28/88 15:43	24.88	4.96E+05	1.23E+07	3.83E+07
10/28/88 15:43	10/31/88 10:26	66.71	5.56E+05	3.71E+07	7.53E+07
10/31/88 10:26	10/31/88 16:26	6.00	8.88E+05	5.33E+06	8.07E+07

Performed by : Dixon F. Parker

Reviewed by : R. N. Macdonald

Date : 1/3/89

Georgia Institute of Technology

NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425

(404) 894-360

G A M M A I R R A D I A T I O N L O G

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Reference: 851039

Item: Cable Tray B
Total Dose: 3.00E+07
Dose Rate: 1.00E+06

Irradiation Time Start	Irradiation Time Stop	Elapsed hours	Dose Rate Rad/hr	Dose Rads	Total Dose Rads
10/25/88 15:56	10/27/88 08:30	40.56	3.56E+05	1.44E+07	1.44E+07
10/27/88 14:50	10/28/88 15:43	24.88	1.17E+05	2.91E+06	1.74E+07
10/28/88 15:43	10/31/88 10:26	66.71	1.23E+05	8.21E+06	2.56E+07
10/31/88 10:26	10/31/88 16:26	6.00	2.21E+05	1.33E+06	2.69E+07
10/31/88 17:52	11/01/88 08:53	15.01	1.55E+05	2.33E+06	2.92E+07
11/01/88 12:10	11/01/88 16:10	4.00	2.89E+05	1.16E+06	3.04E+07

Performed by : [signature]
Dixon F. Parker

Reviewed by : R. N. Macdonald
Date : 1/3/89

Georgia Institute of Technology
NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425
(404) 894-3600

GAMMA IRRADIATION LOG

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Reference: 851039

Item: Cable Tray C
Total Dose: 8.00E+07
Dose Rate: 1.00E+06

Irradiation Time Start	Irradiation Time Stop	Elapsed hours	Dose Rate Rad/hr	Dose Rads	Total Dose Rads
10/25/88 15:56	10/27/88 08:30	40.56	6.03E+05	2.45E+07	2.45E+07
10/27/88 14:50	10/28/88 15:43	24.88	4.79E+05	1.19E+07	3.64E+07
10/28/88 15:43	10/31/88 10:26	66.71	4.31E+05	2.88E+07	6.51E+07
10/31/88 10:26	10/31/88 16:26	6.00	7.37E+05	4.42E+06	6.95E+07
10/31/88 17:52	11/01/88 08:53	15.01	7.13E+05	1.07E+07	8.03E+07

Performed by : [signature] Dixon F. Parker

Reviewed by : R. N. Macdonald

Date : 1/3/89

Georgia Institute of Technology
NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425
(404) 894-3600

GAMMA IRRADIATION LOG

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Reference: 851039

Item: Cable Tray D
Total Dose: 3.00E+07
Dose Rate: 1.00E+06

Irradiation Time Start	Irradiation Time Stop	Elapsed hours	Dose Rate Rad/hr	Dose Rads	Total Dose Rads
10/25/88 15:56	10/27/88 08:30	40.56	2.90E+05	1.18E+07	1.18E+07
10/27/88 14:50	10/28/88 15:43	24.88	1.30E+05	3.23E+06	1.50E+07
10/28/88 15:43	10/31/88 10:26	66.71	1.29E+05	8.61E+06	2.36E+07
10/31/88 10:26	10/31/88 16:26	6.00	2.27E+05	1.36E+06	2.50E+07
10/31/88 17:52	11/01/88 08:53	15.01	2.39E+05	3.59E+06	2.86E+07
11/01/88 12:10	11/01/88 16:10	4.00	5.49E+05	2.20E+06	3.07E+07

Performed by : Dixon F. Parker

Reviewed by : R. N. Macdonald

Date : 1/3/89

Georgia Institute of Technology
NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425
(404) 894-3600

GAMMA IRRADIATION LOG

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Reference: 851039

Item: Cable Tray E
Total Dose: 2.00E+07
Dose Rate: 1.00E+06

Irradiation Time Start	Irradiation Time Stop	Elapsed hours	Dose Rate Rad/hr	Dose Rads	Total Dose Rads
10/25/88 15:56	10/27/88 08:30	40.56	2.09E+05	8.48E+06	8.48E+06
10/27/88 14:50	10/28/88 15:43	24.88	5.75E+04	1.43E+06	9.91E+06
10/28/88 15:43	10/31/88 10:26	66.71	5.38E+04	3.59E+06	1.35E+07
10/31/88 10:26	10/31/88 16:26	6.00	9.79E+04	5.87E+05	1.41E+07
10/31/88 17:52	11/01/88 08:53	15.01	4.42E+05	6.63E+06	2.07E+07

Performed by : [signature]
Dixon F. Parker

Reviewed by : R. N. Macdonald
Date : 1/3/89

Georgia Institute of Technology
NEELY NUCLEAR RESEARCH CENTER
900 ATLANTIC DRIVE
ATLANTA, GEORGIA 30332-0425
(404) 894-3600

GAMMA IRRADIATION LOG

Client: Wyle Labs
PO Number: 4-5739-S
NNRC Reference: 851039

Item: Cable Tray F
Total Dose: 7.50E+06
Dose Rate: 1.00E+06

Irradiation Time Start	Irradiation Time Stop	Elapsed hours	Dose Rate Rad/hr	Dose Rads	Total Dose Rads
10/25/88 15:56	10/27/88 08:30	40.56	1.88E+05	7.63E+06	7.63E+06

Performed by : Dixon F. Parker

Reviewed by : R. N. Macdonald

Date : 1/3/89

TRACEABILITY DATA

Keithley Autoranging Picoammeter
Model Number 485
Serial Number 375586

Calibrated: October 17, 1988
By: Neely Nuclear Research Center
Georgia Institute of Technology
900 Atlantic Drive, N.W.
Atlanta, Georgia 30332
Next Calibration Due: October 1, 1989

INSTRUMENTS USED

Keithley Picoampere Source
Model Number 261
Serial Number 71987

Calibration: August 8, 1988
By: General Electric Company
Integrated Communication Services Operation
2825 Pacific Drive, Suite A
Norcross, Georgia 30071
Next Calibration Due: August 8, 1989

General Electric Traceability
FLU-8506A Number 4350012 (Dated May 26, 1988 and due August 26, 1988
GUI-6500 Number 57023 (Dated May 20, 1988 and due August 20, 1988
SLN-7081 Number 000480 (Dated April 11, 1988 and due October 11, 1988

Hewlett Packard Digital Voltmeter
Model Number 3468A
Serial Number 2237A15867

Calibration: June 6, 1988
By: Hewlett Packard
Product Support Division
2000 South Park Place
Atlanta, Georgia 30339
Next Calibration Due: December 6, 1988

Hewlett Packard Traceability
Traceability Number 3112-C8180 001

TRACEABILITY DATA

LND Probe
Model Number 52160
Serial Number 88-35

Calibrated: October 21, 1988
By: Neely Nuclear Research Center
Georgia Institute of Technology
900 Atlantic Drive, N.W.
Atlanta, Georgia 30332
Next Calibration Due: October 21, 1989

INSTRUMENTS USED

Victoreen Probe
Model Number 550-6A
Serial Number 540

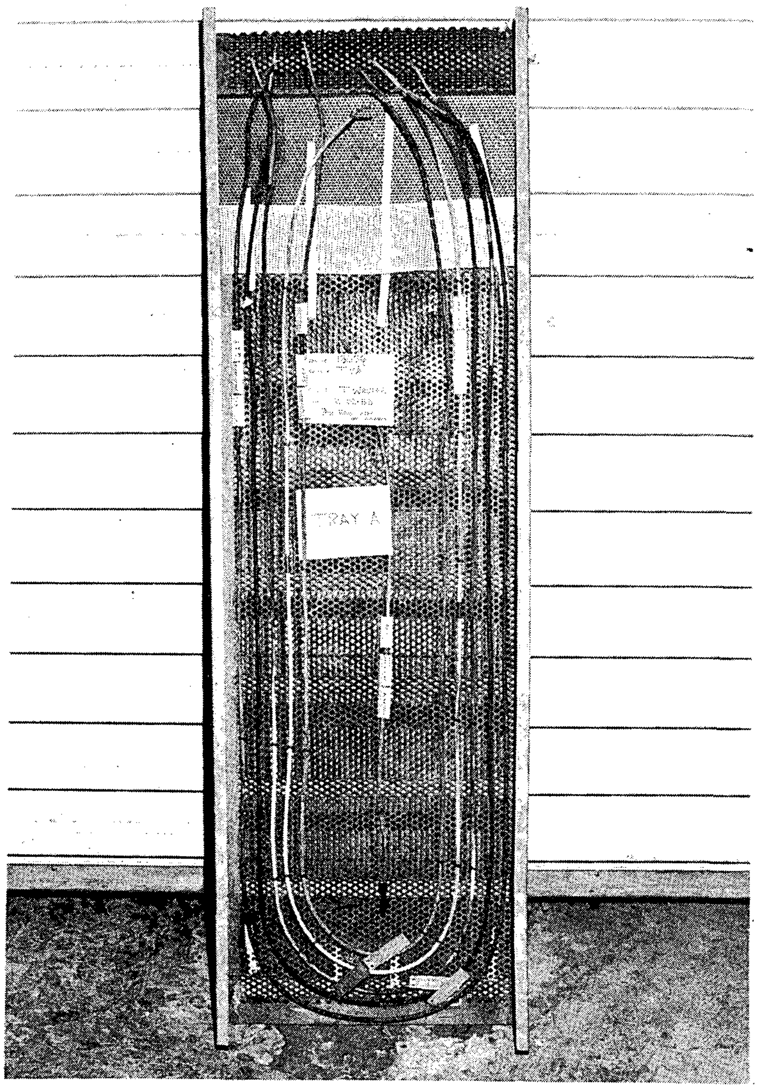
Calibration: October 21, 1987
By: Victoreen, Inc.
10101 Woodland Avenue
Cleveland, Ohio 44104
Next Calibration Due: October 21, 1988

Victoreen Traceability
Test Number DG8118/83
Calibration: September 29, 1983
PTW Chamber Model 30-343
Serial Number N23361-142

APPENDIX II

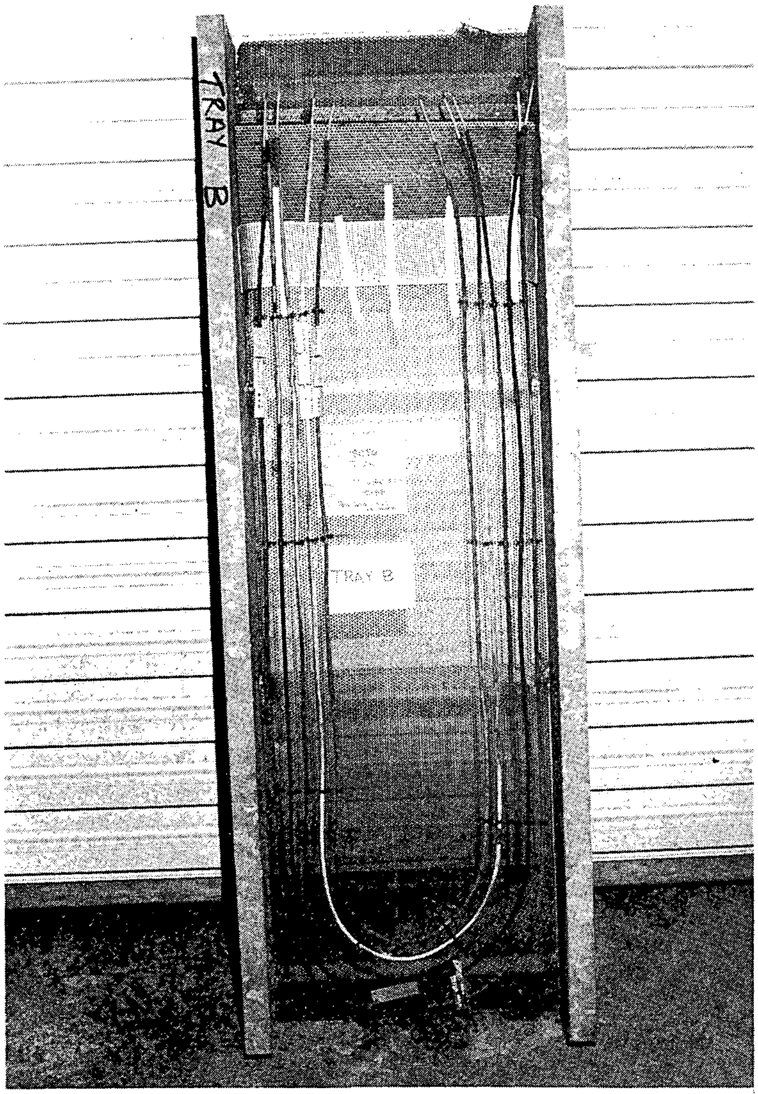
PHOTOGRAPHS

THIS PAGE INTENTIONALLY LEFT BLANK



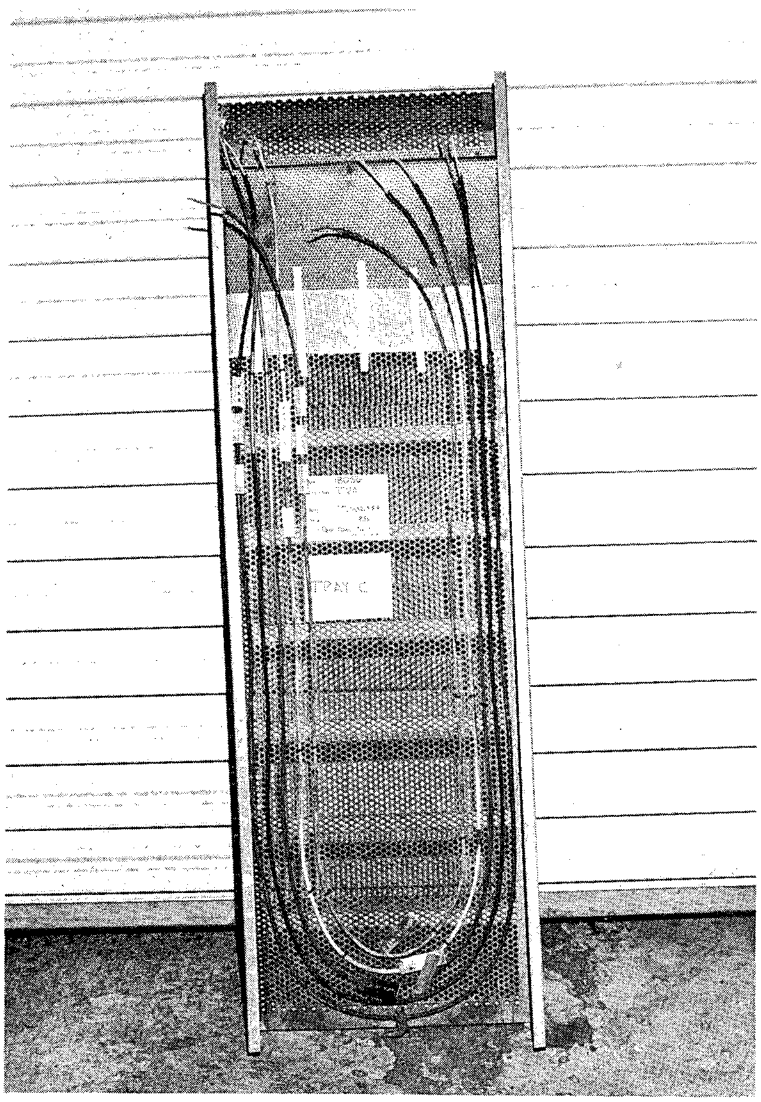
PHOTOGRAPH II-1

POST-RADIATION VISUAL INSPECTION
CABLE TRAY A PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



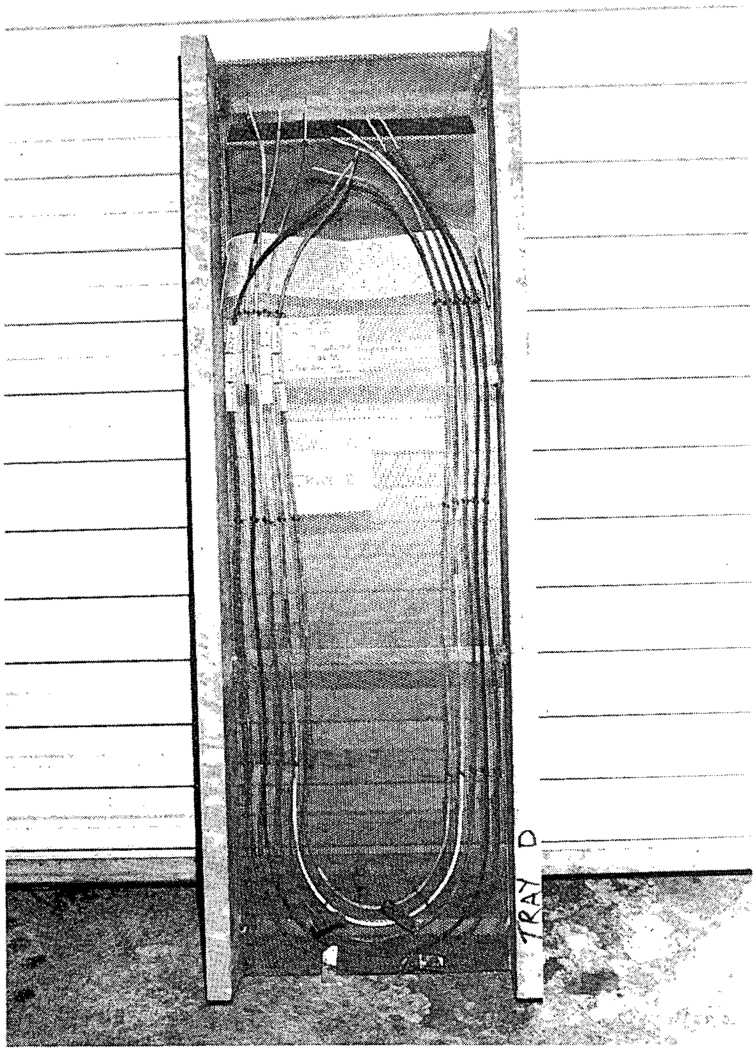
PHOTOGRAPH II-2

**POST-RADIATION VISUAL INSPECTION
CABLE TRAY B PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS**



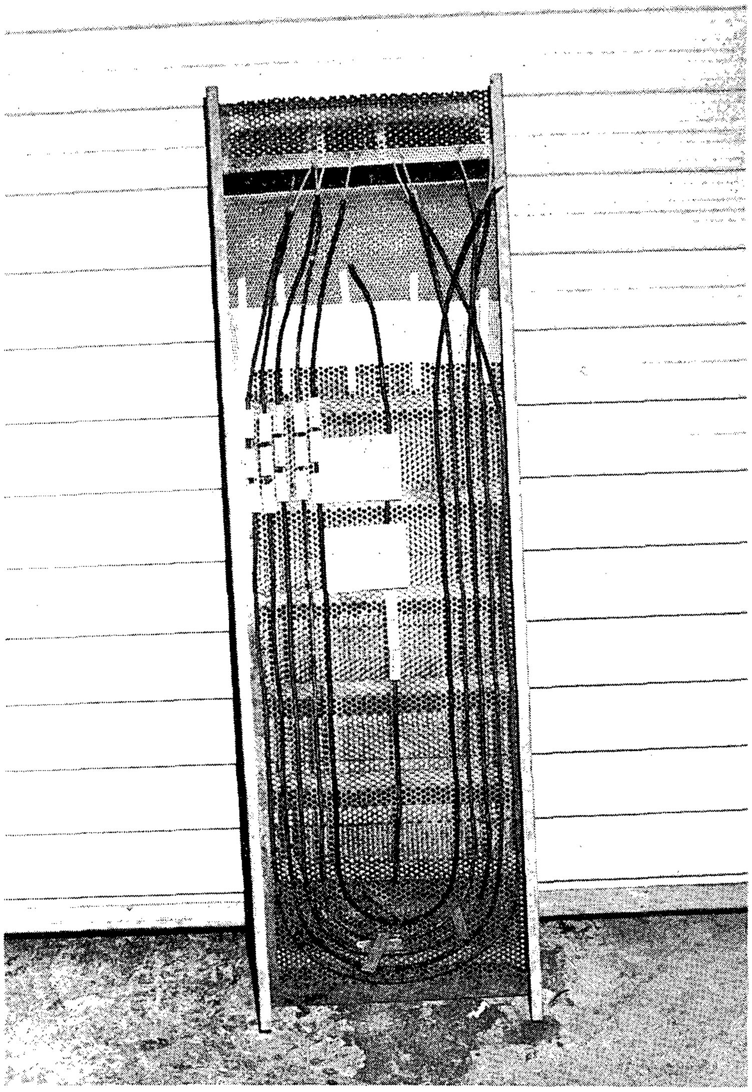
PHOTOGRAPH II-3

POST-RADIATION VISUAL INSPECTION
CABLE TRAY C PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



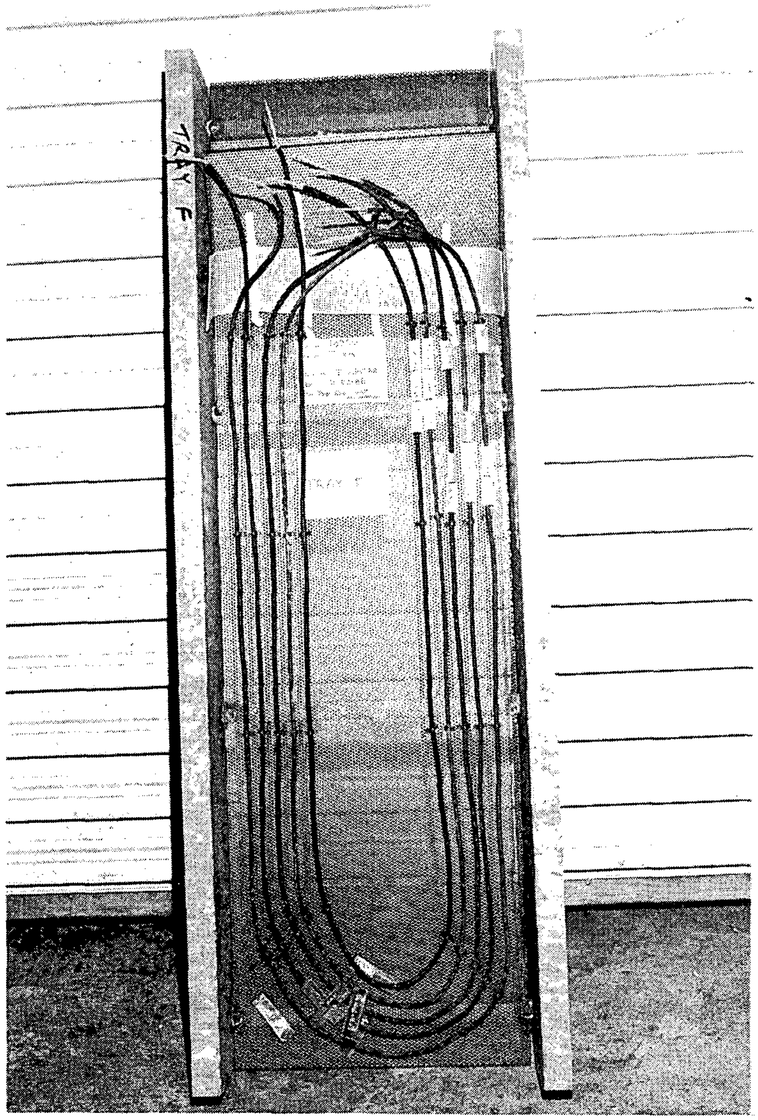
PHOTOGRAPH II-4

POST-RADIATION VISUAL INSPECTION
CABLE TRAY D PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



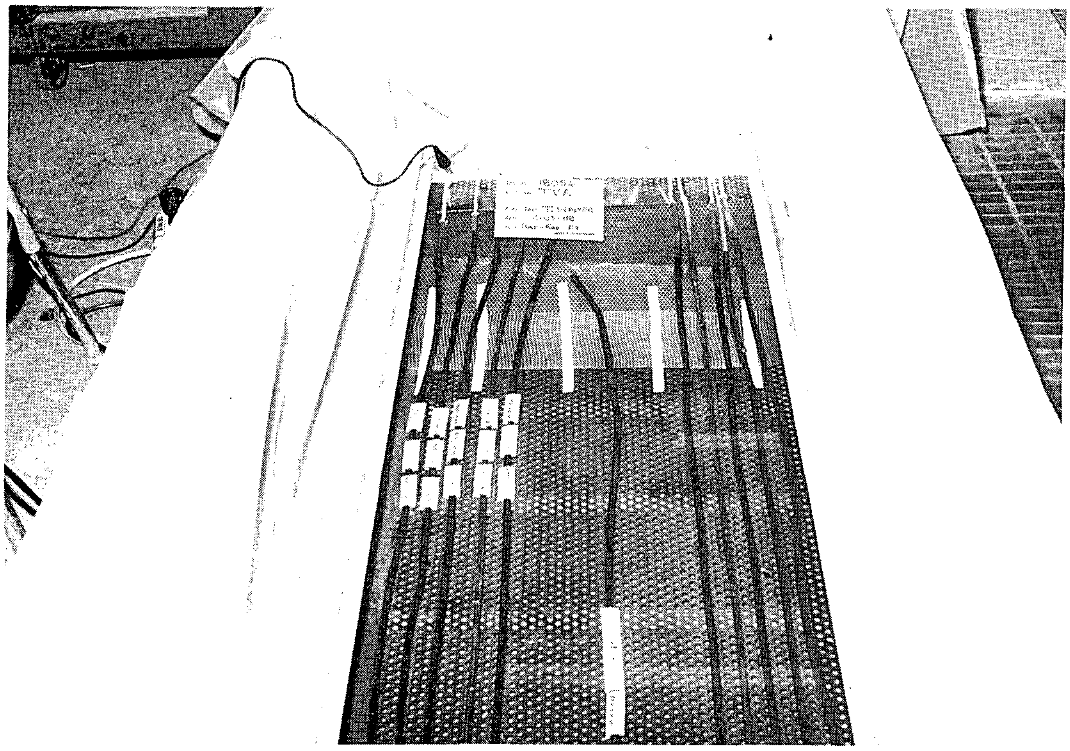
PHOTOGRAPH II-5

POST-RADIATION VISUAL INSPECTION
CABLE TRAY E PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



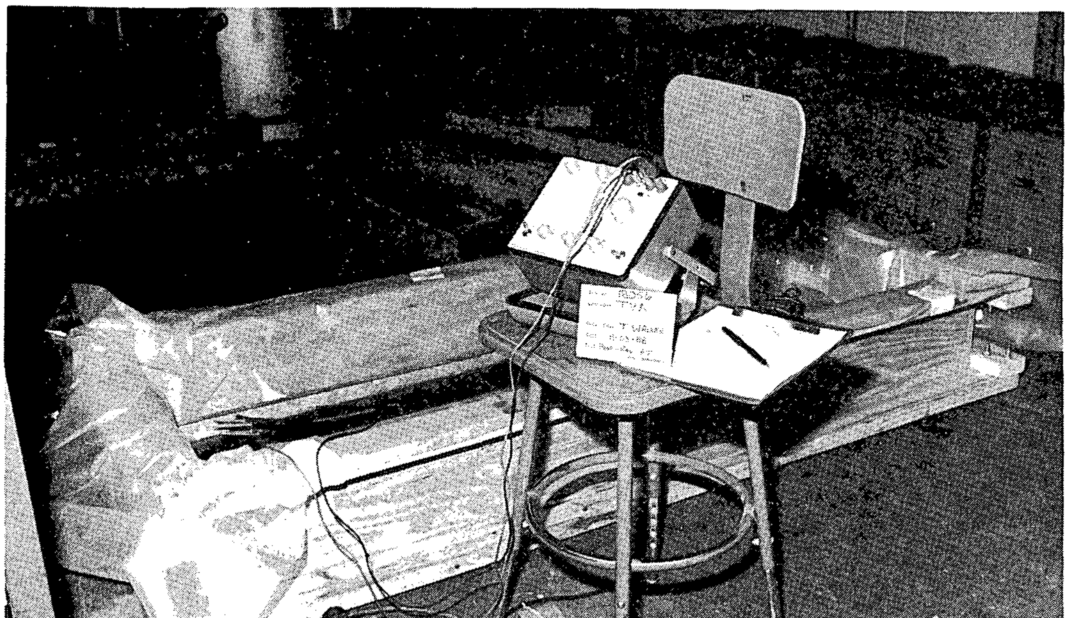
PHOTOGRAPH II-6

**POST-RADIATION VISUAL INSPECTION
CABLE TRAY F PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS**



PHOTOGRAPH II-7

POST-RADIATION FUNCTIONAL TEST
CABLE TRAY E SUBMERGED IN WATER WITH CABLE SPECIMEN
LEAD ENDS ELEVATED OUT OF THE WATER



PHOTOGRAPH II-8

POST-RADIATION FUNCTIONAL TEST
INSULATION RESISTANCE MEASURING INSTRUMENT
USED FOR FUNCTIONAL TESTS

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX III

DATA SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

DATA SHEET

Customer: Tennessee Valley Authority

WYLE LABORATORIES

Specimen: Silicone Rubber Insulated Cables

Part No.: Various | Amb. Temp.: 70°F | Job No.: 18056

Spec.: WLOP 18057-00 | Photo: No | Report No.: 18056-1

Para.: 3.5 | Test Med.: Water | Start Date: 11-03-88

S/N: Listed | Specimen Temp.: Ambient

GSI: N/A

Test Title: POST - RADIATION Functional Test (NORMAL EXPOSURE)

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	5.0 x 10^{11} Ω	RWC-W-A.15	7.8 x 10^{11} Ω
RWC-S-B.40	2.6 x 10^{11} Ω	RWC-W-B.15	8.8 x 10^{11} Ω
RWC-S-C.40	5.0 x 10^{11} Ω	RWC-W-C.15	1.0 x 10^{12} Ω
RWC-S-D.40	5.8 x 10^{11} Ω	RWC-W-D.15	1.2 x 10^{12} Ω
RWC-S-E.40	7.8 x 10^{11} Ω	RWC-W-E.15	9.2 x 10^{11} Ω
RWC-S-A.15	5.0 x 10^{11} Ω	ANA-S-A.40	2.4 x 10^{10} Ω
RWC-S-B.15	2.8 x 10^{11} Ω	ANA-S-B.40	3.0 x 10^{10} Ω
RWC-S-C.15	6.8 x 10^{11} Ω	ANA-S-C.40	2.4 x 10^{10} Ω
RWC-S-D.15	9.6 x 10^{11} Ω	ANA-S-D.40	5.0 x 10^{10} Ω
RWC-S-E.15	8.0 x 10^{11} Ω	ANA-S-E.40	1.2 x 10^{10} Ω
RWC-W-A.40	1.3 x 10^{12} Ω	ANA-S-A.15	3.5 x 10^{10} Ω
RWC-W-B.40	6.0 x 10^{11} Ω	ANA-S-B.15	3.5 x 10^{10} Ω
RWC-W-C.40	1.1 x 10^{12} Ω	ANA-S-C.15	7.2 x 10^{9} Ω
RWC-W-D.40	1.2 x 10^{12} Ω	ANA-S-D.15	1.8 x 10^{10} Ω
RWC-W-E.40	1.4 x 10^{12} Ω	ANA-S-E.15	3.5 x 10^{9} Ω

Tested By: D. Campbell Date: 11/3/88

Witness: N/A Date:

Sheet No. 1 of 1

Approved: Robert [signature] 11-03-88

Notice of Anomaly: NONE

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX IV

INSTRUMENTATION EQUIPMENT SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

INSTRUMENTATION EQUIPMENT SHEET

DATE: 11/02/88
TECHNICIAN: D. COMPTON

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: POST RADIATION FUNCTIONAL

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	MEG MTR	GENERAL RADIO	1864	1864-9700-00	106840	50K-50T OHM	2-5% RANGE	10/03/88	03/31/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 11-2-88

CHECKED & RECEIVED BY Robert [illegible] Watts 11-02-88

Q.A. TR Hamilton 11-2-88

THIS PAGE INTENTIONALLY LEFT BLANK

B43 '89 0303 001 KWB

QA Record

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

February 17, 1989
Ref. No. 18056K-006

Tennessee Valley Authority
J. D. Hutson (Chief Electrical Engr)
400 West Summit Hill Drive
WT11C 126
Knoxville, TN 37902

Attention: Mr. Kent Brown

Subject: Nuclear Qualification of Cables

Reference: Contract TV-73743A, Task 0011-391159

Gentlemen:

Enclosed is Technical Inquiry Response Document No. TR18056-1 regarding radiation exposure reported in Wyle TR 18056-1 dated January 27, 1989. Should you have any further questions, please feel free to give me a call at (205) 837-4411, ext. 554.

Sincerely,

WYLE LABORATORIES
Eastern Operations

Joanne F. Kelly

Joanne F. Kelly
Senior Contracts Administrator

JFK/sec

RIMS, SL26 C-K

TECHNICAL INQUIRY RESPONSE

TO: Tennessee Valley Authority
400 Summitt Hill Drive
Knoxville, TN 37902

DOCUMENT NO. TR18056-1

WYLE JOB NO. 18056

DATE OF INQUIRY January 31, 1989

PAGE 1 of 1 PAGES

DATE February 9, 1989

1.0 ATTENTION Kent Brown

2.0 FROM Fred Sittason

3.0 SUBJECT Wyle TR 18056-1, Radiation Exposure

In response to your request we are submitting additional comments relative to the radiation exposure reported in Wyle TR 18056-1, dated January 27, 1989.

Both radiation laboratories utilized in the 18056 test program, Ga. Tech and Isomedix, include on their data sheets an accuracy value. The accuracy values are a determination of statistical limits of certainty for the methodology employed at their laboratory. These values are calculated, very conservatively, by a linear summation of the statistical limits of the elements of the measurement method employed. There is no implication that radiation dosages should be adjusted to compensate for the defined negative value. Accepted practice is to deliver the dosage required and quote the uncertainty, not to irradiate to excess dose to compensate for the uncertainty.

Wyle has found no evidence, at either radiation laboratory, to indicate that test specimens did not receive the indicated dosages. Calibration results reveal that measurement instruments read significantly more accurately than their statistical limit. We have found no systematic error, trending high or low, in either laboratories' measurement or calibration systems. Conservatisms are applied in calibration techniques, accuracy calculations and exposure methodology.

The test specimens in TR 18056-1 were exposed to the required radiation dosages which were measured as accurately as technologically feasible. Although portions of the test specimens may have been under or over exposed, the average radiation dose received met the test requirements.

Should you have further questions or comments please contact me at (205) 837-4411.

WYLE LABORATORIES
SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

PREPARED BY [signature] 2-9-89 [initials] 2/10/89
Fred Sittason

APPROVED BY [signature] 2/17/89 2-14-89
J. F. Gleason

WYLE Q.A. G. W. Hight 2-14-89
G. W. Hight

WH 1202A, Dec. 1980

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

Reference No. 18056K-008

1 March 1989

Tennessee Valley Authority
J. D. Hutson (Chief Electrical Engineer)
400 West Summit Hill Drive
WT11C 126
Knoxville, TN 37902

Attention: Mr. Kent Brown

Subject: Nuclear Qualification of Cables

Reference: Contract TV-73743A
Task 0011-391159

Enclosed is Technical Inquiry Response Document No. TR18056-1 regarding radiation exposure reported in Wyle TR 18056-1 dated January 27, 1989. Should you have any further questions, please call me at (205) 837-4411, extension 554.

Sincerely,

WYLE LABORATORIES
Eastern Operations

Joanne F. Kelly
Senior Contracts Administrator

JFK/mab

TECHNICAL INQUIRY RESPONSE

TO: Tennessee Valley Authority
400 Summitt Hill Drive
Knoxville, TN 37902

DOCUMENT NO. TRI8056-1

WYLE JOB NO. 18056

DATE OF INQUIRY January 31, 1989

PAGE 1 of 2 PAGES

DATE February 28, 1989

1.0 ATTENTION Kent Brown

2.0 FROM Fred Sittason

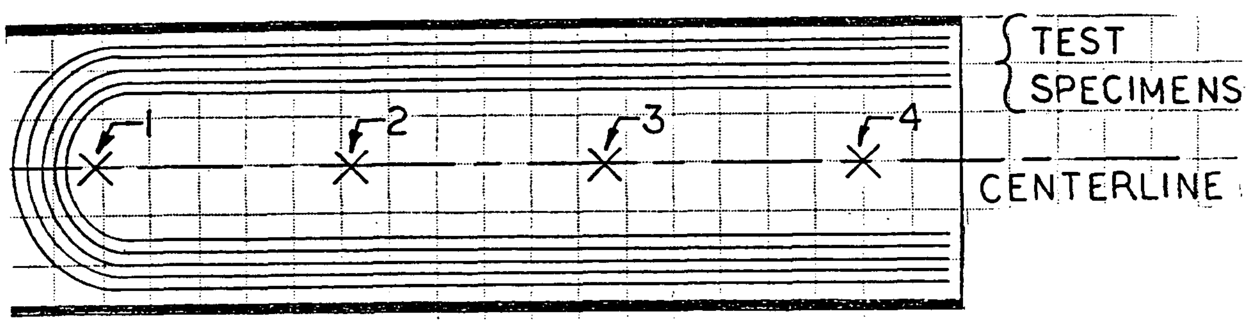
3.0 SUBJECT Wyle TR18056-1, Radiation Exposure

4.0 REFERENCES

In response to your request for additional information relative to Wyle TR 18056-1, dated January 27, and Wyle TIR dated, February 9, 1989, the following is submitted:

As stated in the TIR, the average radiation dose the specimens received met the test requirements, although portions of the specimens may have been under or over exposed.

During the normal radiation exposure, at Ga. Tech., dosimeters were recorded at four locations on each tray as dipicted below:



WYLE LABORATORIES
SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

PREPARED BY Todd Walter 03-01-89

APPROVED BY Fred Sittason 3-1-89

WYLE Q.A. G. W. Hight 3-1-89

WH 1202A, Dec. 1980

Four readings for each exposure period were averaged to calculate the dose rates for each tray. This data is recorded in Section II, Wyle TR 18056-1. The data can be summed to calculate the total dose received at each dosimeter position for Trays A and E.

Cable Tray A

Electrometer Reading (μA) #1	#2	#3	#4	Exposure Time (Hrs)	TID (MRads) #1	#2	#3	#4
1.197	1.218	1.507	1.428	40.56	23.205	23.613	29.229	27.694
.9335	1.121	1.141	.9601	24.88	11.093	13.328	13.567	11.410
1.067	1.264	1.278	1.052	66.71	34.011	40.307	40.755	33.532
1.745	1.737	1.917	2.028	6.0	5.008	4.985	5.502	5.822
				Totals	73.317	82.233	89.053	78.458

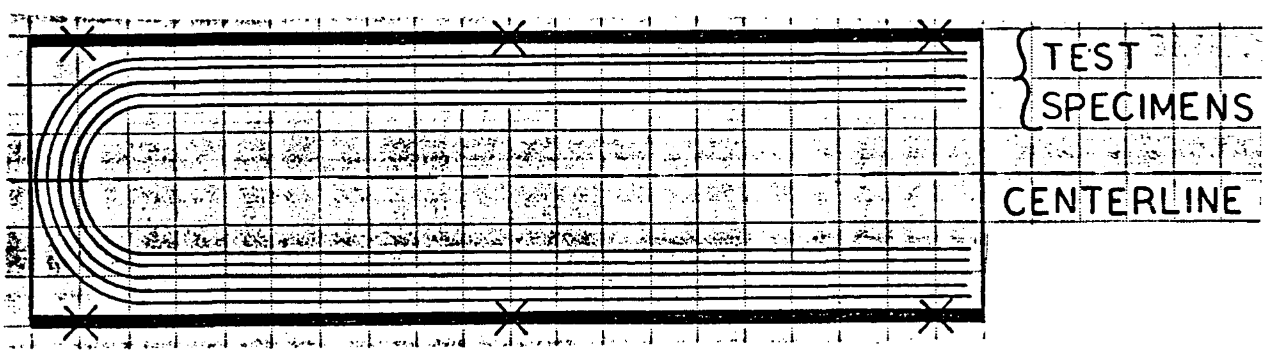
Cable Tray E

Electrometer Reading (μA) #1	#2	#3	#4	Exposure Time (Hrs)	TID (MRads) #1	#2	#3	#4
.4254	.4571	.4652	.4170	40.56	8.221	8.827	8.985	8.048
.1157	.1259	.1288	.1213	24.88	1.345	1.467	1.501	1.412
.1130	.1222	.1169	.1091*	66.71	3.520	3.814	3.645	3.396
.1994	.2173	.2152	.1975	6.0	0.565	0.617	0.610	0.560
.9279	.9990	.9075	.8674	15.01	6.652	7.164	6.506	6.217
				Totals	20.303	21.889	21.247	19.633

Typical Calculation:

* ((0.1091E(-6) X 4.791E11) - 1367) x 66.71 = 3.396E6 Rads

The accident radiation exposure was recorded by Isomedix at six locations along the tray sides as depicted below:



Isomedix reported the minimum position dosage and the maximum position dosage. That data is contained in Section IV, Wyle TR 18056-1.

SECTION III

THERMAL AGING AND POST-THERMAL AGING FUNCTIONAL TEST

1.0 REQUIREMENTS

1.1 Thermal Aging

The test specimens shall be subjected to Thermal Aging as specified in Paragraph 3.6 of Section VII.

1.2 Post- Thermal Aging Functional Test

The test specimens shall be subjected to a Post-Thermal Aging Functional Test upon completion of Thermal Aging. The Functional Test shall be performed as specified in Paragraph 3.7 of Section VII.

2.0 PROCEDURES

2.1 Thermal Aging

The test specimens were subjected to Thermal Aging which involved several aging temperatures and aging times. Cable Trays A, C, and E were initially aged at 112°C (+5, -0 deg C) for 102 hours (+2, -0 hrs). Cable Trays B, D, and F were initially aged at 105°C (+5, -0 deg C) for 101 hours (+2, -0 hrs). Upon completion of the initial aging requirements, Cable Trays A, B, C, and D were removed from the thermal aging chambers to allow additional aging of Cable Trays E and F. Cable Tray E was subjected to additional thermal aging at 120°C (+5, -0 deg C) for 23 hours (+2, -0 hrs). Cable Tray F was subjected to additional thermal aging at 112°C (+5, -0 deg C) for 21 hours (+2, -0 hrs). The test specimens' actual aging times are as listed below:

Cable Tray Designation	Plant/Age Designation	Specimen Manufacturer	Initial Aging Temperature/Time	Additional Aging Temperature/Time
A	Sequoyah 40-year	RWC	112°C/102.5 hrs	---
B	Sequoyah 15-year	RWC	105°C/101.5 hrs	---
C	Watts Bar 40-year	RWC	112°C/102.5 hrs	---
D	Watts Bar 15-year	RWC	105°C/101.5 hrs	---
E	Sequoyah 40-year	ANA	112°C/102.5 hrs	120°C/23.5 hrs
F	Sequoyah 15-year	ANA	105°C/101.5 hrs	112°C/21.5 hrs

Photographs of the test specimens were taken at each phase of the Thermal Aging Program.

2.0 **PROCEDURES (Continued)**

2.2 **Post-Thermal Aging Functional Test**

Upon completion of Thermal Aging, the test specimens were subjected to a Post-Thermal Aging Functional Test. The Functional Test was performed as described in Paragraph 2.3, Section I, of this report.

3.0 **RESULTS**

The test specimens were subjected to the Thermal Aging and Post-Thermal Aging Functional Tests of Paragraph 2.0 and met the requirements of Paragraph 1.0 with exceptions as noted below:

Notice of Anomaly Number 1 documents the over-temperature condition for the test specimens mounted in Cable Trays A, C, and E, during the initial Thermal Aging period. During startup of the Thermal Aging Chamber, a period of approximately 5 minutes existed when the chamber temperature exceeded the maximum specified level. The amount of time that the test specimens were subjected to the over-temperature condition was considered to be insignificant. Performance of the test specimens was not expected to be affected and the program was continued.

Observations recorded during the Post-Thermal Aging Functional Test Visual Inspection are presented in the following paragraphs.

During the Post-Thermal Aging Visual Inspection, prior to functional testing, the test specimens were noted to have maintained a high degree of flexibility. Metal identification tags applied to the test specimens during specimen preparation were intact and legible on all specimens.

Cable Tray A was noted to have TVA identification tags degraded to a point where the tags were not legible. The silicone rubber insulation on Test Specimens A and E lead ends was darker in appearance than the remaining specimens in the tray. Ash coloring on the Asbestos Braided Jacket of Test Specimens A, B, and C was apparent.

Cable Tray B was noted to have TVA identification tags on Cable Specimens C and D degraded significantly. Ash coloring on the Asbestos Braided Jacket of Cable Specimens A, B, C and E was apparent. In general, the test specimens seemed to be more flexible than the corresponding 40-year specimens of Cable Tray A.

Cable Tray C was noted to have TVA identification tags on Test Specimens C and D degraded to a point where the tags were not legible. The silicone rubber insulation on Test Specimens A and E lead ends was darker in appearance than the remaining specimens in the tray. Ash coloring on the Asbestos Braided Jacket of Test Specimens A, B, and C was apparent.

3.0 RESULTS (Continued)

Cable Tray D was noted to have TVA identification tags on Cable Specimens C and D degraded to the point where the tags were not legible. All of the test specimens exhibited ash coloring on the Asbestos Braided Jacket with Test Specimen D being the least apparent. In general the test specimens seemed to be more flexible than the corresponding 40-year specimens of Cable Tray C.

Cable Tray E was noted to have ash coloring on the Asbestos Braided Jacket of Test Specimens B and D. All of the test specimens seemed to have become stiff during Thermal Aging.

Cable Tray F was noted to have ash coloring on the Asbestos Braided Jacket of Test Specimen B. The test specimens seemed to be no more flexible than the corresponding 40-year specimens of Cable Tray E.

Photographs and data recorded during this phase of the test program are presented in Appendices I through V of this Section as noted below:

- Appendix I contains Notice of Anomaly Number 1.
- Appendix II contains Photographs III-1 through III-10 which show the cable trays, with specimens attached, upon completion of Thermal Aging. The photographs also show the cable trays during the Post-Thermal Aging Functional Test Visual Inspection.
- Appendix III contains typical temperature circular charts of the Thermal Aging Chambers.
- Appendix IV contains the Data Sheet generated during the Post-Thermal Aging Functional Test.
- Appendix V contains Instrumentation Equipment Sheets generated for the Thermal Aging Chambers and the Post-Thermal Aging Functional Tests.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX I

NOTICE OF ANOMALY

THIS PAGE INTENTIONALLY LEFT BLANK

WYLE LABORATORIES
(Eastern Operations)

NOTICE OF ANOMALY

DATE: November 10, 1988

NOTICE NO: 1 P.O. NUMBER: N/A CONTRACT NO: TV-73743A

CUSTOMER: Tennessee Valley Authority WYLE JOB NO: 18056

NOTIFICATION MADE TO: Don Arp NOTIFICATION DATE: 11/09/88

NOTIFICATION MADE BY: T. Walter VIA: In person

CATEGORY: ☐ SPECIMEN ☒ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: 11/03/88

PART NAME: Silicone Rubber Insulated Cables PART NO. Various

TEST: Thermal Aging - 40-Year Specimens I.D. NO. Various

SPECIFICATION: WLQP 18057-00 PARA. NO. 3.6

REQUIREMENTS:

The designated 40-year specimens of RWC - Sequoyah, RWC - Watts Bar, and ANA - Sequoyah shall be subjected to thermal aging at a temperature of 112°C (+5, -0) deg C for 102 hours (+2, -0) hours. The designated 40-year specimens of ANA - Sequoyah shall then be subjected to thermal aging at a temperature of 120°C (+5, -0) deg C for 23 hours (+2, -0) hours.

DESCRIPTION OF ANOMALY:

During the thermal aging chamber temperature startup, the chamber temperature was inadvertently allowed to increase in excess of the temperature tolerance acceptance criteria. The out-of-specification temperature was determined to have been approximately 5.6 deg C above the required temperature of 112°C, for a period of less than 5 minutes.

DISPOSITION · COMMENTS · RECOMMENDATIONS:

The short period of specimen exposure to the out-of-specification temperature was considered to have no effect upon the qualification program for the silicone rubber insulated cables. The customer was notified of the anomalous condition and agreed that documentation of the condition was necessary.

Testing was continued with the customer's concurrence.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

PROJECT ENGINEER: [signature] 11-10-88

TEST WITNESS: N/A

PROJECT MANAGER: [signature] 11/14/88

REPRESENTING: N/A

INTERDEPARTMENTAL COORDINATION: [signature] 11-14

QUALITY ASSURANCE: [signature] 11-15-88

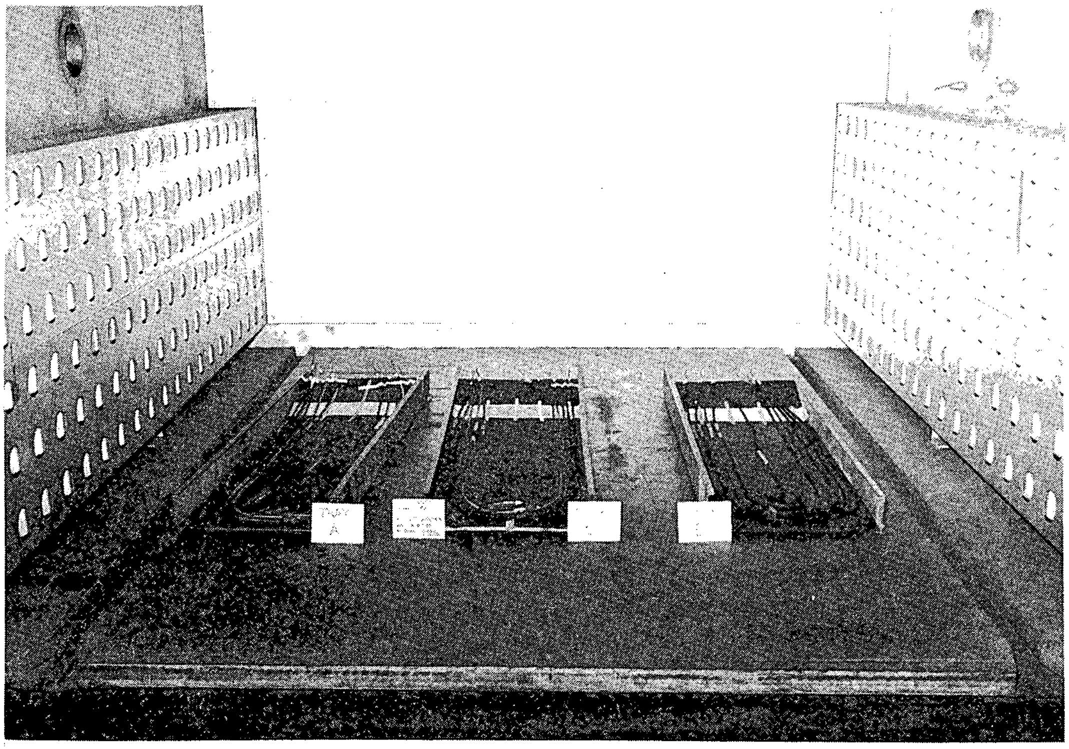
Wyle Form WH 1066, Rev. JAN '85

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX II

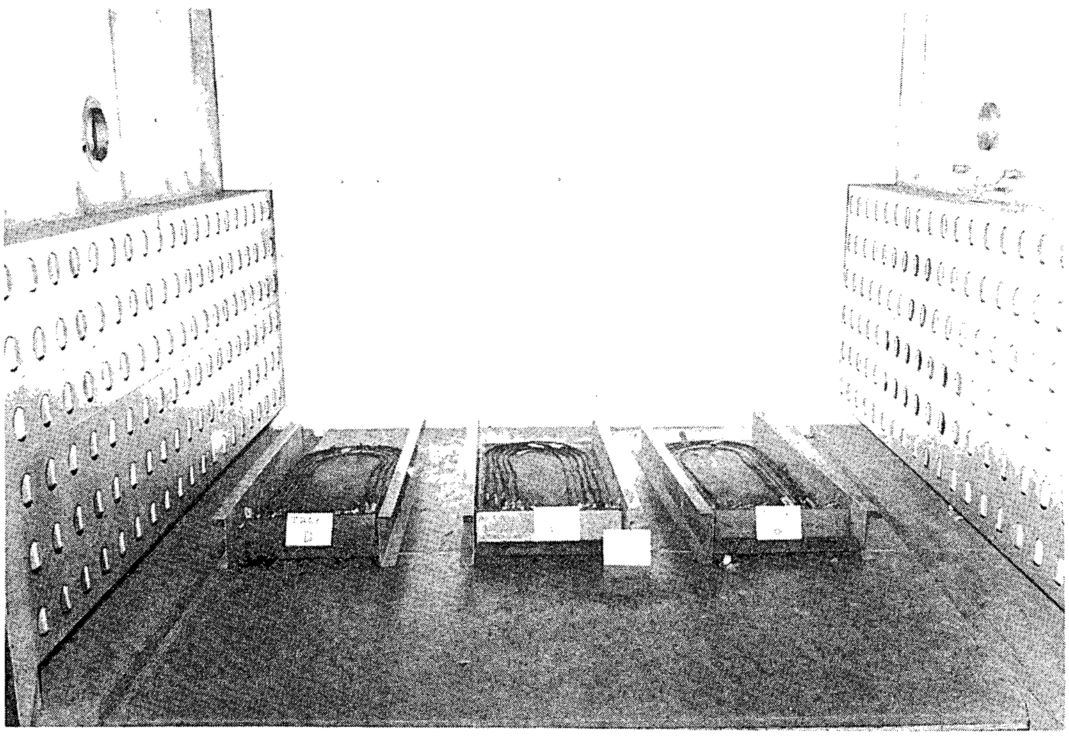
PHOTOGRAPHS

THIS PAGE INTENTIONALLY LEFT BLANK



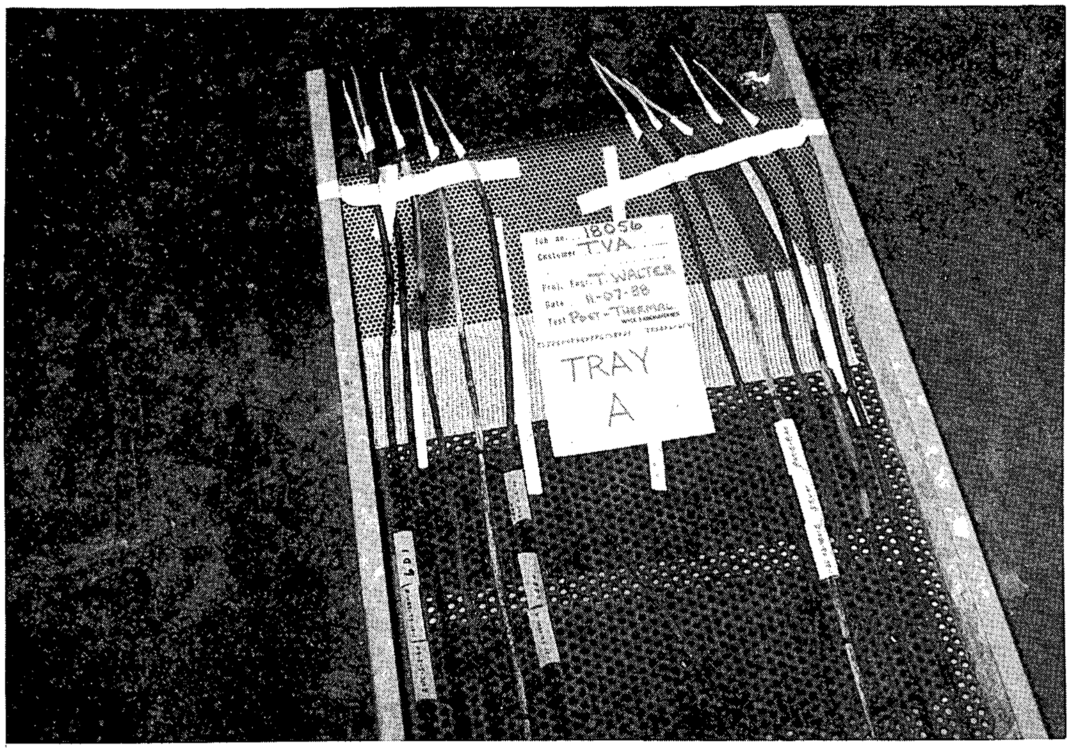
PHOTOGRAPH III-1

POST-THERMAL AGING
CABLE TRAYS A, C, AND E UPON COMPLETION OF
THERMAL AGING AT 112°C



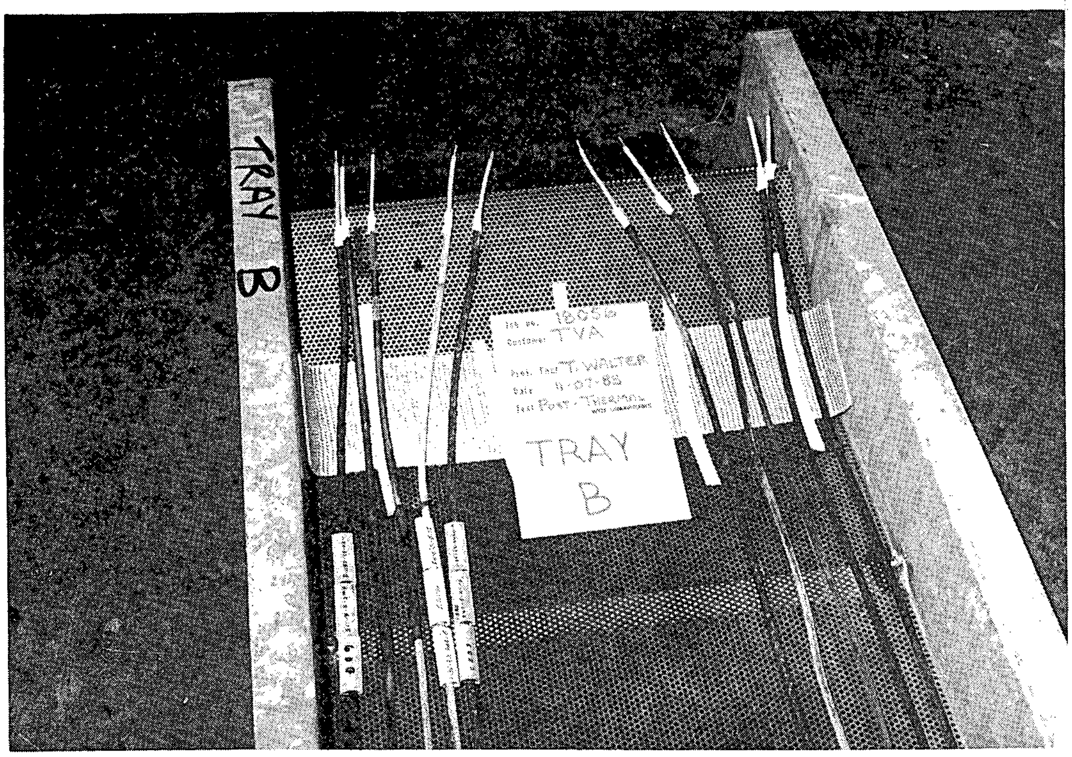
PHOTOGRAPH III-2

POST-THERMAL AGING
CABLE TRAYS B, D, AND F UPON COMPLETION OF
THERMAL AGING AT 105°C



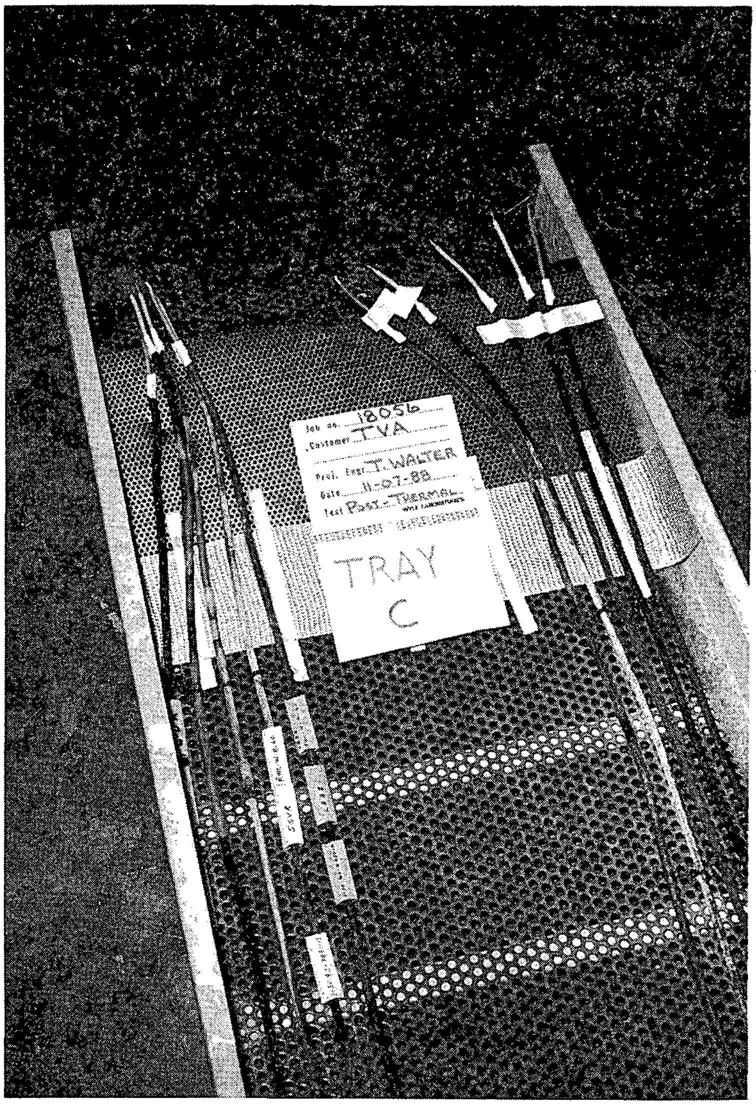
PHOTOGRAPH III-3

POST-THERMAL AGING VISUAL INSPECTION
CABLE TRAY A UPON COMPLETION OF THERMAL AGING AT 112°C



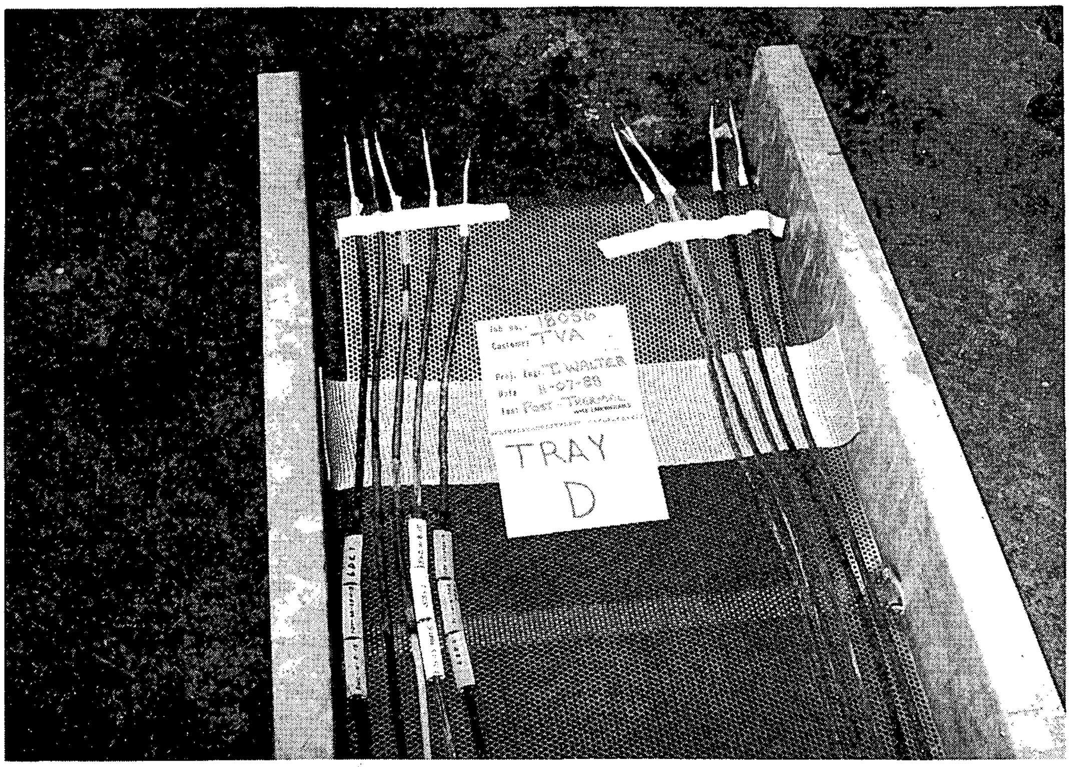
PHOTOGRAPH III-4

POST-THERMAL AGING VISUAL INSPECTION
CABLE TRAY B UPON COMPLETION OF THERMAL AGING AT 105°C



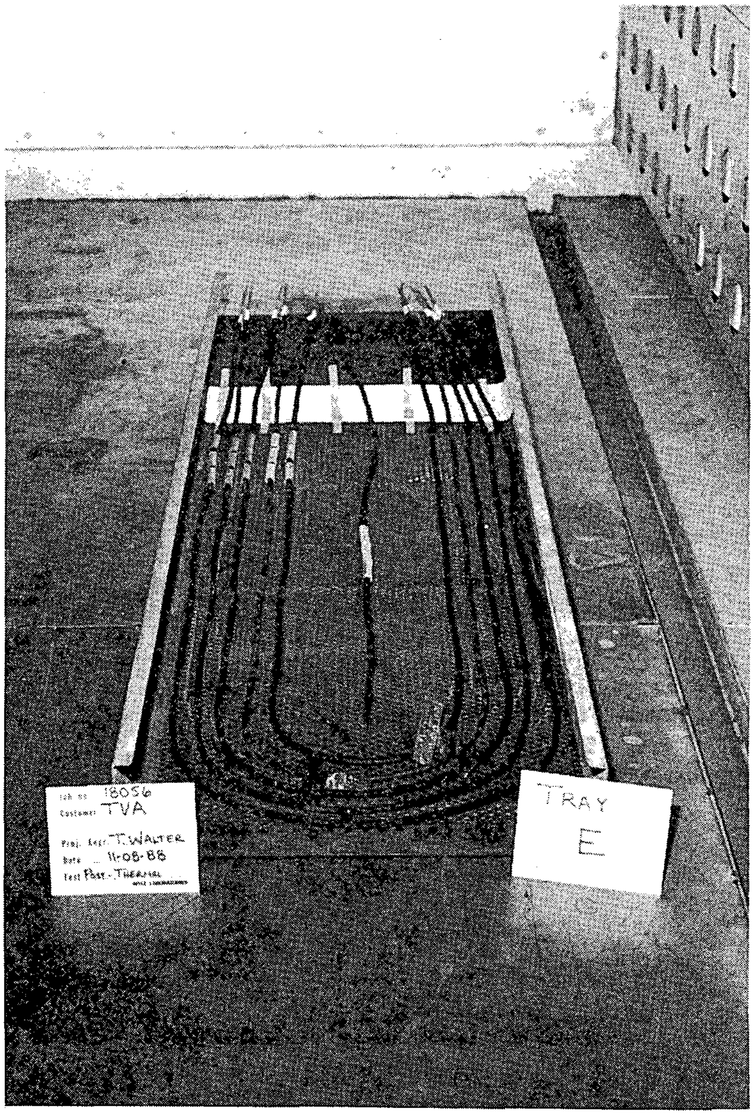
PHOTOGRAPH III-5

POST-THERMAL AGING VISUAL INSPECTION
CABLE TRAY C UPON COMPLETION OF THERMAL AGING AT 112°C



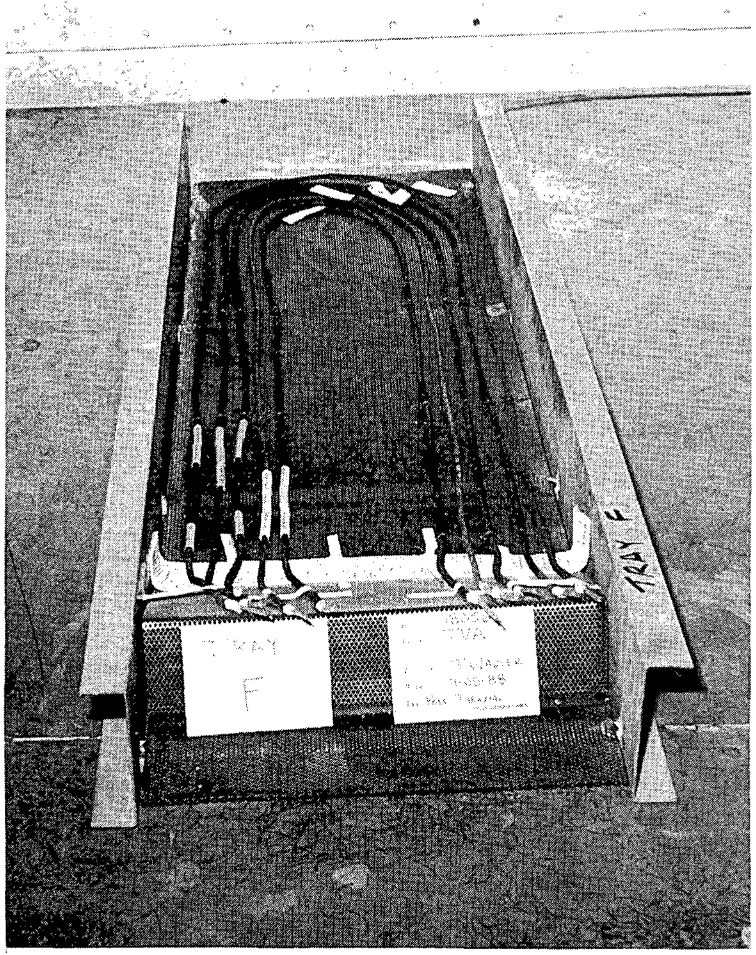
PHOTOGRAPH III-6

POST-THERMAL AGING VISUAL INSPECTION
CABLE TRAY D UPON COMPLETION OF THERMAL AGING AT 105°C



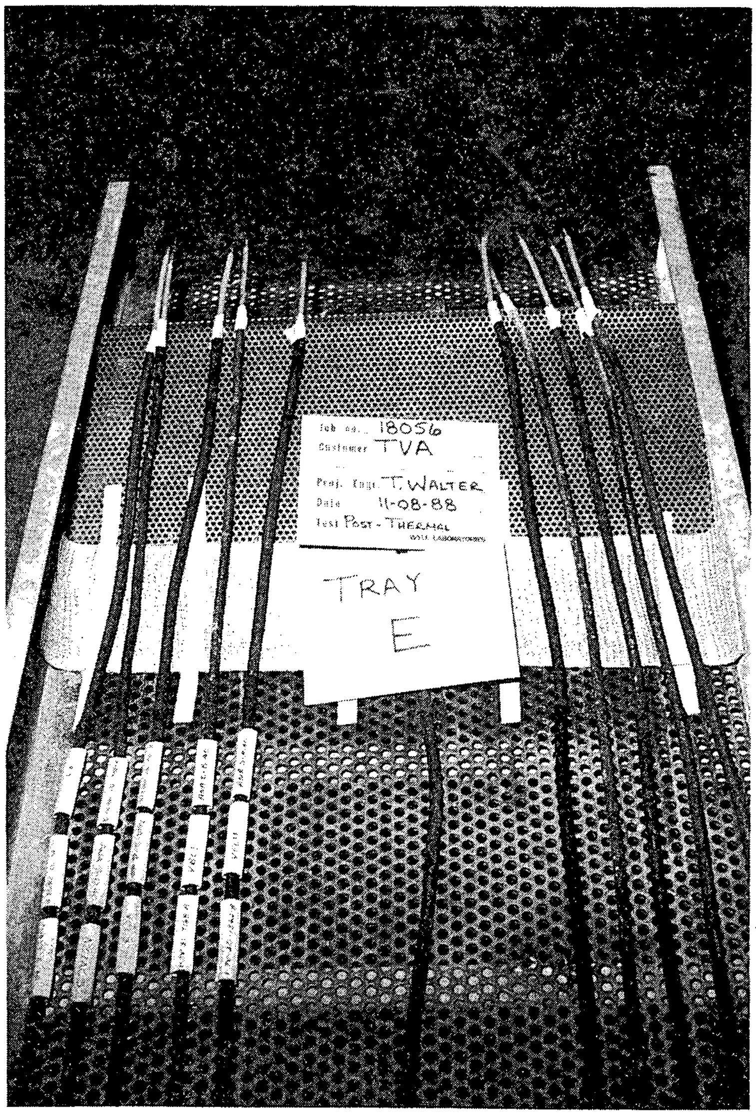
PHOTOGRAPH III-7

POST-THERMAL AGING
CABLE TRAY E UPON COMPLETION OF
ADDITIONAL THERMAL AGING AT 120°C



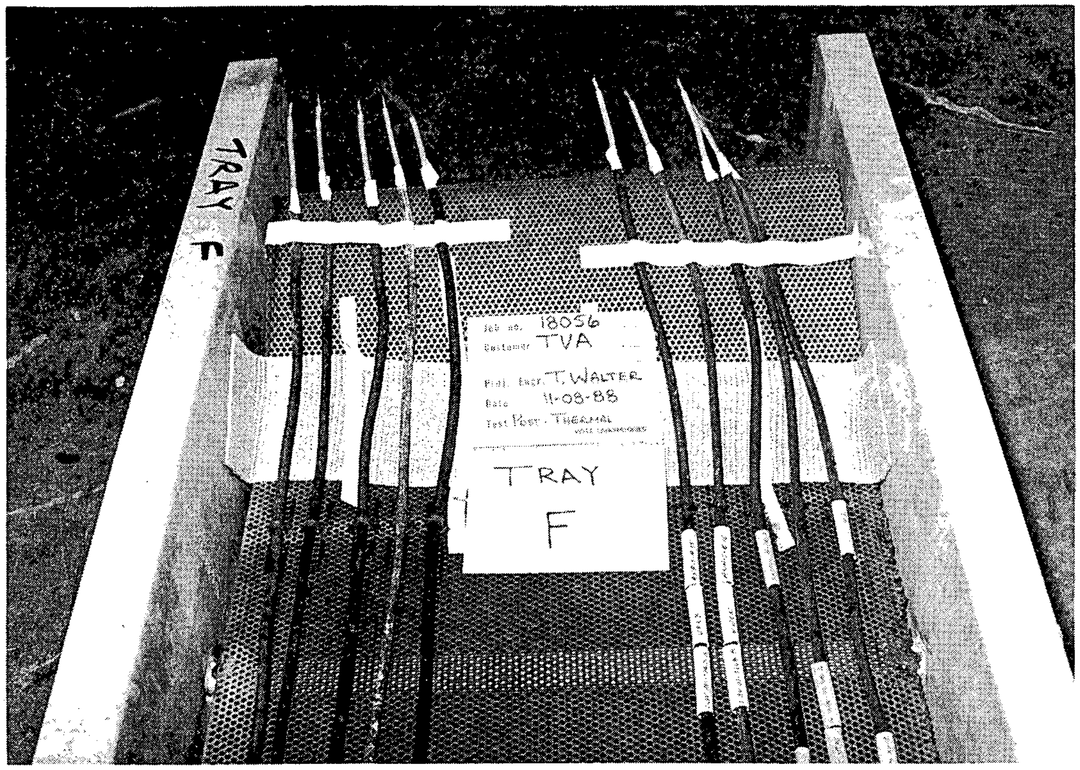
PHOTOGRAPH III-8

**POST-THERMAL AGING
CABLE TRAY F UPON COMPLETION OF
ADDITIONAL THERMAL AGING AT 112°C**



PHOTOGRAPH III-9

POST-THERMAL AGING VISUAL INSPECTION CABLE TRAY E UPON COMPLETION OF ADDITIONAL THERMAL AGING AT 120°C



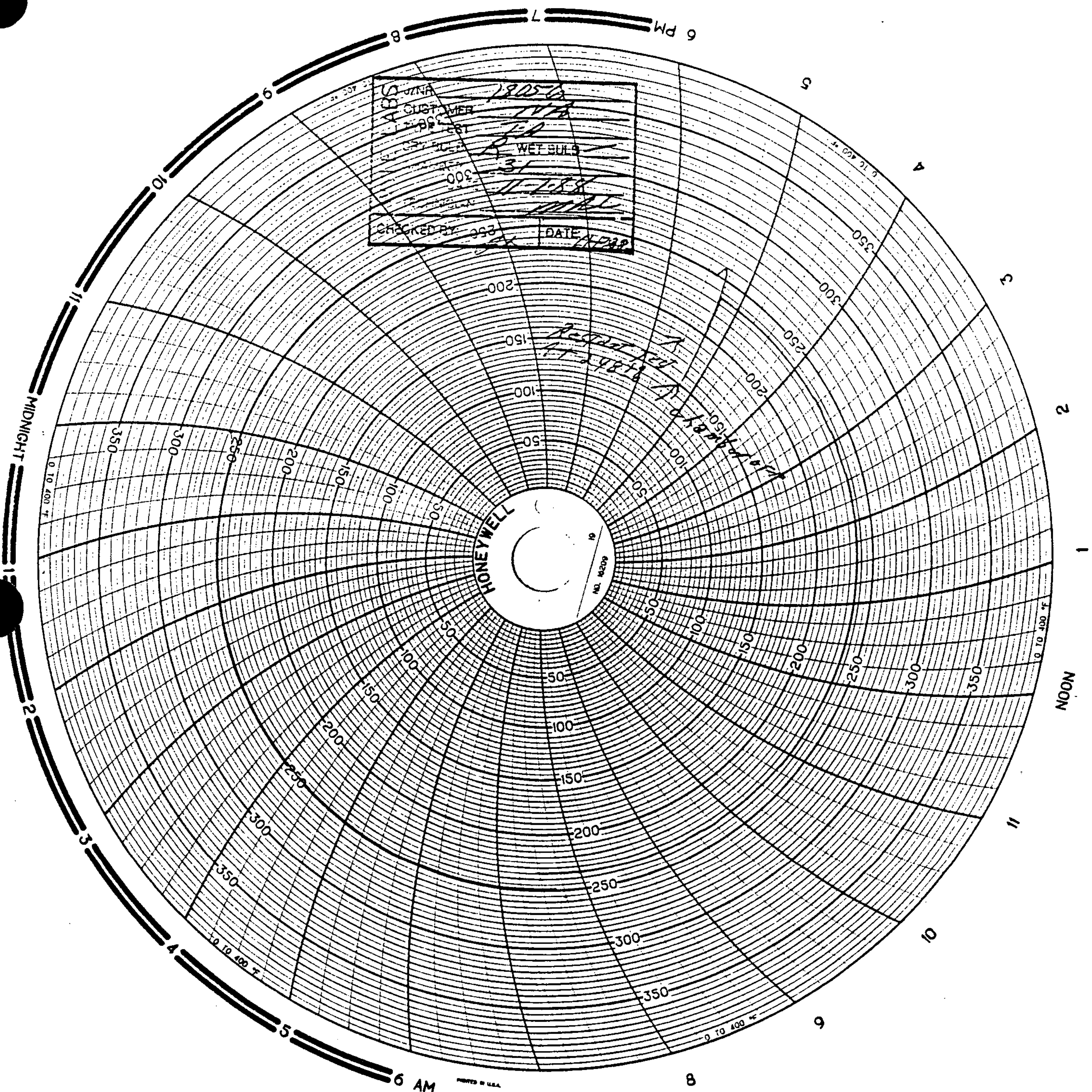
PHOTOGRAPH III-10

**POST-THERMAL AGING VISUAL INSPECTION
CABLE TRAY F UPON COMPLETION OF
ADDITIONAL THERMAL AGING AT 112°C**

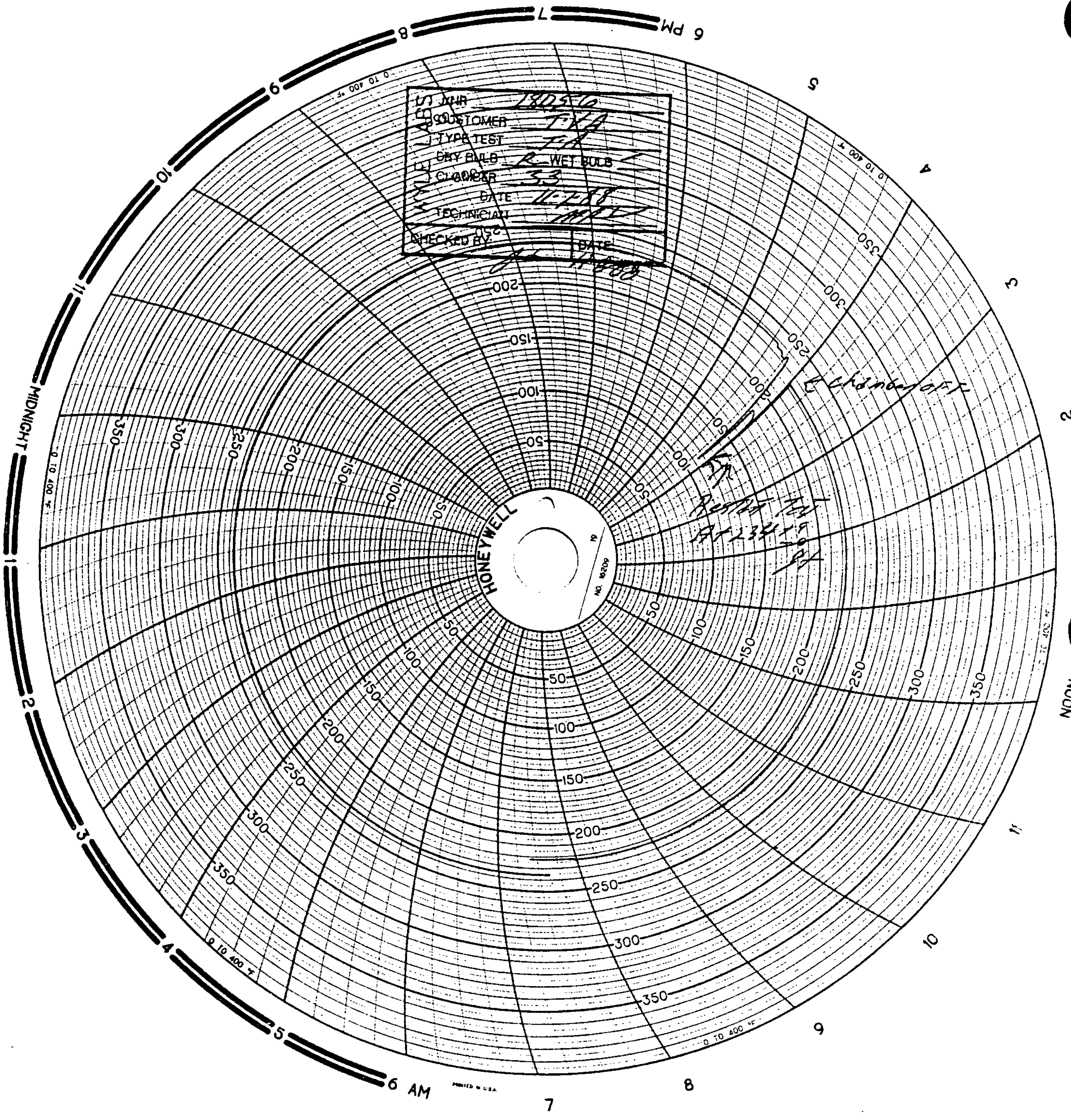
APPENDIX III

CIRCULAR TEMPERATURE CHARTS

THIS PAGE INTENTIONALLY LEFT BLANK



TYPICAL TEMPERATURE CIRCULAR CHART INDICATING COMPLETION OF THERMAL AGING AT 112°C AND BEGINNING OF THERMAL AGING AT 120°C



TYPICAL TEMPERATURE CIRCULAR CHART INDICATING COMPLETION OF THERMAL AGING AT 105°C AND BEGINNING OF THERMAL AGING AT 112°C

APPENDIX IV

DATA SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLOP 18057-00
Para.: 3.7
S/N: Listed
GSI: N/A

Amb. Temp.: 72°F
Photo: No
Test Med.: Water
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 11-09-88

Test Title: POST-THERMAL AGING Functional Test

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	$4.0 \times 10^{11}\ \Omega$	RWC-W-A.15	$4.0 \times 10^{11}\ \Omega$
RWC-S-B.40	$5.4 \times 10^{11}\ \Omega$	RWC-W-B.15	$3.5 \times 10^{11}\ \Omega$
RWC-S-C.40	$4.5 \times 10^{11}\ \Omega$	RWC-W-C.15	$3.5 \times 10^{11}\ \Omega$
RWC-S-D.40	$3.5 \times 10^{11}\ \Omega$	RWC-W-D.15	$3.5 \times 10^{11}\ \Omega$
RWC-S-E.40	$5.0 \times 10^{11}\ \Omega$	RWC-W-E.15	$4.5 \times 10^{11}\ \Omega$
RWC-S-A.15	$4.5 \times 10^{11}\ \Omega$	ANA-S-A.40	$5.0 \times 10^{10}\ \Omega$
RWC-S-B.15	$6.8 \times 10^{11}\ \Omega$	ANA-S-B.40	$4.5 \times 10^{10}\ \Omega$
RWC-S-C.15	$4.5 \times 10^{11}\ \Omega$	ANA-S-C.40	$4.5 \times 10^{10}\ \Omega$
RWC-S-D.15	$7.2 \times 10^{11}\ \Omega$	ANA-S-D.40	$7.4 \times 10^{10}\ \Omega$
RWC-S-E.15	$2.4 \times 10^{11}\ \Omega$	ANA-S-E.40	$2.0 \times 10^{10}\ \Omega$
RWC-W-A.40	$4.5 \times 10^{11}\ \Omega$	ANA-S-A.15	$7.0 \times 10^{10}\ \Omega$
RWC-W-B.40	$4.0 \times 10^{11}\ \Omega$	ANA-S-B.15	$6.8 \times 10^{10}\ \Omega$
RWC-W-C.40	$3.5 \times 10^{11}\ \Omega$	ANA-S-C.15	$3.2 \times 10^{10}\ \Omega$
RWC-W-D.40	$2.8 \times 10^{11}\ \Omega$	ANA-S-D.15	$4.5 \times 10^{10}\ \Omega$
RWC-W-E.40	$3.0 \times 10^{11}\ \Omega$	ANA-S-E.15	$8.2 \times 10^{9}\ \Omega$

Tested By: D. Compton Date: 11/9/88
Witness: N/A Date:
Sheet No. 1 of 1
Approved: Robert [signature] 11-09-88

Notice of Anomaly: NONE

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX V

INSTRUMENTATION EQUIPMENT SHEETS

THIS PAGE INTENTIONALLY LEFT BLANK

INSTRUMENTATION EQUIPMENT SHEET

Page No. III-29

Test Report No. 18056-1

DATE: 11/01/88
TECHNICIAN: M. LUTTRELL

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: 33 & 31
TYPE TEST: T-A

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CONTR TEMP	RESEARCH	61011	316940192	011854	-125+375*F T	.5%	06/29/88	12/26/88
2	TEMP ALARM	RESEARCH	639LLP	31291	011801	-125+375*F T	.5%	07/28/88	01/24/89
3	CONTR TEMP	RESEARCH	61011	316940188	011850	-175+375*F T	.5%	08/01/88	01/27/89
4	TEMP ALARM	RESEARCH	639LLP	30661-13	011286	-125+375*F T	.5%	07/28/88	01/24/89
5	RECORD TEMP	HONEYWELL	45	8338381293002	101137	0+400*F T	.5%	10/27/88	01/25/89
6	RECORD TEMP	HONEYWELL	45	8051310384014	094508	0+400*F T	.5%	11/01/88	01/30/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION D E Perry 11/1/88

CHECKED & RECEIVED BY Robert [illegible] 11-02-88

Q.A. TR Hamilton 11-2-88

INSTRUMENTATION EQUIPMENT SHEET

DATE: 11/08/88
TECHNICIAN: D. COMPTON

JOB NUMBER: 18056-00
CUSTOMER: T.V.A.

TEST AREA: LOCA
TYPE TEST: POST T/A FUNCTIONAL

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	MEG MTR	GENERAL RADIO	1864	1864-9700-00	106840	50K-50T OHM	2-5% RANGE	10/03/88	03/31/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R. E. Archer 11-8-88

CHECKED & RECEIVED BY [signature] 11-08-88

Q.A. [signature] Hamilton 11-8-88

SECTION IV

ACCIDENT RADIATION EXPOSURE AND POST-RADIATION FUNCTIONAL TEST

1.0 REQUIREMENTS

1.1 Accident Radiation Exposure

The test specimens shall be subjected to the Accident Radiation Exposure as specified in Paragraph 3.8 of Section VII.

1.2 Post-Radiation Functional Test

The test specimens shall be subjected to a Functional Test upon completion of Accident Radiation Exposure. The Functional Test shall be performed as specified in Paragraph 3.9 of Section VII.

2.0 PROCEDURES

2.1 Accident Radiation Exposure

The test specimens were subjected to the Accident Irradiation at Isomedix, Inc. Radiation Facility (New Jersey). The test specimens were subjected to a Total Integrated Dose (TID) which was specified for the particular test specimen plant designation. The TID to each of the test specimen cable trays was as described below:

Cable Tray Designation	Plant/Age Designation	Specimen Manufacturer	Cumulative TID (minimum)
A	Sequoyah 40-year	RWC	7.2E7 rads
B	Sequoyah 15-year	RWC	7.28E7 rads
C	Watts Bar 40-year	RWC	1.782E8 rads
D	Watts Bar 15-year	RWC	1.778E8 rads
E	Sequoyah 40-year	ANA	7.22E7 rads
F	Sequoyah 15-year	ANA	7.22E7 rads

Upon completion of irradiation, the test specimens were returned to Wyle Laboratories' Test Facility for completion of testing.

2.0 PROCEDURES (Continued)

2.2 Post-Radiation Functional Test

Upon completion of irradiation, the test specimens were subjected to a Post-Radiation Functional Test. The Functional Test was performed as described in Paragraph 2.3, Section I, of this report.

3.0 RESULTS

The test specimens were subjected to the Accident Radiation Exposure and Post-Radiation Functional Test of Paragraph 2.0 and met the requirements of Paragraph 1.0. Photographs of the test specimens mounted in the cable trays were taken upon receipt at Wyle Laboratories. Observations recorded during the Post-Radiation Functional Test Visual Inspection are presented in the following paragraphs.

During the visual inspection, it was noted that the test specimens appeared to be in good condition and showed no evidence of damage or severe degradation. All of the test specimens were noted to be extremely brittle as mounted in the cable trays. Special care was required during any situation involving handling of the test specimens. The Tefzel cable ties were intact and were maintaining the position of the test specimens and the small cable lengths on the cable trays. Visual inspections for each individual cable tray are presented below.

Cable Tray A was noted to have silicone insulation on the lead ends of Test Specimens A and E that was much darker in apperance than the remaining test specimens on the tray. All of the test specimen lead ends were noted to be darker than when inspected during the Post-Normal Radiation Visual Inspection. The lead end of Test Specimen A had a crack in the silicone insulation approximately one inch from the specimen end. The crack was the result of flexing the lead end during the visual inspection. Test Specimens A, B, C, and E were noted to have ash coloring on the Asbestos Braided Jacket material.

Cable Tray B was noted to have ash coloring on the jacket material of Test Specimens A, B, C, and E. One lead end of Test Specimens D and E was damaged such that the silicone rubber was torn away and the individual conductors were exposed. This damage occurred approximately one inch from the specimen end and was considered to have occurred due to handling. The appearance of the silicone insulation of the lead ends of Test Specimens A and E and the remaining specimens on the tray was as noted in the preceding paragraph.

Cable Tray C was noted to have darkened silicone on the lead ends of Test Specimens A and E. The remaining specimens on the tray were as noted previously for Cable Tray A. Test Specimens A B, and C were noted to have ash coloring on the jacket material. Ash coloring on the jacket material of Specimen D was minimal.

3.0 **RESULTS (Continued)**

Cable Tray D was noted to have darkened silicone insulation on the lead ends of Test Specimens A and E. The remaining specimens on the cable tray were as described previously for Cable Tray A. Test Specimens A, B, C, and E were noted to have ash coloring on the jacket material.

Cable Tray E was noted to have ash coloring most prevalent on the jacket material of Test Specimen B. Small areas of ash coloring were evident on the jacket material of Test Specimens B, C, D, and E. The silicone insulation at the lead ends of each test specimen was noted to have changed to a light green color.

Cable Tray F was noted to have test specimen lead ends that were light green as described in the previous paragraph. Test Specimen B had the most prevalent ash coloring on the jacket material of Test Specimens B, C, D, and E. Test Specimen A was noted to be very black in color with no indications of ash coloring on the jacket material.

Upon completion of the Post-Radiation Functional Test, the RWC and ANA 15-year specimens mounted in Cable Trays B, D, and F, were stored in shipping boxes and secured against damage. Test Specimen E of Cable Tray F exhibited an erratic resistance reading when subjected to the Post-Radiation Functional Test. It was not possible to determine the point/area of degradation on Test Specimen E.

The data recorded during this phase of the test program is presented in Appendices I through IV of this Section as noted below:

- Appendix I contains Letters of Certification indicating dose rates, exposure time and cumulative total dose on the test specimens.
- Appendix II contains Photographs IV-1 through IV-12 which show the test specimens during the Post-Radiation Visual Inspection.
- Appendix III contains the Data Sheet generated during the Post-Radiation Functional Tests.
- Appendix IV contains the Instrumentation Equipment Sheet generated for the Post-Radiation Functional Tests.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX I

LETTERS OF CERTIFICATION FOR THE IRRADIATION EXPOSURE

THIS PAGE INTENTIONALLY LEFT BLANK

COMPONENT IRRADIATION CERTIFICATION
Page No. IV-7
Test Report No. 18056-1

CUSTOMER: WYLE LABS   P.O. NO. 4-5942-P

AIR EQUIV. REQUIRED DOSE (MRADS) 71.5

RATE NOT TO EXCEED (MRADS/HR) < 1.0

SPECIMENS:

QTY	PART NO.	SERIAL NO.	DESCRIPTION
1		A	Cables Trays

DATA:

SOURCE TYPE: COBALT-60 / GAMMA

TOTAL DELIVERED DOSE (AIR): MIN. 72.0 MRADS MAX. 78.0 MRADS

DOSE RATE (AIR): MIN. .48 MRADS/HR MAX. .52 MRADS/HR

TOTAL EXPOSURE HOURS: 150

SPECIMEN ROTATION: TWO WAY N/A FOUR WAY N/A NONE X

DATE IN: 11/11/88 DATE OUT: 11/19/88

DOSIMETRY:

DOSIMETER TYPE: Harwell 4034 BATCH AR TOLERANCE ±8%

CALIBRATION DATE: 3/9/88

READOUT INSTRUMENT: B&L Spectronic 1001

SERIAL NO. 0715493N CALIBRATION DATE 9/29/88

COMMENTS: None

ATTACHMENTS: WORKSHEETS N/A DRAWINGS N/A NOTICE OF ANOMOLY N/A

AUTHORIZED SIGNATURE: Albert L De Carlo

TITLE: General Manager DATE 11/28/88

ISOMEDIX (NEW JERSEY), INC.
9 APOLLO DRIVE, WHIPPANY, NEW JERSEY 07981 • (201) 887-2754

COMPONENT IRRADIATION CERTIFICATION

Test Report No. 18056-1

CUSTOMER: WYLE LABS   P.O. NO. 4-5942-P

AIR EQUIV. REQUIRED DOSE (MRADS) 71.5

RATE NOT TO EXCEED (MRADS/HR) ≤ 1.0

SPECIMENS:

QTY	PART NO.	SERIAL NO.	DESCRIPTION
1		B	Cable Trays

DATA:

SOURCE TYPE: COBALT-60 / GAMMA

TOTAL DELIVERED DOSE (AIR): MIN. 72.8 MRADS MAX. 77.6 MRADS

DOSE RATE (AIR): MIN. .46 MRADS/HR MAX. .49 MRADS/HR

TOTAL EXPOSURE HOURS: 158.3

SPECIMEN ROTATION: TWO WAY N/A FOUR WAY N/A NONE x

DATE IN: 11/11/88 DATE OUT: 11/20/88

DOSIMETRY:

DOSIMETER TYPE: Harwell 4034 BATCH AR TOLERANCE ± 8%

CALIBRATION DATE: 3/9/88

READOUT INSTRUMENT: B&L Spectronic 1001

SERIAL NO. 0715493N CALIBRATION DATE 9/29/88

COMMENTS: None

ATTACHMENTS: WORKSHEETS N/A DRAWINGS N/A NOTICE OF ANOMOLY N/A

AUTHORIZED SIGNATURE: Albert L De Carlo

TITLE: General Manager DATE 11/28/88

ISOMEDIX (NEW JERSEY), INC.
9 APOLLO DRIVE, WHIPPANY, NEW JERSEY 07981 • (201) 887-2754

CUSTOMER: WYLE LABS **P.O. NO.** 4-5942-P

AIR EQUIV. REQUIRED DOSE (MRADS) 176.0

RATE NOT TO EXCEED (MRADS/HR) < 1.0

SPECIMENS:

QTY	PART NO.	SERIAL NO.	DESCRIPTION
1		C	Cable Trays

DATA:

SOURCE TYPE: COBALT-60 / GAMMA

TOTAL DELIVERED DOSE (AIR): MIN. 178.2 MRADS MAX. 190.9 MRADS

DOSE RATE (AIR): MIN. .84 MRADS/HR MAX. .90 MRADS/HR

TOTAL EXPOSURE HOURS: 212.1

SPECIMEN ROTATION: TWO WAY N/A FOUR WAY N/A NONE X

DATE IN: 11/11/88 DATE OUT: 11/23/88

DOSIMETRY:

DOSIMETER TYPE: Harwell 4034 BATCH AR TOLERANCE ±8%

CALIBRATION DATE: 3/9/88

READOUT INSTRUMENT: B&L Spectronic 1001

SERIAL NO. 0715493N CALIBRATION DATE 9/29/88

COMMENTS: None

ATTACHMENTS: WORKSHEETS N/A DRAWINGS N/A NOTICE OF ANOMOLY N/A

AUTHORIZED SIGNATURE: Albert L De Carlo

TITLE: General Manager DATE 11/28/88

ISOMEDIX (NEW JERSEY), INC.
9 APOLLO DRIVE, WHIPPANY, NEW JERSEY 07981 • (201) 887-2754

COMPONENT IRRADIATION CERTIFICATION
Page No. IV-10
Test Report No. 18056-1

CUSTOMER: WYLE LABS P.O. NO. 4-5942-P

AIR EQUIV. REQUIRED DOSE (MRADS) 176.0

RATE NOT TO EXCEED (MRADS/HR) < 1.0

SPECIMENS:

QTY	PART NO.	SERIAL NO.	DESCRIPTION
1		D	Cable Trays

DATA:

SOURCE TYPE: COBALT-60 / GAMMA

TOTAL DELIVERED DOSE (AIR): MIN. 177.8 MRADS MAX. 195.8 MRADS

DOSE RATE (AIR): MIN. .79 MRADS/HR MAX. .87 MRADS/HR

TOTAL EXPOSURE HOURS: 225.0

SPECIMEN ROTATION: TWO WAY N/A FOUR WAY N/A NONE X

DATE IN: 11/11/88 DATE OUT: 11/24/88 -

DOSIMETRY:

DOSIMETER TYPE: Harwell 4034 BATCH AR TOLERANCE ±8%

CALIBRATION DATE: 3/9/88

READOUT INSTRUMENT: B&L Spectronic 1001

SERIAL NO. 0715493N CALIBRATION DATE 9/29/88

COMMENTS: None

ATTACHMENTS: WORKSHEETS N/A DRAWINGS N/A NOTICE OF ANOMOLY N/A

AUTHORIZED SIGNATURE: Albert L De Carlo

TITLE: General Manager DATE 11/28/88

ISOMEDIX (NEW JERSEY), INC.
9 APOLLO DRIVE, WHIPPANY, NEW JERSEY 07981 • (201) 887-2754

COMPONENT IRRADIATION CERTIFICATION

Page No. IV-11

Test Report No. 18056-1

CUSTOMER: WYLE LABS P.O. NO. 4-5942-P

AIR EQUIV. REQUIRED DOSE (MRADS) 71.5

RATE NOT TO EXCEED (MRADS/HR) < 1.0

SPECIMENS:

QTY	PART NO.	SERIAL NO.	DESCRIPTION
1		E	Cable Trays

DATA:

SOURCE TYPE: COBALT-60 / GAMMA

TOTAL DELIVERED DOSE (AIR): MIN. 72.2 MRADS MAX. 79.8 MRADS

DOSE RATE (AIR): MIN. .38 MRADS/HR MAX. .42 MRADS/HR

TOTAL EXPOSURE HOURS: 190

SPECIMEN ROTATION: TWO WAY N/A FOUR WAY N/A NONE X

DATE IN: 11/11/88 DATE OUT: 11/22/88

DOSIMETRY:

DOSIMETER TYPE: Harwell 4034 BATCH AR TOLERANCE ±8%

CALIBRATION DATE: 3/9/88

READOUT INSTRUMENT: B&L Spectronic 1001

SERIAL NO. 0715493N CALIBRATION DATE 9/29/88

COMMENTS: None

ATTACHMENTS: WORKSHEETS N/A DRAWINGS N/A NOTICE OF ANOMOLY N/A

AUTHORIZED SIGNATURE: Albert L De Carlo

TITLE: General Manager DATE 11/28/88

ISOMEDIX (NEW JERSEY), INC.

9 APOLLO DRIVE, WHIPPANY, NEW JERSEY 07981 • (201) 887-2754

CUSTOMER: Wyle Labs P.O. NO. 4-5942-P

AIR EQUIV. REQUIRED DOSE (MRADS) 71.5

RATE NOT TO EXCEED (MRADS/HR) < 1.0

SPECIMENS:

QTY	PART NO.	SERIAL NO.	DESCRIPTION
1		F	Cable Trays

DATA:

SOURCE TYPE: COBALT-60 / GAMMA

TOTAL DELIVERED DOSE (AIR): MIN. 72.2 MRADS MAX. 83.9 MRADS

DOSE RATE (AIR): MIN. .37 MRADS/HR MAX. .43 MRADS/HR

TOTAL EXPOSURE HOURS: 195

SPECIMEN ROTATION: TWO WAY N/A FOUR WAY N/A NONE X

DATE IN: 11/11/88 DATE OUT: 11/22/88

DOSIMETRY:

DOSIMETER TYPE: Harwell 4034 BATCH AR TOLERANCE ±8%

CALIBRATION DATE: 3/9/88

READOUT INSTRUMENT: B&L Spectronic 1001

SERIAL NO. 0715493N CALIBRATION DATE 9/29/88

COMMENTS: None

ATTACHMENTS: WORKSHEETS N/A DRAWINGS N/A NOTICE OF ANOMOLY N/A

AUTHORIZED SIGNATURE: Albert L De Carlo

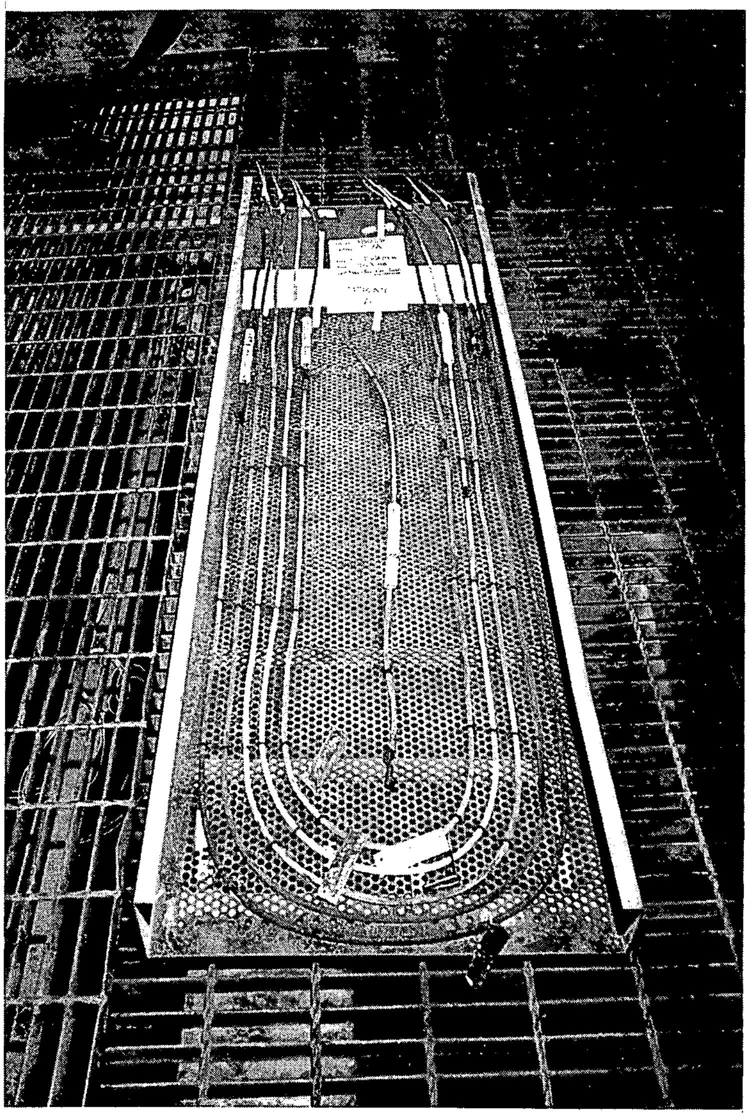
TITLE: General Manager DATE 11/28/88

ISOMEDIX (NEW JERSEY), INC.
9 APOLLO DRIVE, WHIPPANY, NEW JERSEY 07981 • (201) 887-2754

APPENDIX II

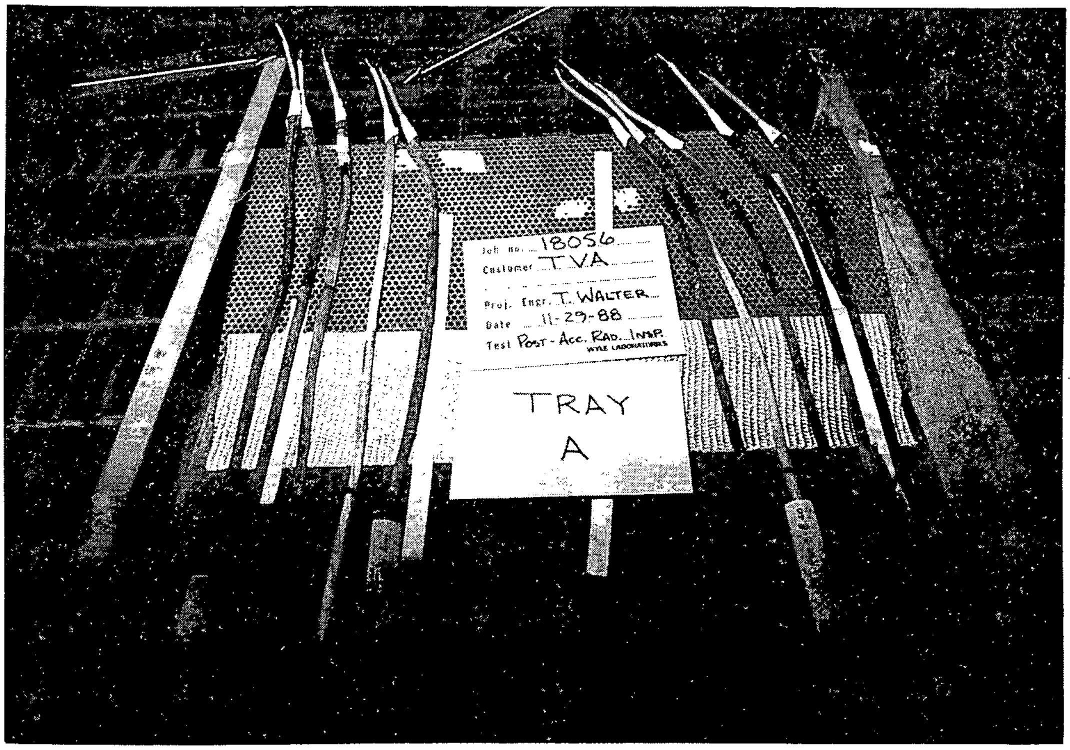
PHOTOGRAPHS

THIS PAGE INTENTIONALLY LEFT BLANK



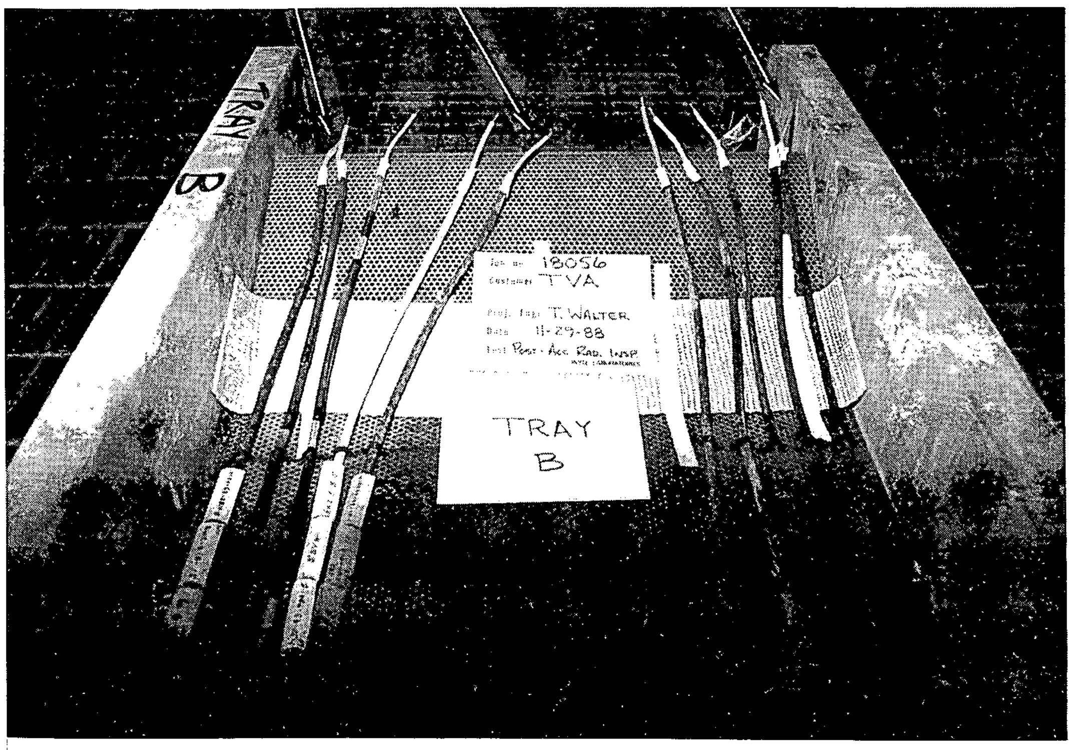
PHOTOGRAPH IV-1

POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY A PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



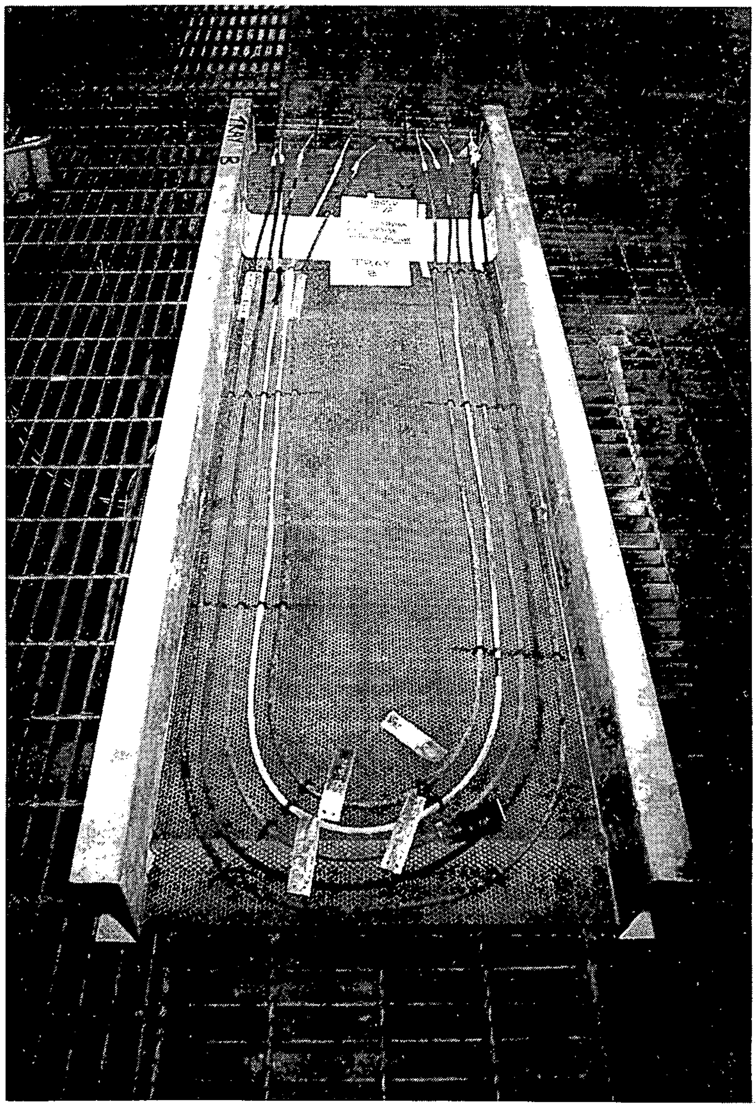
PHOTOGRAPH IV-2

**POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY A TEST SPECIMEN LEAD ENDS
(NOTE DARKENED SILICONE RUBBER INSULATION)**



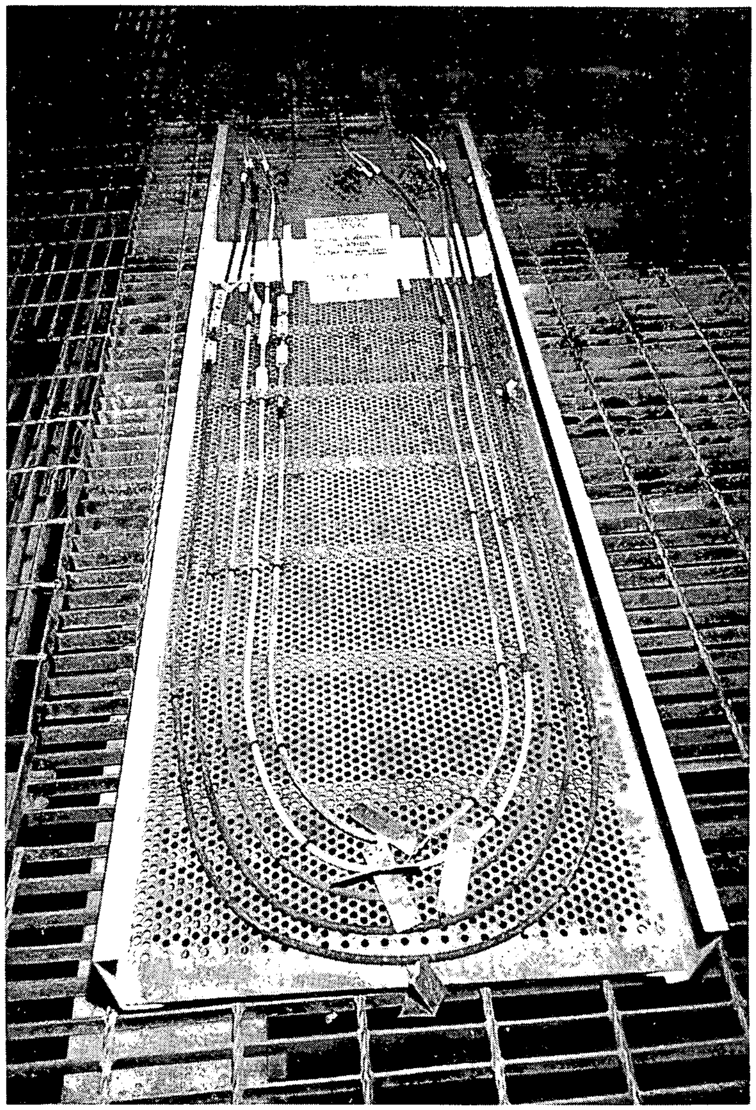
PHOTOGRAPH IV-3

**POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY B TEST SPECIMEN LEAD ENDS
(NOTE DAMAGED LEAD ENDS AND DARKENED INSULATION)**



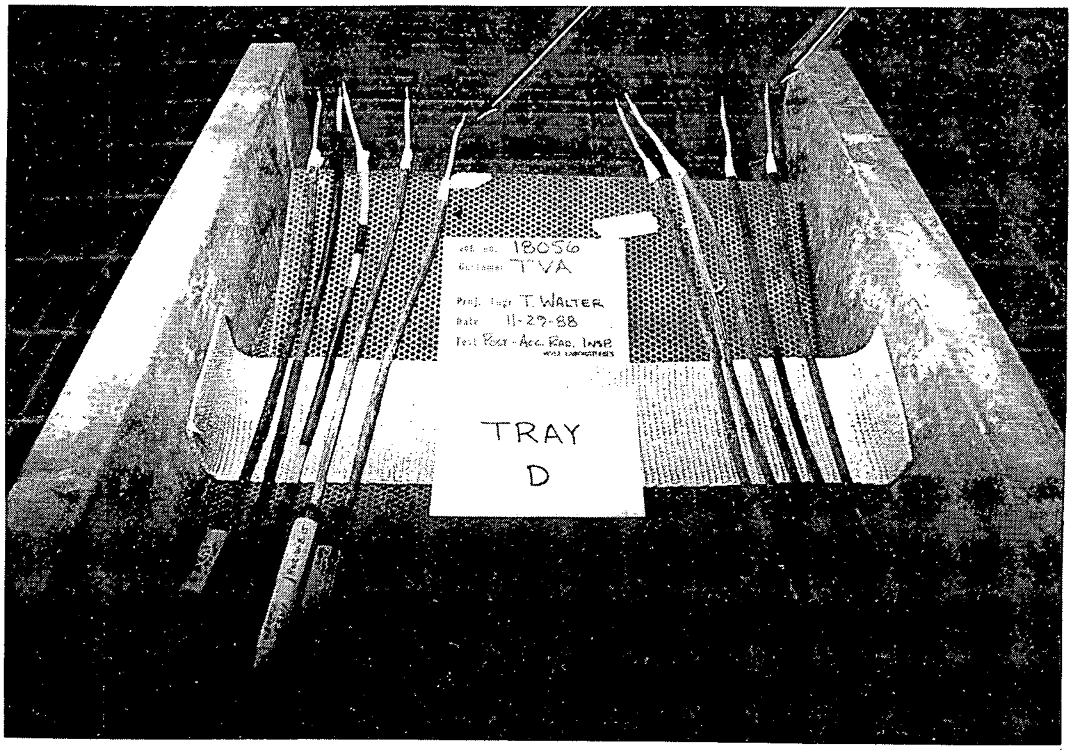
PHOTOGRAPH IV-4

POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY B PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



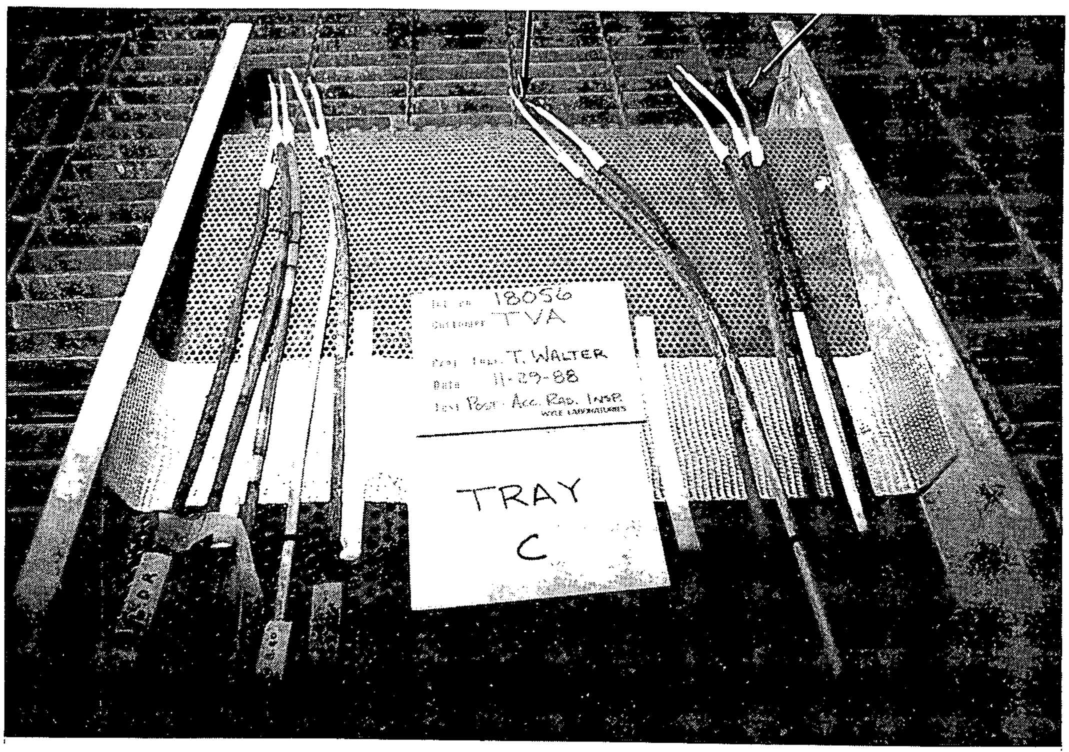
PHOTOGRAPH IV-5

POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY C PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



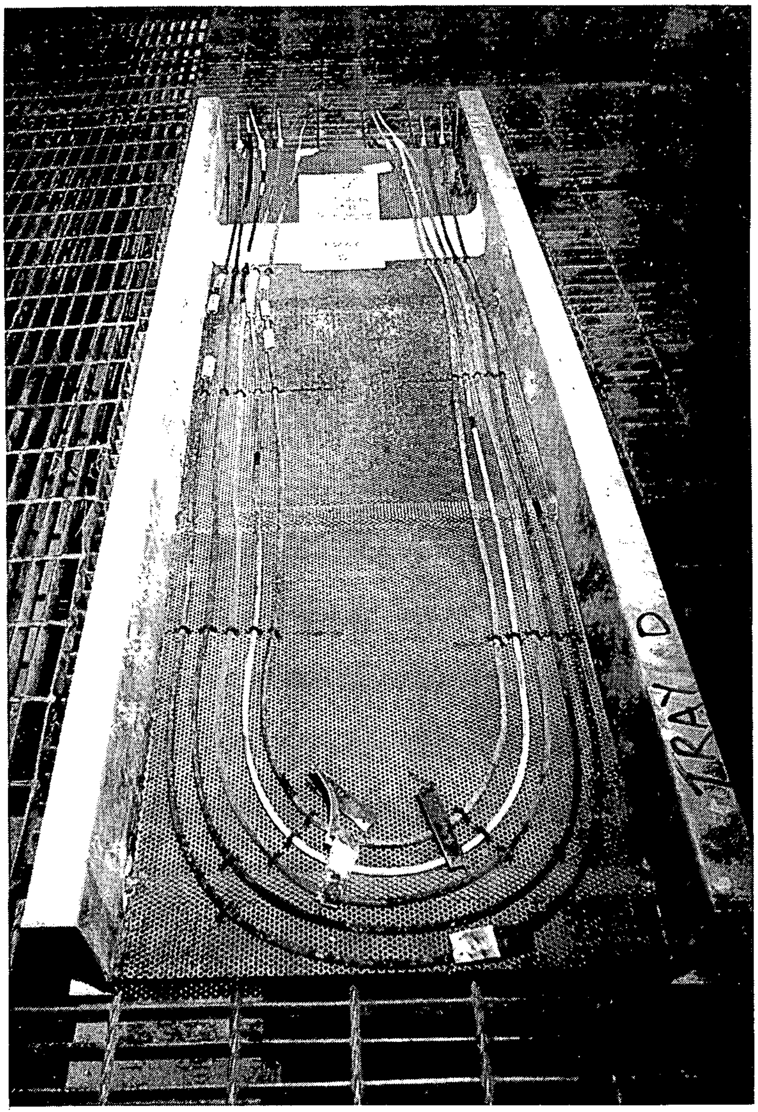
PHOTOGRAPH IV-6

**POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY C TEST SPECIMEN LEAD ENDS
(NOTE DARKENED SILICONE RUBBER INSULATION)**



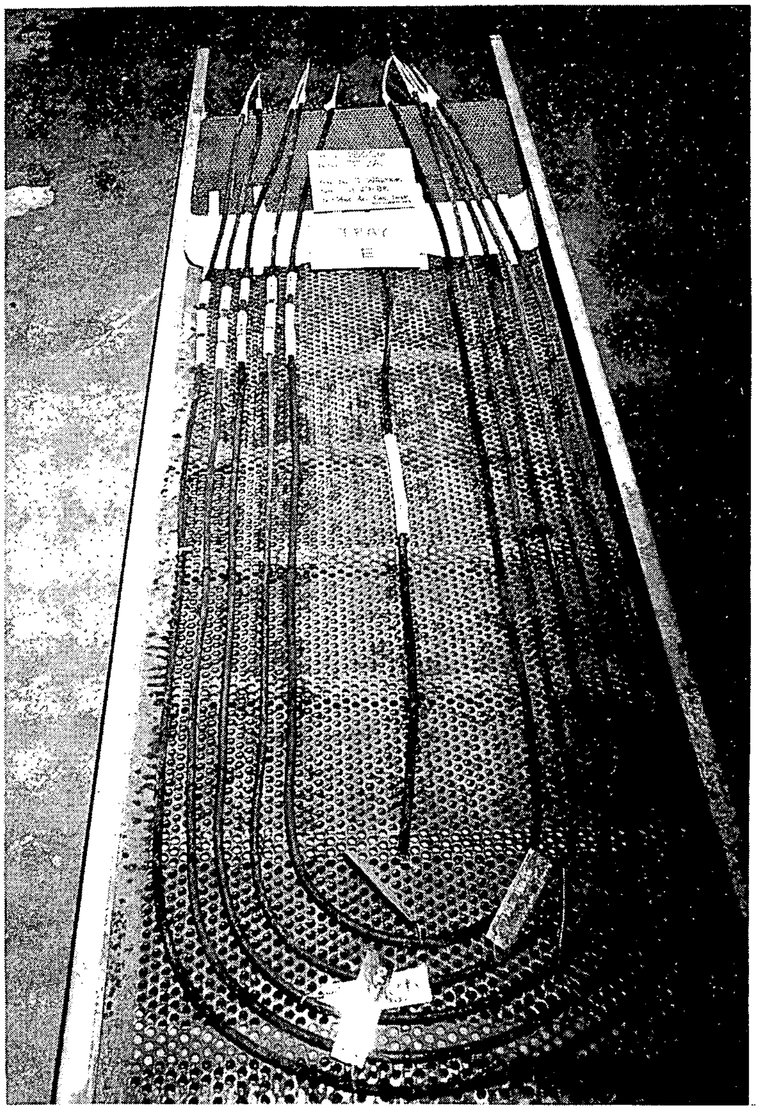
PHOTOGRAPH IV-7

**POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY D TEST SPECIMEN LEAD ENDS
(NOTE DARKENED SILICONE RUBBER INSULATION)**



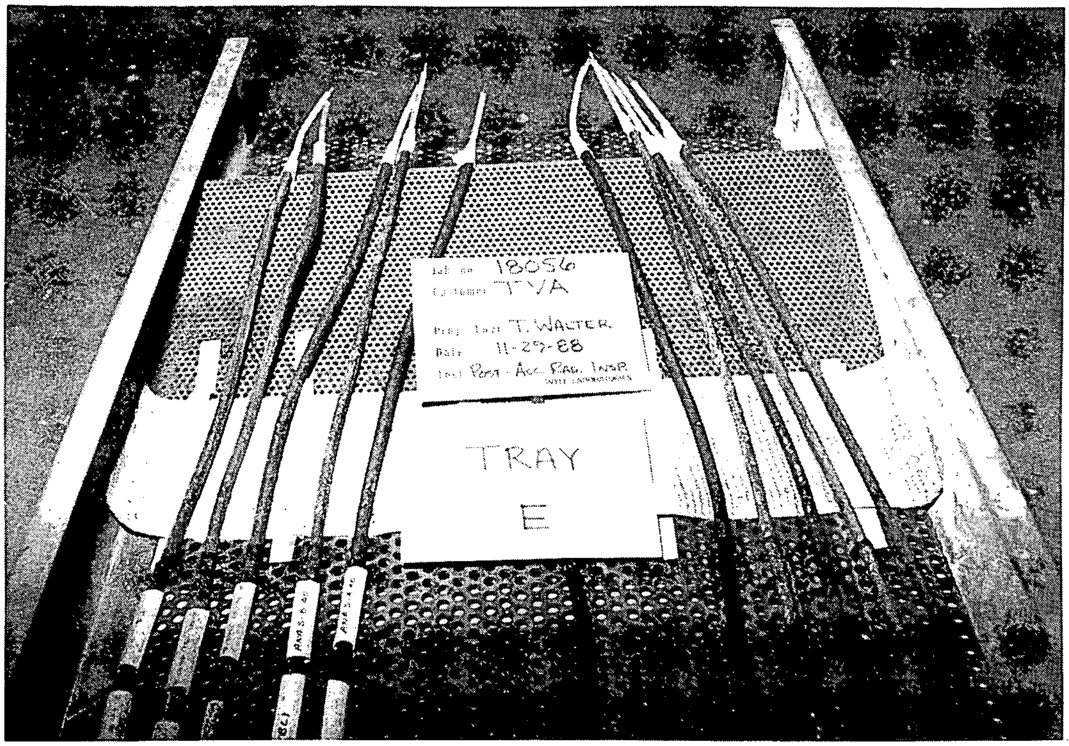
PHOTOGRAPH IV-8

POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY D PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS



PHOTOGRAPH IV-9

POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY E PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS

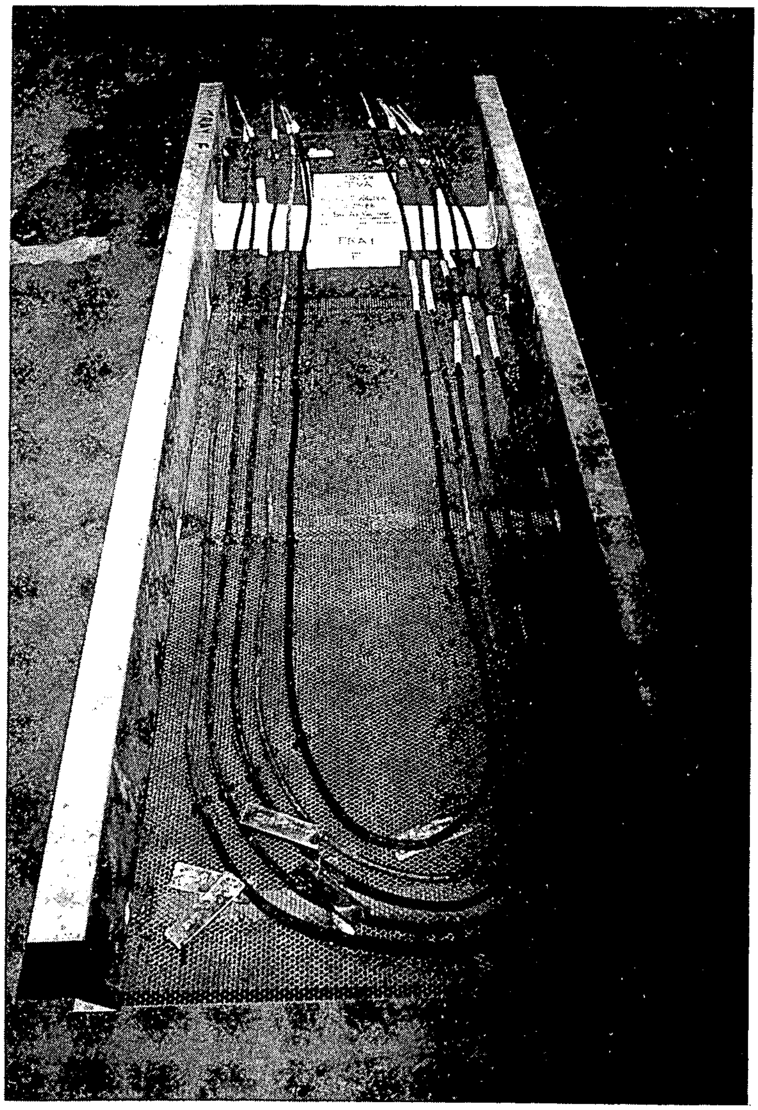


PHOTOGRPAH IV-10

**POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY E TEST SPECIMEN LEAD ENDS**

PHOTOGRAPH IV-11

**POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY F TEST SPECIMEN LEAD ENDS**



PHOTOGRAPH IV-12

POST-ACCIDENT RADIATION VISUAL INSPECTION
CABLE TRAY F PRIOR TO INSULATION RESISTANCE FUNCTIONAL TESTS

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX III

DATA SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLOP 18057-00, IPR 01
Para.: 3.9
S/N: Listed
GSI: N/A

Amb. Temp.: 76°F
Photo: No
Test Med.: Water
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 11/29/88

Test Title: POST-ACCIDENT RADIATION Functional Test

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	3.5E12Ω	RWC-W-A.15	2.1E12Ω
RWC-S-B.40	6.3E11Ω	RWC-W-B.15	3.0E11Ω
RWC-S-C.40	3.0E12Ω	RWC-W-C.15	1.4E11Ω
RWC-S-D.40	2.8E12Ω	RWC-W-D.15	6.4E9Ω
RWC-S-E.40	3.2E12Ω	RWC-W-E.15	2.2E12Ω
RWC-S-A.15	2.6E12Ω	ANA-S-A.40	3.5E11Ω
RWC-S-B.15	2.3E11Ω	ANA-S-B.40	2.2E11Ω
RWC-S-C.15	9.8E11Ω	ANA-S-C.40	6.2E10Ω
RWC-S-D.15	2.1E12Ω	ANA-S-D.40	1.4E11Ω
RWC-S-E.15	4.0E10Ω	ANA-S-E.40	2.2E11Ω
RWC-W-A.40	2.2E12Ω	ANA-S-A.15	1.1E11Ω
RWC-W-B.40	~~2.2E12~~ BH 2.2E11Ω	ANA-S-B.15	4.5E11Ω
RWC-W-C.40	1.7E11Ω	ANA-S-C.15	9.4E10Ω
RWC-W-D.40	3.1E11Ω	ANA-S-D.15	8.8E9Ω
RWC-W-E.40	2.3E12Ω	ANA-S-E.15	5.4E6Ω *

*ERRATIC READING

Notice of Anomaly: NONE

Tested By: B. Hardy Date: 11/29/88
Witness: N/A Date:
Sheet No. 1 of 1
Approved: Robert [illegible] 11-29-88

Wyle Form WH 614A, Rev. APR '84

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX IV

INSTRUMENTATION EQUIPMENT SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

INSTRUMENTATION EQUIPMENT SHEET

Test Report No. 18056-1

DATE: 11/29/88
TECHNICIAN: B. HARDY

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: POST ACCIDENT RAD. FUNCT.

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	MEG MTR	GENERAL RADIO	1864	1864-9700-00	106840	50K-50T OHM	2-5% RANGE	10/03/88	03/31/89
2	MEG MTR	GENERAL RADIO	1864	657113180	011898	50K-50TOHM	2-5%RANGE	10/13/88	04/11/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 11-29-88

CHECKED & RECEIVED BY [signature] 11-29-88

Q.A. [signature] 11/29/88 (9 Wyle)

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION V

ACCIDENT SIMULATION AND POST-TEST FUNCTIONAL TEST

1.0 REQUIREMENTS

1.1 Accident Simulation

The test specimens shall be subjected to the Accident Simulation (LOCA) specified in Paragraph 3.10 of Section VII.

1.2 Post-Test Functional Test

The test specimens shall be subjected to a Functional Test upon completion of the Accident Simulation (LOCA). The Functional Test shall be performed as specified in Paragraph 3.11 of Section VII.

2.0 PROCEDURES

2.1 Test Setup

2.1.1 Chamber Calibration

A "trial run" accident simulation was performed in the test chamber which encompassed the first four hours of the required profile. The "trial run" was conducted to verify the actual temperature and pressure capabilities of the test chamber. Dummy loads were placed in the chamber to approximate actual volume and mass of the test specimens. The period of the "trial run" accident simulation, which required chemical spray, was performed using a DI water solution.

2.1.2 Test Specimen Preparation

The test specimens of Cable Trays A, C, and E, were spliced to the test leads using uninsulated butt splices and Raychem WCSF-N heatshrink tubing. The test leads, butt splices, and heatshrink tubing were provided by Tennessee Valley Authority (TVA). The splices between the cable specimens and the test leads were prepared by TVA technician personnel before mounting the cable trays in the test chamber. The small cable lengths of Cable Trays A and E were used to familiarize the technicians with the test specimen material. Several of the test specimen lead ends were cut back from the original lead end due to visible cracks in the silicone rubber insulation. The first six inches of cable on both ends of each specimen was considered not to be a part of the test specimen as documented in Paragraph 2.4 of Section VII.

TVA personnel used new Tefzel cable ties to secure the test specimens to the cable trays. The cable ties were also used to secure the test specimen splices and test leads to the inclined section of each cable tray. The splices and test leads of the cable trays were secured to prevent damage to the test specimens during installation into the test chamber.

2.0 **PROCEDURES (Continued)**

2.1 **Test Setup (Continued)**

2.1.2 **Test Specimen Preparation (Continued)**

Before mounting the specimen cable trays in the chamber, the test specimens were submerged in a water bath and subjected to an Insulation Resistance Functional Test. The cable trays were then mounted in the test chamber and the test lead chamber penetrations were sealed per Wyle Laboratories' standard practice.

2.1.3 **Electrical Powering**

Each test specimen in the program was connected to an individual circuit typical of the circuit shown in Figure 3 of Section VII. The test specimens were powered as listed below:

Cable Tray	Specimen No.	Circuit No.	Test Current (A)
A	RWC-S-A.40	1	15 Amps
	RWC-S-B.40	2	15 Amps
	RWC-S-C.40	3	15 Amps
	RWC-S-D.40	4	15 Amps
	RWC-S-E.40	5	15 Amps
C	RWC-W-A.40	6	15 Amps
	RWC-W-B.40	7	15 Amps
	RWC-W-C.40	8	15 Amps
	RWC-W-D.40	9	15 Amps
	RWC-W-E.40	10	15 Amps
E	ANA-S-A.40	11	21 Amps
	ANA-S-B.40	12	15 Amps
	ANA-S-C.40	13	21 Amps
	ANA-S-D.40	14	15 Amps
	ANA-S-E.40	15	21 Amps

The applied voltage to all of the test specimens was 305 VAC with allowable tolerances for voltage and current as follows:

Voltage	+10, -0 VAC
Current	+10%, -0% of specified value

2.1.4 **Monitoring**

The test specimen circuits were monitored and recorded as specified in Paragraph 3.10.5 of Section VII. The monitored channels on the Data Acquisition System (DAS) were as follows:

2.0 **PROCEDURES (Continued)**

2.1 **Test Setup (Continued)**

2.1.4 **Monitoring (Continued)**

Channel No.	Units	Description
1	°F	Thermocouple No. 1 mounted within 2 inches of top center of Cable Tray "E"
2	°F	Thermocouple No. 2 mounted within 2 inches of top center of Cable Tray "A"
3	°F	Thermocouple No. 3 mounted within 2 inches of bottom center of Cable Tray "A"
4	°F	Average Temperature of Thermocouple Nos. 1, 2, and 3
5	PSIG	Chamber Pressure
6	GPM	Chemical Spray Flow
7-21	VAC	Circuits 1 through 15 Applied Voltage
22-36	Amps	Circuits 1 through 15 Current
37-51	mAmps	Circuits 1 through 15 Specimen Leakage

Chemical spray PH was monitored and recorded hourly during the 24-hour period in which the chemical spray was present. The Data Acquisition System (DAS) was used to monitor the environmental channels, applied voltage, current, and leakage on each of the specimen circuits. The DAS displayed requested information on a color monitor, fed a high-speed line printer, and fed a Hewlett Packard (HP) Model 1000 minicomputer. The HP 1000 stored data on hard disk and was used to generate the plots of various parameters versus time. The DAS line printer operated during the test program at the print rate listed below:

Print Rate	Test Time (approx.)	Comments
10 seconds	7 minutes	Initiate ramp
1 minute	22 hours 45 min.	
10 minutes	2 hours 40 min.	
10 seconds	5 minutes	End chem. spray
10 minutes	4 hours 30 min.	
15 minutes	525 hours 30 min.	To end of test

2.0 **PROCEDURES (Continued)**

2.2 **Pre-Test Wet Insulation Resistance Measurements**

2.2.1 Initial Test

The test specimens were subjected to insulation resistance measurements while submerged in the test chamber. The measurements were taken by applying 500 VDC for 1 minute before the reading of the resistance between each conductor (specimen, splice, and test lead out of the chamber) and chamber ground. During the insulation resistance measurements, the test chamber was flooded with tap water to a level which assured that the test specimens, splices, and test leads were submerged.

2.2.2 Additional Tests

Insulation resistance measurement readings were repeated on the test specimens, splices, and test leads after the accident chamber had been drained. At the Customer's request, the test specimens were left in the accident chamber and insulation resistance measurement readings were repeated approximately 48 hours after draining the chamber.

The test specimens were subjected to an additional Insulation Resistance Test before opening the accident chamber. The test occurred approximately 72 hours after draining the chamber. At the Customer's request, the test chamber was opened and Cable Tray C (RWC Watts Bar 40-year specimens) was removed. Upon removal of the cable tray, the test chamber was sealed and flooded. Insulation resistance measurements were then repeated for the test specimens mounted in Cable Trays A and E.

2.3 **Accident Exposure**

The test specimens of Cable Trays A and E were powered with the required voltage and current and were subjected to steam to stabilize at 104°F for a minimum of 30 minutes. Upon stabilization, the test specimens were subjected to the accident profile as specified in Figure 2 of Section VII. The peak conditions of 342°F at 15 PSIG were achieved within 30 seconds and the chamber temperature and pressure were varied as necessary to envelope the required profile. The specimens were subjected to chemical spray at approximately 75 minutes into the Accident Simulation and remained on for 24 hours and 22 minutes from that point. The chemical spray flow rate requirement of 7.0 gallons per minute (GPM) was determined from the 0.3 GPM per square foot test requirement specified in Paragraph 3.10.7 of Section VII. The area of chemical spray coverage was determined to be approximately 23 ft^2.

Intermittent voltage level fluctuations in the test facility power supply caused out-of-specification voltage and temperature/pressure levels. These out-of-specification conditions were accounted for by extending the total test time by 5 hours and 30 minutes.

2.0 PROCEDURES (Continued)

2.4 Post-Test Functional Test

Upon completion of the Accident Simulation Test, the test specimens of Cable Tray A and E were subjected to a Post-Test Functional Test. The Functional Test was performed as described in Paragraph 2.2.1 of this Section.

Upon completion of the Post-Test Functional Test, the test specimens were removed from the accident chamber and subjected to a visual inspection. The Post-Test Functional Test visual inspection was performed as specified in Paragraph 3.3.1 of Section VII.

3.0 RESULTS

The test specimens were subjected to the specimen preparation and the pre-test insulation resistance measurements of Paragraph 2.0. The test specimens of Cable Trays A and E were subjected to the Accident Simulation and Post-Test Functional Test of Paragraph 2.0. Results of the test specimens' performance are presented in the following paragraphs.

3.1 Test Setup

3.1.1 Chamber Calibration

Computer-generated plots of the environmental data recorded during the "trial run" are presented in the Appendices of this Section.

3.1.2 Test Specimen Preparation

The test leads, butt splices, and heatshrink tubing provided by TVA were received by Wyle Laboratories and documented on a Test Inspection Sheet. The descriptions of the equipment provided by TVA are presented in the appendices of this Section.

3.1.3 Electrical Powering and Monitoring

The test specimens of Cable Trays A and E were connected to typical circuits as presented in the appendices of this Section.

3.2 Pre-Test Wet Insulation Resistance Measurements

Notice of Anomaly Number 2 documents the low resistance values recorded during the pre-test wet insulation resistance measurements. The low resistance values were recorded for Test Specimens RWC-W-C.40 and RWC-W-D.40 of Cable Tray C. The accident chamber was drained and the insulation resistance measurements were repeated immediately after draining and at specified intervals. At the Customer's request, Cable Tray C was removed from the Accident Chamber and discontinued from the test program. The pre-test wet insulation resistance measurements were repeated on the test specimens of Cable Trays A and E, and testing was continued.

3.0 **RESULTS (Continued)**

3.2 **Pre-Test Wet Insulation Resistance Measurements (Continued)**

Notice of Anomaly Number 2 is presented in the Appendices of this Section. The Data Sheets generated during the insulation resistance measurements are also presented in the Appendices of this Section.

3.3 **Accident Exposure**

All of the test specimens of Cable Trays A and E successfully maintained the applied voltage and current throughout the Accident Test. Leakage currents remained within monitoring equipment tolerance levels on all specimen circuits except Circuit No. 1 (RWC-S-A.40) which reached a maximum recorded peak leakage of 9 milliamps. A plot of the recorded leakage currents for Circuit Nos. 1 through 5 and 11 through 15, inclusive, are presented in the Appendices of this Section.

Data Sheets indicating the chemical spray solution PH and flow were generated during the 24-hour period of chemical spray. The chemical spray PH, Flow Data Sheets, and a typical printout of the data monitored by the DAS are presented in the Appendices of this Section.

Notice of Anomaly Number 3 documents the extension of the post-DBE aging period. As a result of power supply line voltage fluctuations and power losses, the test specimens experienced out-of-specification conditions. A conservative estimate of the test time expended was determined to be 5 hours and 30 minutes. The test profile was extended by 5 hours and 30 minutes at the post-DBE aging temperature of 150°F (+9, -0) deg F. The test specimens remained powered during the additional test time.

Notice of Anomaly Number 4 documents the out-of-specification PH level of the chemical spray solution during the Accident Simulation (LOCA). The PH level of the solution was increased above the specification (plus tolerance) near the end of the chemical spray period. The PH level was not considered detrimental to the test specimens over the short period remaining in the chemical spray test.

Computer-generated plots of the Accident Simulation profiles (required and actual), including the Post-DBE Aging period, are presented in the Appendices of this Section.

Photographs of the specimen preparation, accident test setup, test equipment, and thermocouple locations are presented in the Appendices of this Section.

3.4 **Post-Test Functional Test**

The Data Sheet generated during the Insulation Resistance Measurement Tests is presented in the Appendices of this Section. Photographs of the test specimens in the cable trays upon completion of the Post-Test Functional Test Visual Inspection are also presented in the Appendices of this Section.

3.0 RESULTS (Continued)

3.4 **Post-Test Functional Test (Continued)**

Observations recorded during the Post-Test Functional Test visual inspection, with the test specimens mounted in the cable trays, are presented in the following paragraphs.

Cable Tray A was noted to have test specimens in a degraded condition. Ash coloring was most prevalent on the asbestos braided jacket material of Test Specimen B. Test Specimens C and D showed indications of rust having impregnated the jacket material near the metal surface of the cable tray. The Wyle-supplied metal identification tags on the test specimens were degraded and partially destroyed due to the chemical spray during the test. The asbestos braided jacket materials showed no indication of expanding or loosening around the silicone rubber insulation of the test specimens.

Cable Tray E was noted to have test specimens in good condition. Ash coloring was very uniform on the top side of the asbestos braided jacket material for Test Specimens B, C, D, and E. Test Specimen A was noted to have a dark black jacket material. TVA identification tags were not legible on Test Specimens C, D, and E. The Wyle-supplied metal identification tags on the test specimens were degraded and partially destroyed due to chemical spray during the test. The asbestos braided jacket material showed indications of having absorbed moisture during the Accident Test. The fibers of the jacket material were swollen and tight around the silicone rubber insulation of the test specimens.

3.5 **Appendices**

The data recorded during this phase of the test program is presented in Appendices I through VII of this section as noted below:

- Appendix I contains Notices of Anomaly Nos. 2, 3, and 4. Notice of Anomaly No. 2 documents removal of Cable Tray C from the test program. Notice of Anomaly No. 3 documents additional test time added to the post-DBE aging period of the Accident Simulation Test. Notice of Anomaly No. 4 documents an out-of-specification PH level of the chemical spray solution during the Accident Simulation Test.

- Appendix II contains Equipment Inspection Sheets for the TVA-supplied components used during test specimen preparation.

- Appendix III contains a typical wiring diagram for each of the test specimen circuits of Cable Trays A and E.

- Appendix IV contains Computer Plots V-1 through V-6 for the "trial run" and V-7 through V-26 for the Accident Simulation (LOCA). Typical line printer outputs and chemical spray PH and Flow Data Sheets are also presented.

3.0 **RESULTS (Continued)**

3.5 **Appendices (Continued)**

- Appendix V contains Photographs V-1 and V-2 of the "trial run" test setup. Photographs V-3 through V-8 show the test specimens of Cable Trays A, C, and E during the specimen preparation. Photographs V-9 through V-15 show the test specimens and equipment during various stages of the Accident Simulation Test Setup. Photographs V-16 through V-19 show the test specimens during the Post-Test Functional Test Visual Inspection.

- Appendix VI contains Data Sheets generated during Insulation Resistance Measurement Tests.

- Appendix VII contains the Instrumentation Equipment Sheets required for the Accident Simulation (LOCA) Test and the Insulation Resistance Measurement Tests.

APPENDIX I

NOTICES OF ANOMALY

THIS PAGE INTENTIONALLY LEFT BLANK

WYLE LABORATORIES
(Eastern Operations)

NOTICE OF ANOMALY

DATE: December 12, 1988

NOTICE NO: 2 P.O. NUMBER: N/A CONTRACT NO: TV-73743A

CUSTOMER: Tennessee Valley Authority WYLE JOB NO: 18056

NOTIFICATION MADE TO: Kent Brown NOTIFICATION DATE: 12/07/88

NOTIFICATION MADE BY: T. Walter VIA: In person

CATEGORY: ☐ SPECIMEN ☒ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: 12-03-88

PART NAME: Silicone Rubber Insulated Cables PART NO. KS-500

TEST: Accident Simulation (LOCA) I.D. NO. RWC-W 40-year

SPECIFICATION: WLQP 18057, IPR 01 PARA. NO. 3.10

REQUIREMENTS:

After placing the test specimens, mounted in their respective cable trays, in the Accident Simulation Chamber, wet insulation resistance measurements shall be performed while the specimens are submerged.

DESCRIPTION OF ANOMALY:

During the wet insulation resistance measurement test, Cable Specimens RWC-W-C.40 and RWC-W-D.40 exhibited low resistance values, the test chamber was drained and additional insulation resistance tests were conducted. The data recorded for insulation resistance testing of the specimens is as presented in the table on the following page.

DISPOSITION · COMMENTS · RECOMMENDATIONS:

At the Customer's request, the Accident Chamber was opened on December 07, 1988 and Cable Tray C was removed. Cable Tray C contains Rockbestos (RWC) cable specimens, identified as representative for Watts Bar Power Plant, at an equivalent age of 40 years.

Upon removal of the Watts Bar cable specimens, the remaining cable specimens will be subjected to a repeat submerged insulation resistance test and the test program continued.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

TEST WITNESS: Kent Brown/Don Arp

REPRESENTING: TVA

QUALITY ASSURANCE: Kevin M Turner 12-13-88

PROJECT ENGINEER: [signature] 12-12-88

PROJECT MANAGER: [signature] 12/12/88

INTERDEPARTMENTAL COORDINATION: [signature] 12-13

Notice of Anomaly No. 2
J/N 18056
Page 2

Date	Functional Test	Medium	Specimen	Recorded Data
11/30/88	Post-Specimen Preparation (prior to installation in test chamber)	Water	RWC-W-C.40 RWC-W-D.40	4.0E10 ohms 1.4E12 ohms
12/03/88	Submerged IR (specimens mounted in flooded test chamber)	Water	RWC-W-C.40 RWC-W-D.40	1.1E7 ohms 9.5E5 ohms
12/03/88	Insulation Resistance (specimens mounted in test chamber - readings taken after draining chamber)	Air	RWC-W-C.40 RWC-W-D.40	2.0E7 ohms 1.8E6 ohms
12/05/88	Insulation Resistance (specimens mounted in test chamber - readings taken approximately 48 hours after draining chamber)	Air	RWC-W-C.40 RWC-W-D.40	1.4E5 ohms @ 10V 6.0E5 ohms
12/06/88	Insulation Resistance (specimens mounted in test chamber - readings taken prior to opening chamber to remove Cable Tray C)	Air	RWC-W-A.40 RWC-W-C.40 RWC-W-D.40 RWC-W-E.40	4.0E7 ohms 3.0E5 ohms @ 100 1.0E6 ohms 1.1E8 ohms

All remaining 40-year cable specimens not listed above maintained insulation resistance values in excess of 1.0E11 ohms during all functional tests.

WYLE LABORATORIES

(Eastern Operations)

NOTICE OF ANOMALY

DATE: December 30, 1988

NOTICE NO: 3 P.O. NUMBER: N/A CONTRACT NO: TV-73743A

CUSTOMER: Tennessee Valley Authority WYLE JOB NO: 18056

NOTIFICATION MADE TO: Kent Brown NOTIFICATION DATE: 12/28/88

NOTIFICATION MADE BY: T. Walter VIA: Telephone

CATEGORY: ☐ SPECIMEN ☒ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: 12/28/88

PART NAME: Silicone Rubber Insulated Cables PART NO. KS-500 & CC-2193 Nuclesil

TEST: Accident Simulation (LOCA) I.D. NO. RWC-S & ANA-S 40-year

SPECIFICATION: WLQP 18057, IPR 01 PARA. NO. 3.10.4

REQUIREMENTS:

The test specimens shall be powered continuously throughout the Accident Simulation with an applied voltage of 305 (+10, -0) VAC. Individual specimen circuits shall be powered at 15 or 20 Amps (+10%, -0%), as applicable.

DESCRIPTION OF ANOMALY:

Review of the Accident Simulation data printout sheets indicated that the test specimens experienced out-of-specification voltages and chamber temperature/pressure. The out-of-specification conditions were determined to be the result of power supply line voltage fluctuations at the test facility and power losses.

DISPOSITION · COMMENTS · RECOMMENDATIONS:

A conservative estimate of test time expended during low voltage levels and out-of-specification chamber temperature/pressure was determined to be 5 hours 30 minutes.

The test profile shall be extended by 5 hours 30 minutes at the post-DBE aging temperature of 150°F (+9, -0) deg F. The test specimens shall remain powered during the extended test profile.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

TEST WITNESS: N/A

REPRESENTING: N/A

QUALITY ASSURANCE: G.W. [signature] 1/3/89

PROJECT ENGINEER: [signature] 12-30-88

PROJECT MANAGER: Don Smith 12/30/88

INTERDEPARTMENTAL COORDINATION: [signature]

Wyle Form WH 1066, Rev. JAN '85

THIS PAGE INTENTIONALLY LEFT BLANK

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: January 26, 1989

NOTICE NO: 4 P.O. NUMBER: N/A CONTRACT NO: TV-73743A

CUSTOMER: Tennessee Valley Authority WYLE JOB NO: 18056

NOTIFICATION MADE TO: Kent Brown/Don Arp NOTIFICATION DATE: 01/25/89

NOTIFICATION MADE BY: T. Walter VIA: In person

CATEGORY: ☐ SPECIMEN ☒ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: 12/09/88

PART NAME: Silicone Rubber Insulated Cables PART NO. KS-500 & CC-2193 Nuclesil

TEST: Accident Simulation (LOCA) I.D. NO. RWC-S & ANA-S 40-year

SPECIFICATION: WLQP 18057, IPR 01 PARA. NO. 3.10.7

REQUIREMENTS:

The chemical spray PH requirement for the Accident Simulation shall be 8.35 (+1, -0) at 25°C.

DESCRIPTION OF ANOMALY:

At approximately 22 hours into the 24-hour chemical spray requirement, caustic was added to the chemical spray solution in order to increase the PH level. The resulting PH level was measured to be 9.5.

DISPOSITION · COMMENTS · RECOMMENDATIONS:

The out-of-specification PH level was considered to be nominal compared to the chemical spray PH requirement. The remaining period of chemical spray at the elevated PH level did not appear to cause adverse effects upon the test specimens.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

PROJECT ENGINEER: Robert Todd Walter 01-26-89

TEST WITNESS: N/A

PROJECT MANAGER: Don Smith 1/27/89

REPRESENTING: N/A

INTERDEPARTMENTAL COORDINATION: [signature]

QUALITY ASSURANCE: Kevin M Tenner 2-2-89

Wyle Form WH 1066, Rev. JAN '85

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX II

EQUIPMENT INSPECTION SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

TEST ~~SPECIMEN~~ INSPECTION

RTW

CUSTOMER: TENNESSEE VALLEY AUTHORITY
JOB NO.: 18056
SPECIFICATION: WLQP 18057-00
DATE: 10-24-88

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION.	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
1.0	BUTT SPLICES - 90 EACH	AMP	330369	N/A	YES	No
	10-12 AWG					
	PACKAGE TAG AS FOLLOWS:					
	ANP-717N 90 EA					
	QA II 88NLG-349138					
	II#5 10-20-87					
	P/N 330369 C199-C6					
	DEDICATED MATERIAL					
	PKG No. 5192					
	T/A 19586 ($NP-1-87)					
2.0	REDUCING BUTT SPLICES					
	~~20~~ 60 EACH, COATED BLUE (RTW)	N/A	N/A	N/A	YES	NO
	SHIPPING TICKET No.					
	$58-8408 DESCRIBES THE					
	ITEMS AS FOLLOWS:					
	ADAPTER FOR BUTT SPLICE					
	CONN. FOR ADAPTING SIZE					
	12-10 AWG TO 16-14 AWG					
	AMP CAT No. 327637					
	ARC-6608					
	C197-D1					
	269738					

NOTES: — NOT TEST SPECIMENS —

Specimen Failed: NONE
Specimen Passed: N/A
NOA Written: NONE

Inspected By: [signature] Date: 10-21-88
Witness: N/A Date:
Sheet No. 1 of 2
Approved: [signature] 1/23/89

Page No. V-20
Test Report No. 18056-1

TEST ~~SPECIMEN~~ RTW INSPECTION

CUSTOMER TENNESSEE VALLEY AUTHORITY
JOB NO. 18056
SPECIFICATION WLQP 18057-00
DATE 10-24-88

CHECK AS APPROPRIATE

ITEM NO.	DESCRIPTION	MANUF.	PART/MODEL NO.	SAME I.D. AS SPEC	CONDITION SATISFACTORY	PHOTO TAKEN
3.0	HEAT SHRINK SLEEVING	RAYCHEM	WCSF 115-N	N/A	YES	NO
	6" LONG PIECES - 90 EA.					
	ADDITIONALLY, SHIPPING					
	TICKET No. S58-8408					
	DESCRIBES THE ITEMS AS					
	FOLLOWS:					
	BBJ-554F					
	R27-5					
	RD059518					
4.0	3 X 500 FT REELS OF	ROCKBESTOS	A83-0116	N/A	YES	NO
	1/C #10AWG FWL SIS F					
	CABLE					
	SHIPPING ORDER No.					
	093/7505 IDENTIFIES					
	CUSTOMER'S ORDER No. AS					
	88NLC-74953A AND					
	COC TO RSS-4-002					

NOTES: — NOT TEST SPECIMENS —

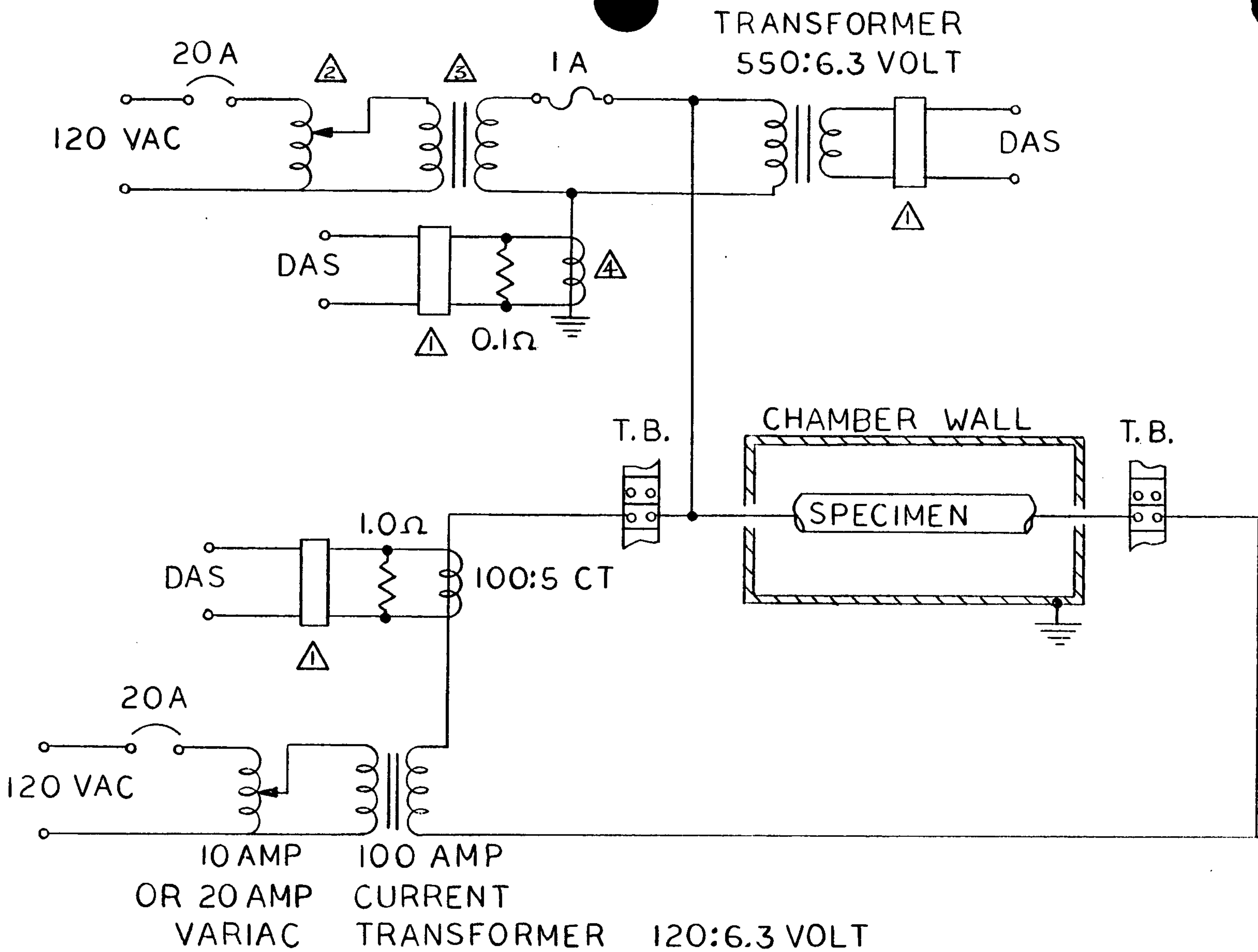
Specimen Failed NONE
Specimen Passed N/A
NOA Written NONE

Inspected By Robert [signature] Date: 10-24-88
Witness N/A Date:
Sheet No. 2 of 2
Approved Holly Carr 1/23/89

APPENDIX III

TYPICAL ACCIDENT TEST SETUP

THIS PAGE INTENTIONALLY LEFT BLANK



1. AC/DC CONVERTER
2. 10 OR 20 AMP VARIAC PER 5 ISOLATION TRANSFORMERS
3. ISOLATION TRANSFORMER — 120:600 VOLT
4. MULTI-TAP CURRENT TRANSFORMER 5:20 OR 5:25

TYPICAL TEST SETUP

THIS PAGE INTENTIONALLY LEFT BLANK

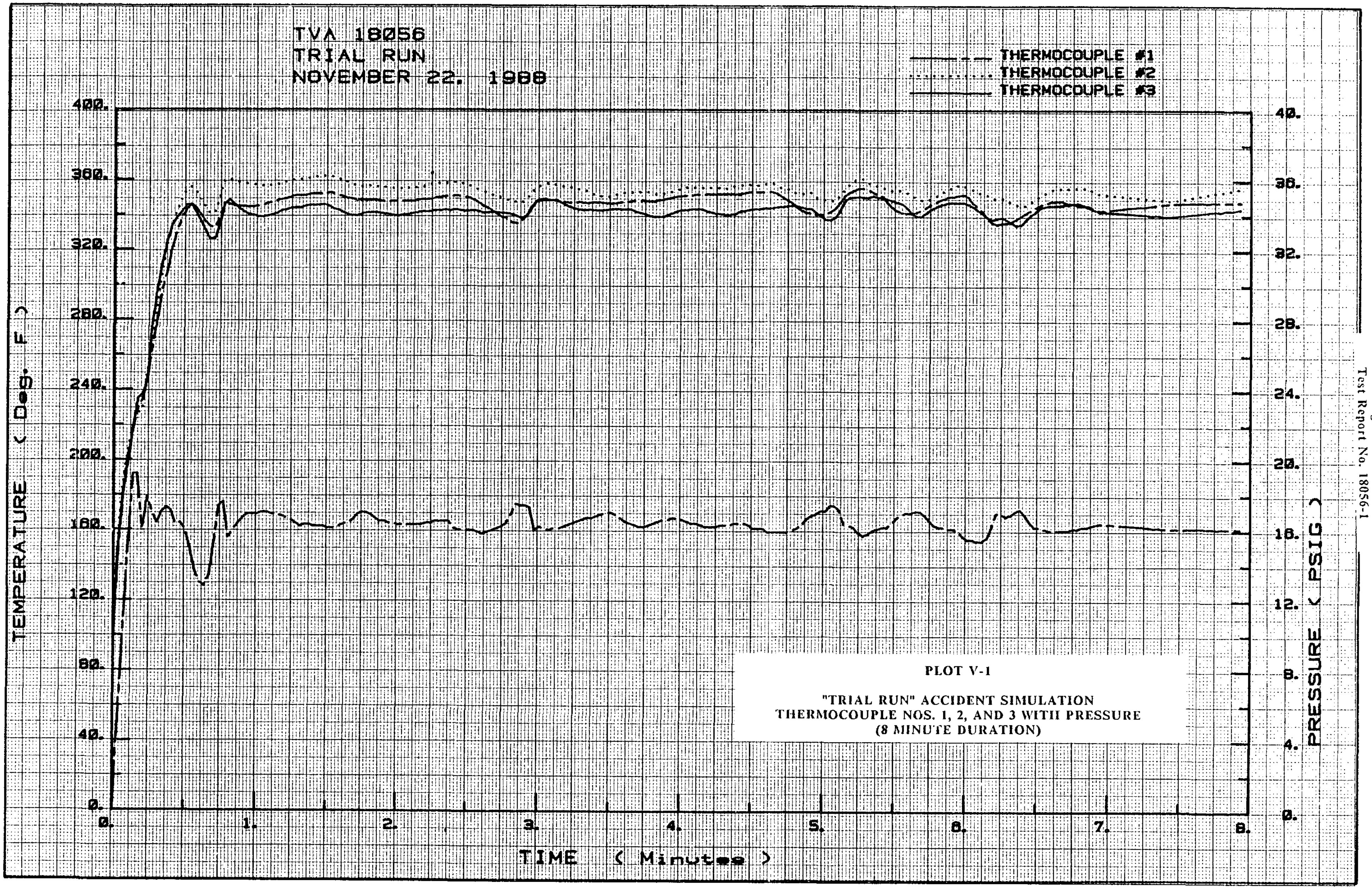
APPENDIX IV

COMPUTER PLOTS AND ACCIDENT DATA

THIS PAGE INTENTIONALLY LEFT BLANK

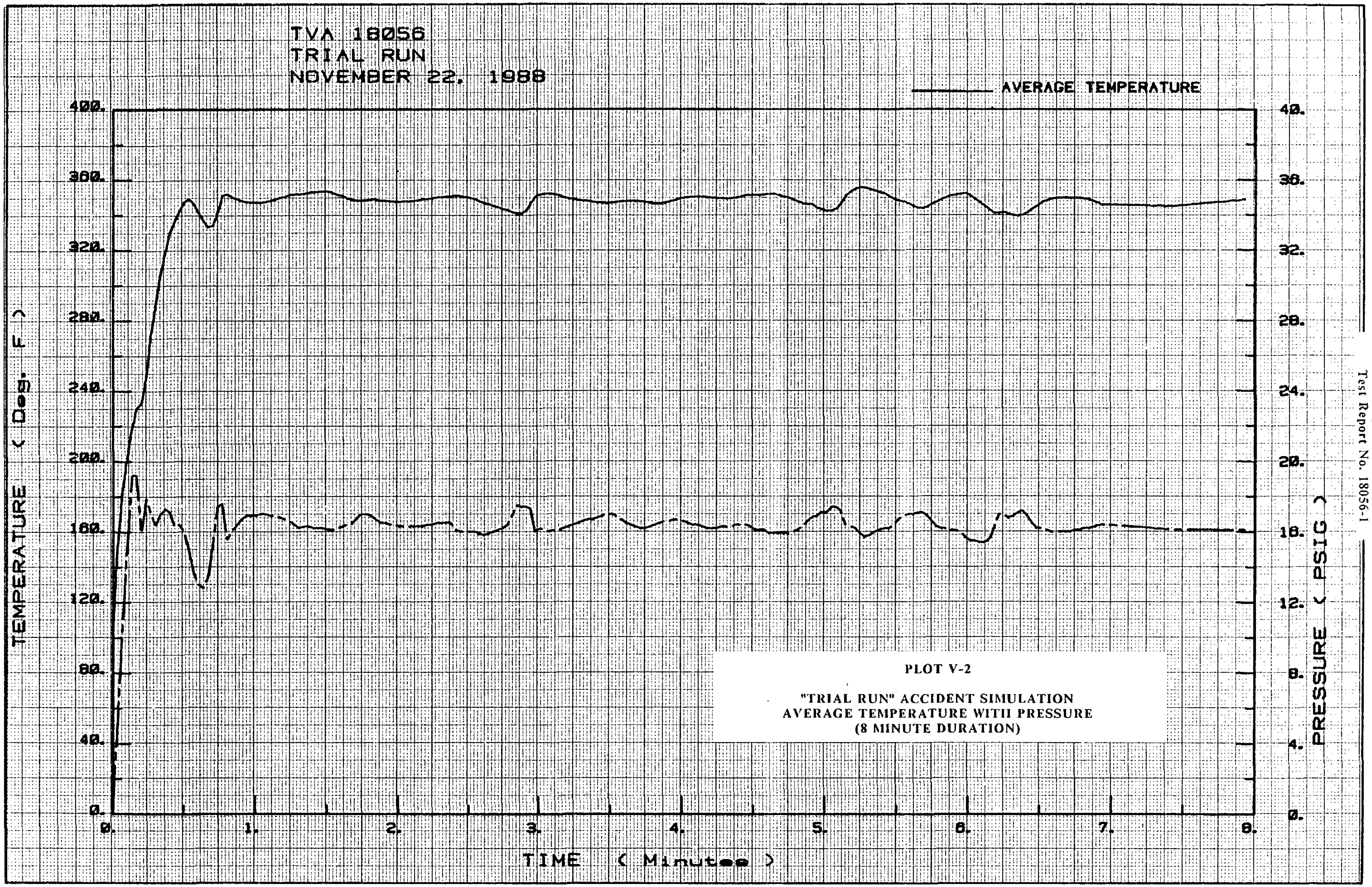
TRIAL RUN COMPUTER PLOTS

THIS PAGE INTENTIONALLY LEFT BLANK



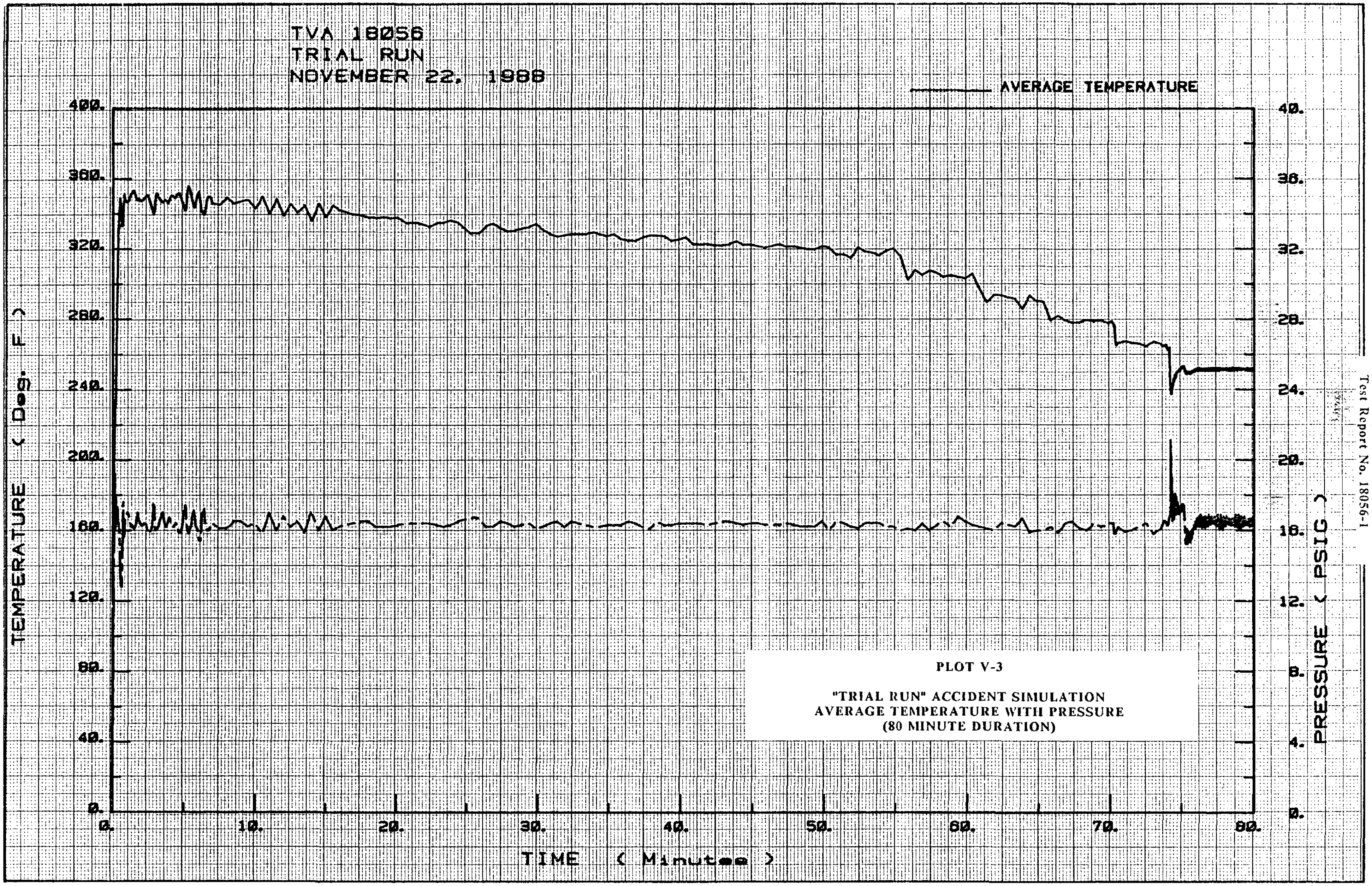
PLOT V-1

"TRIAL RUN" ACCIDENT SIMULATION
THERMOCOUPLE NOS. 1, 2, AND 3 WITH PRESSURE
(8 MINUTE DURATION)



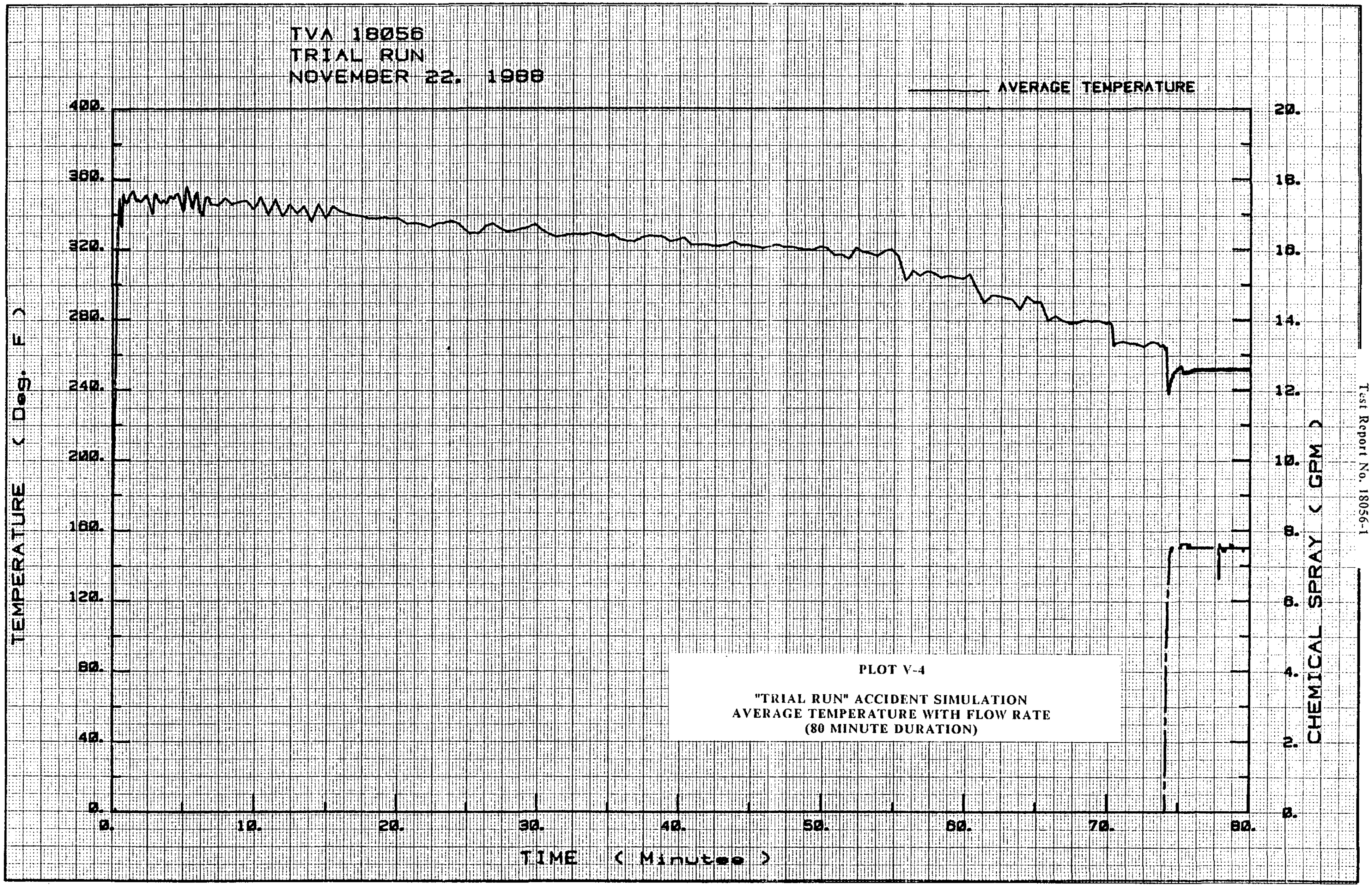
PLOT V-2

"TRIAL RUN" ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(8 MINUTE DURATION)



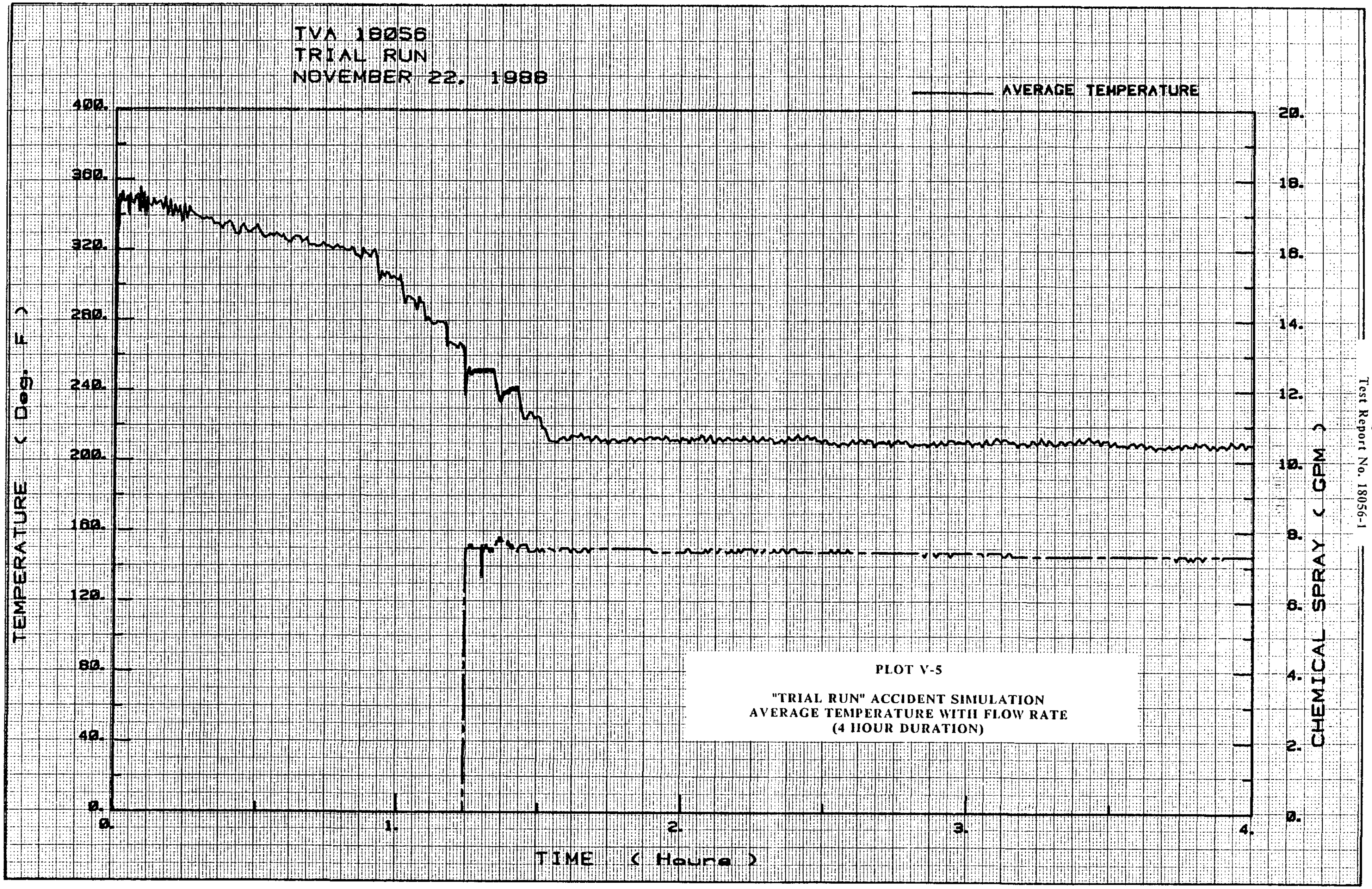
PLOT V-3

"TRIAL RUN" ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(80 MINUTE DURATION)



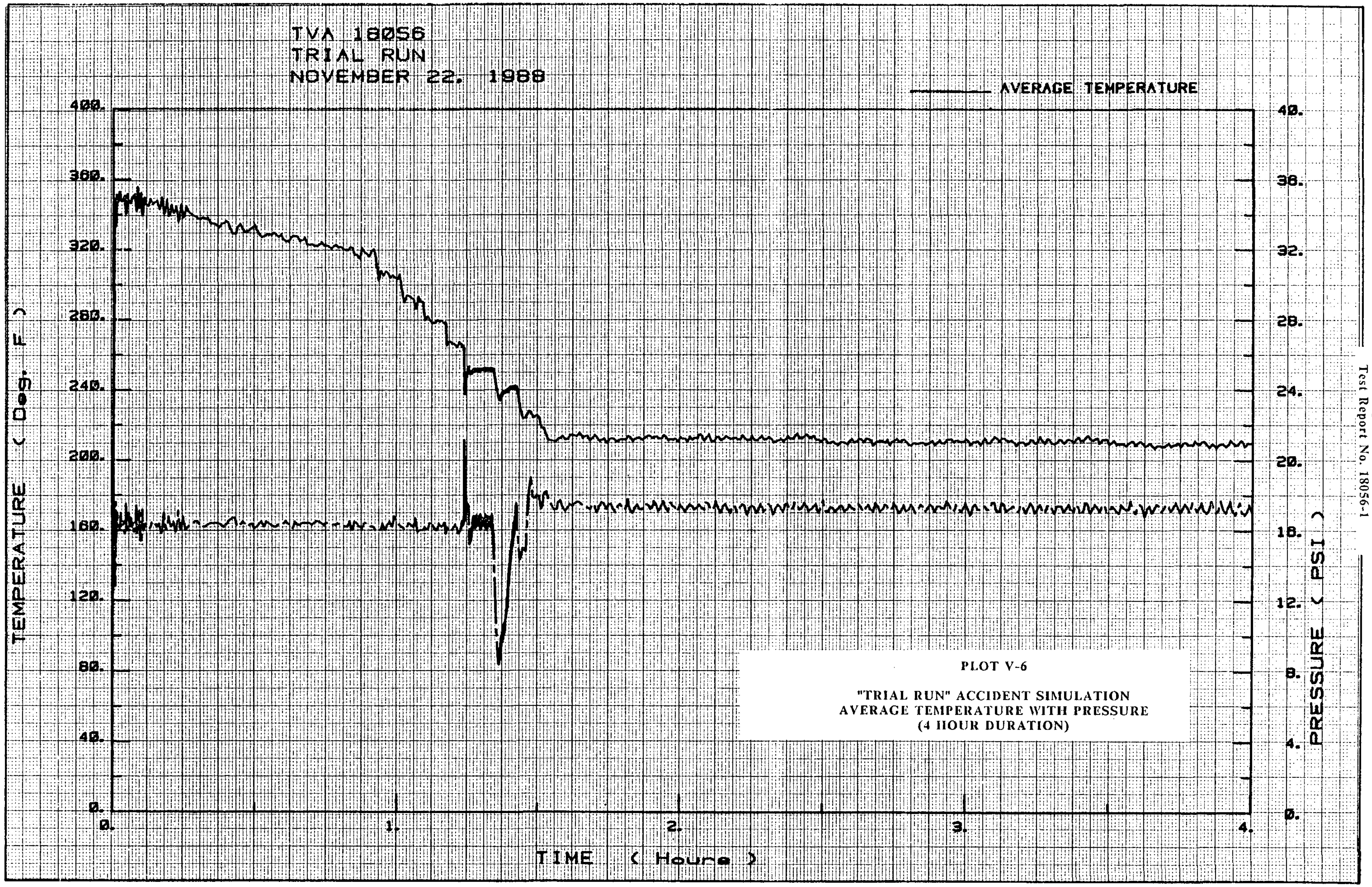
PLOT V-4

"TRIAL RUN" ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH FLOW RATE
(80 MINUTE DURATION)



PLOT V-5

"TRIAL RUN" ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH FLOW RATE
(4 HOUR DURATION)

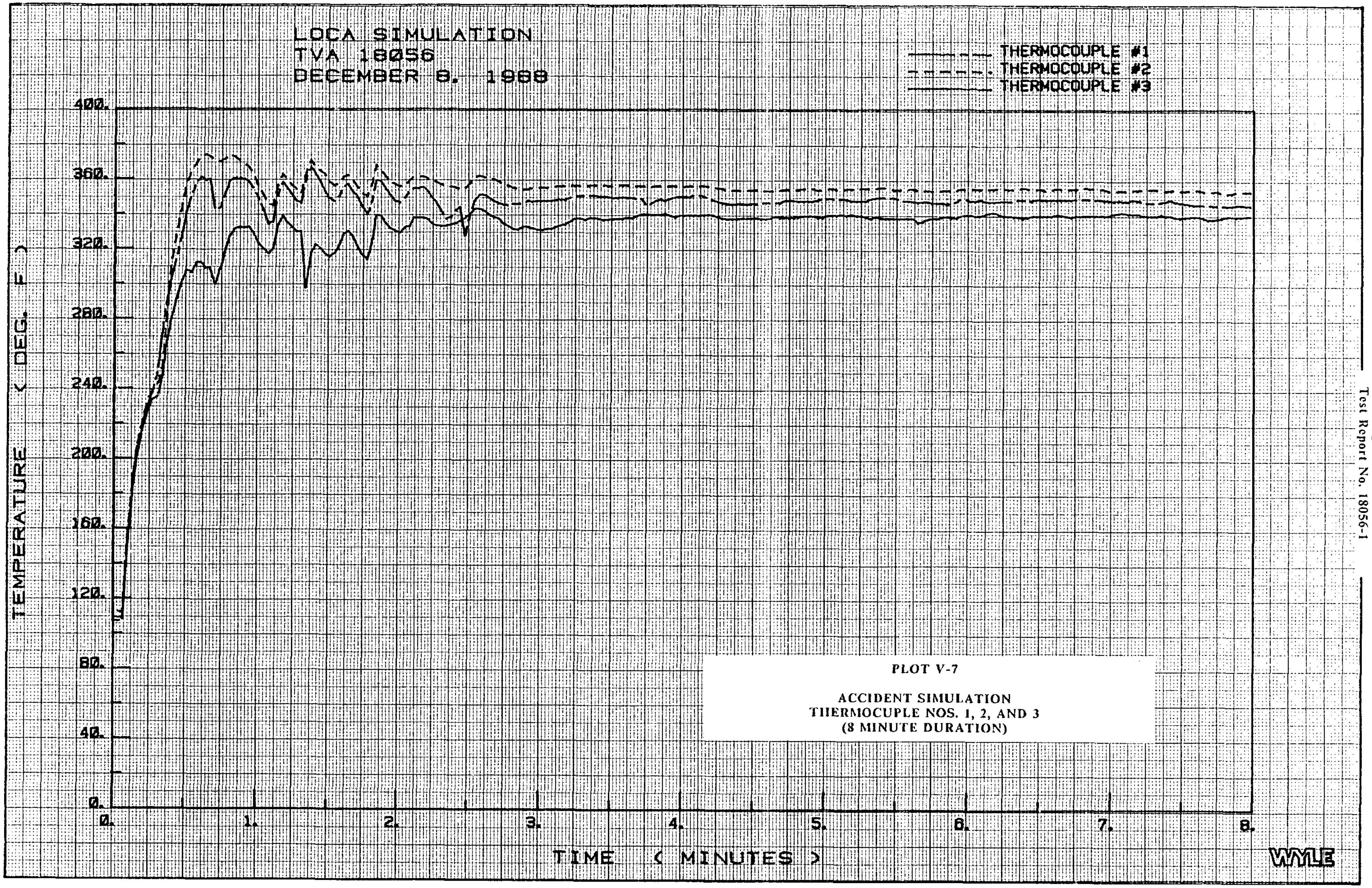


PLOT V-6

"TRIAL RUN" ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(4 HOUR DURATION)

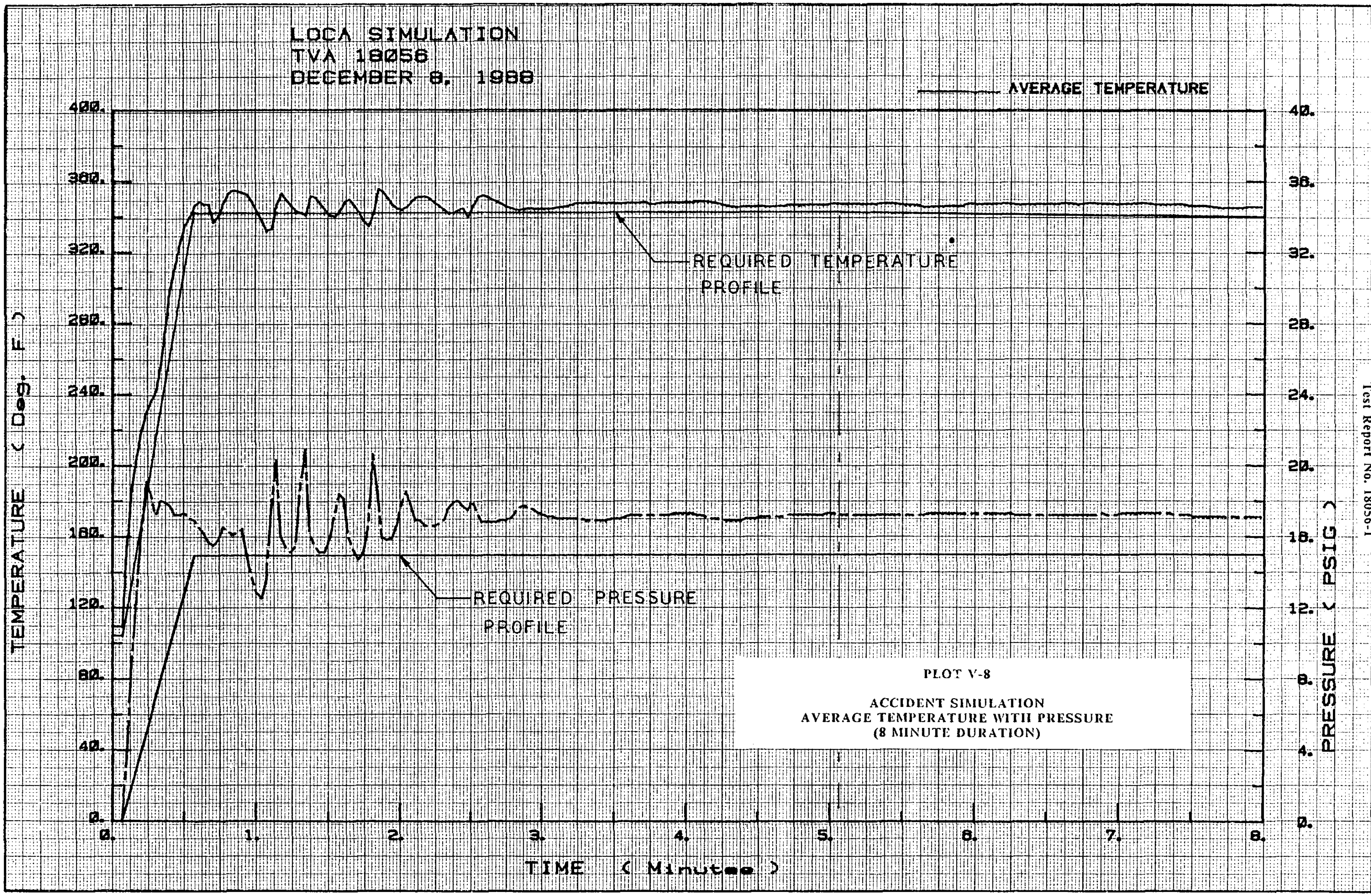
ACCIDENT SIMULATION (LOCA)
COMPUTER PLOTS

THIS PAGE INTENTIONALLY LEFT BLANK



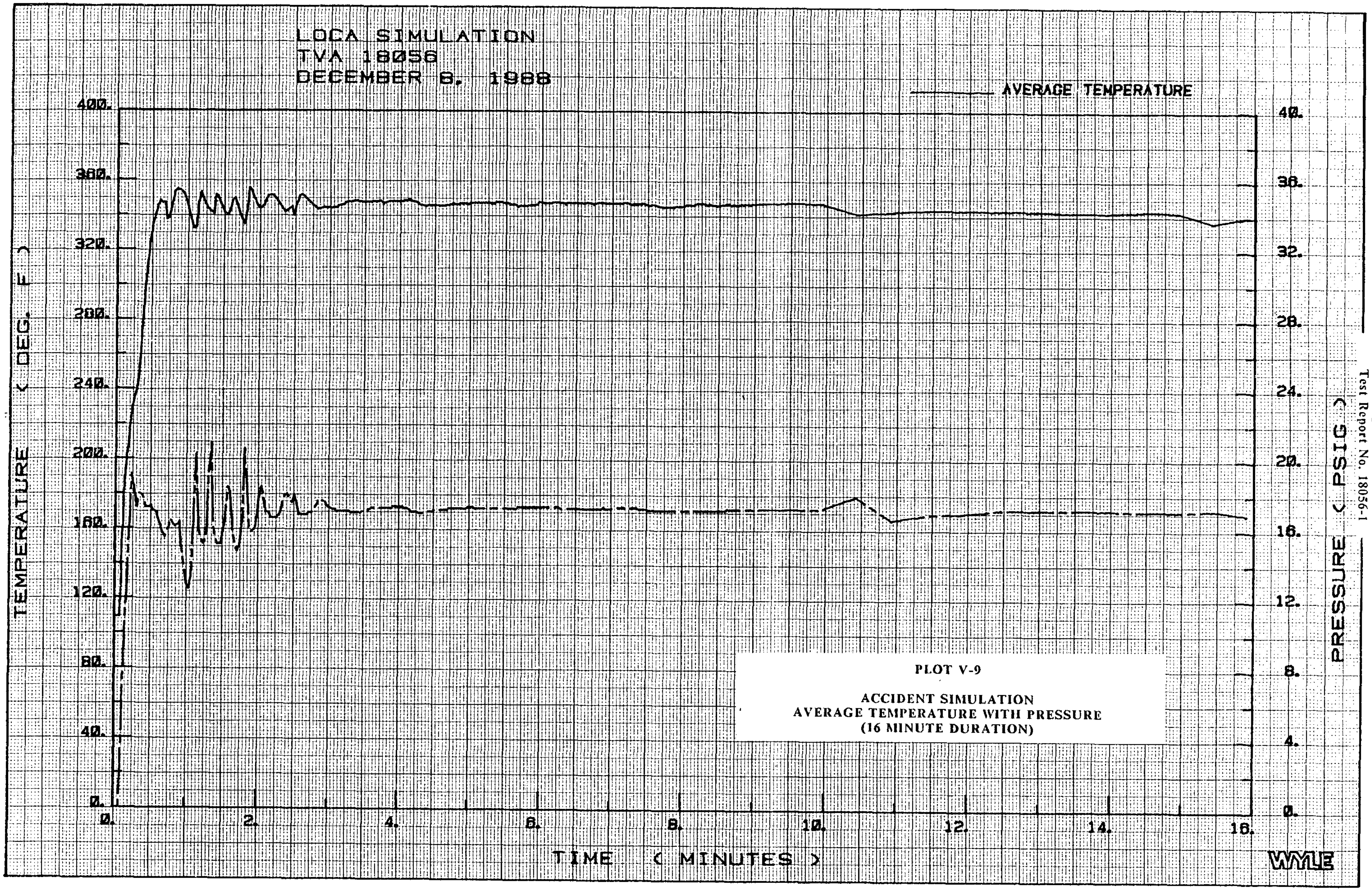
PLOT V-7

ACCIDENT SIMULATION
THERMOCUPLE NOS. 1, 2, AND 3
(8 MINUTE DURATION)



PLOT V-8

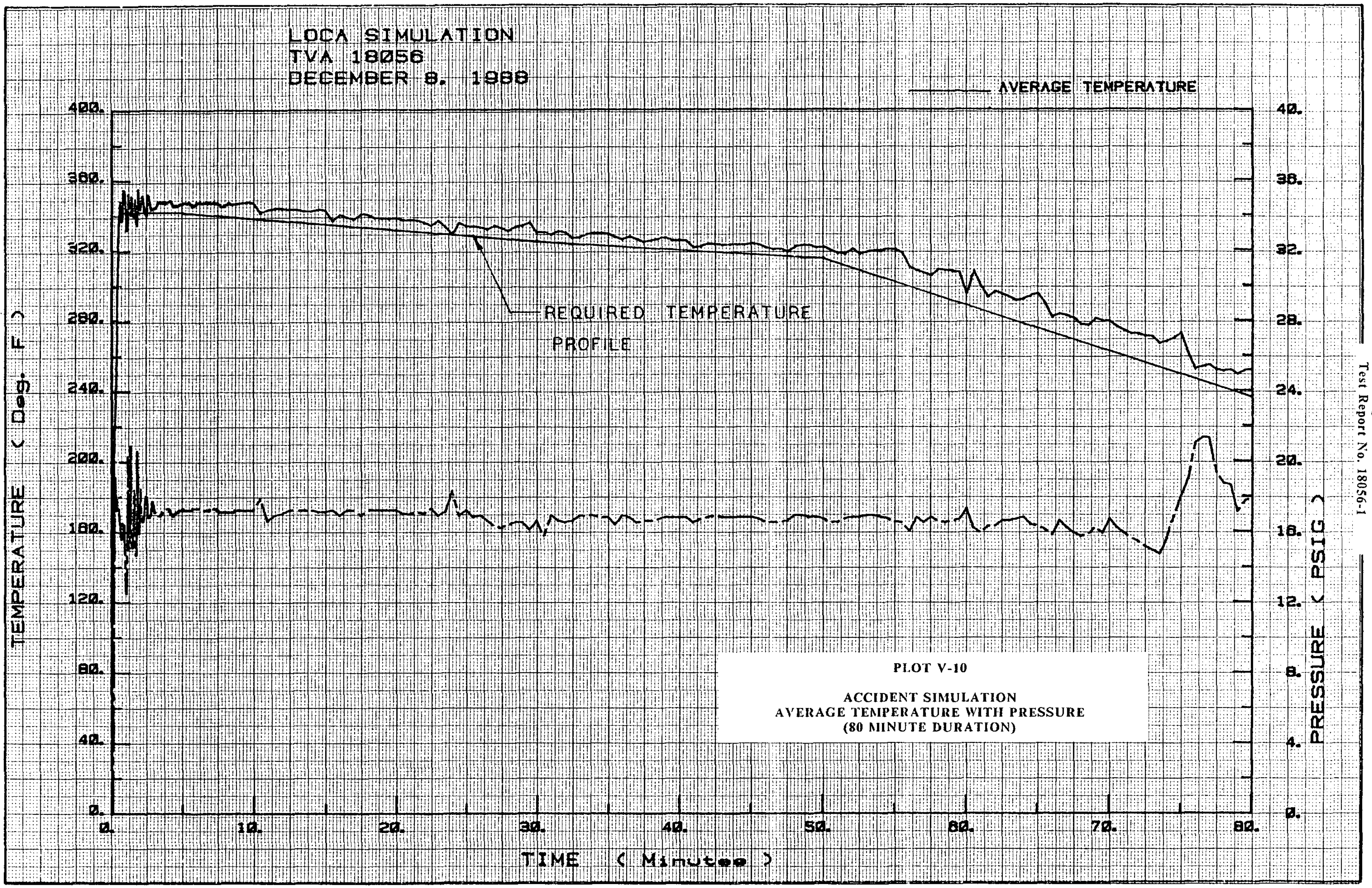
ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(8 MINUTE DURATION)



PLOT V-9

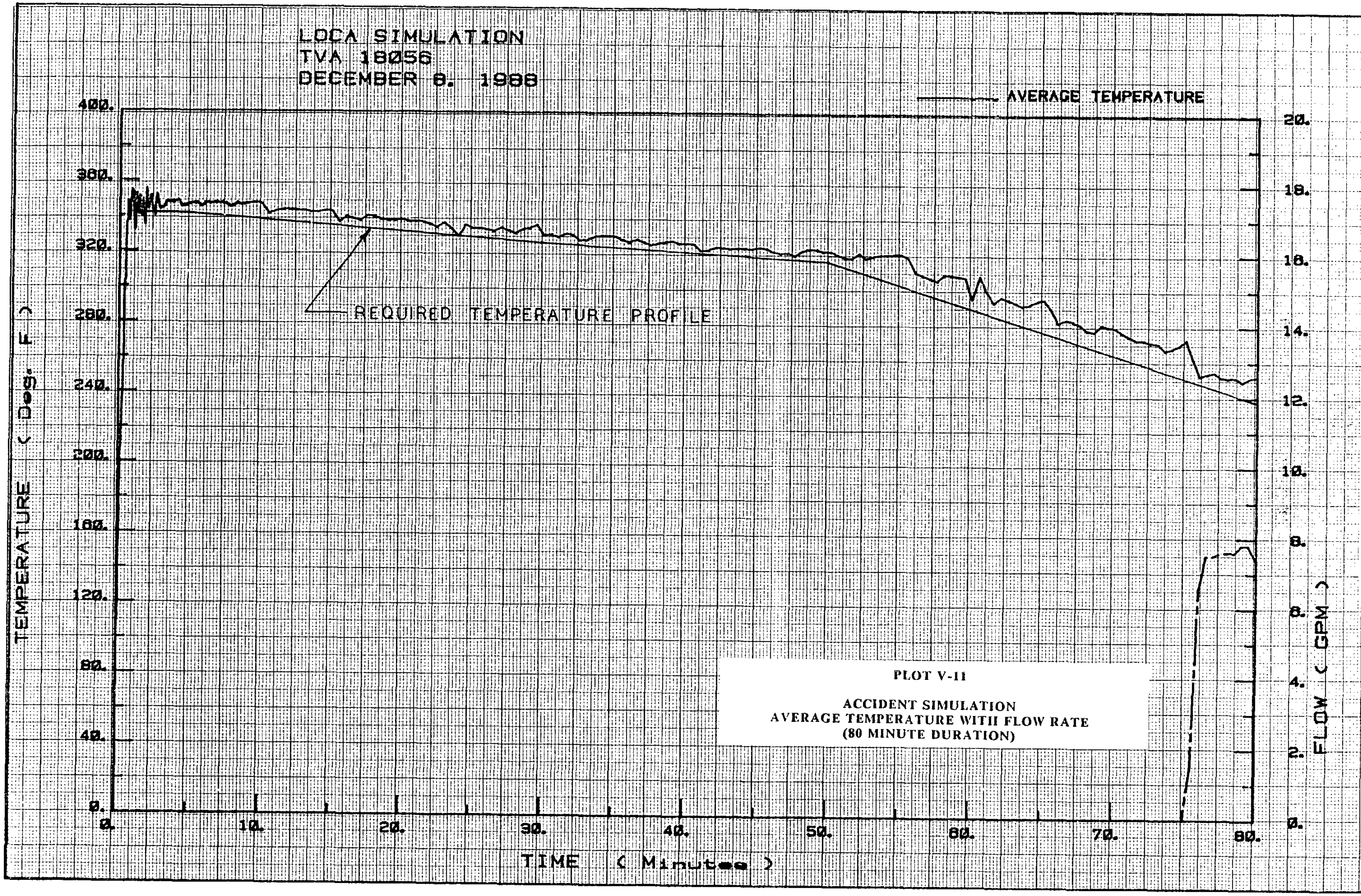
ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(16 MINUTE DURATION)

10 X 10 TO THE CENTIMETER • 25 X 38 CM



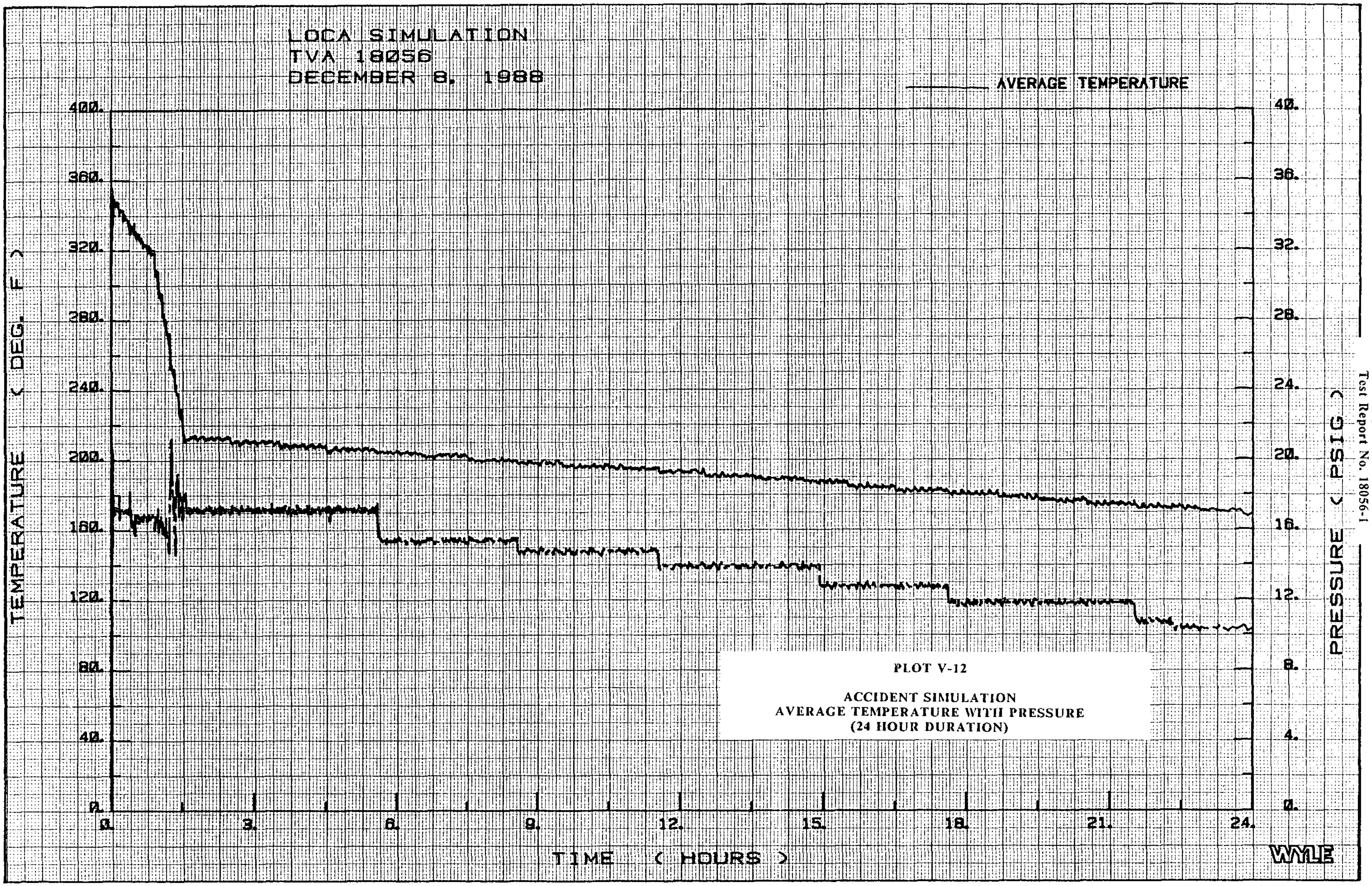
PLOT V-10

ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(80 MINUTE DURATION)



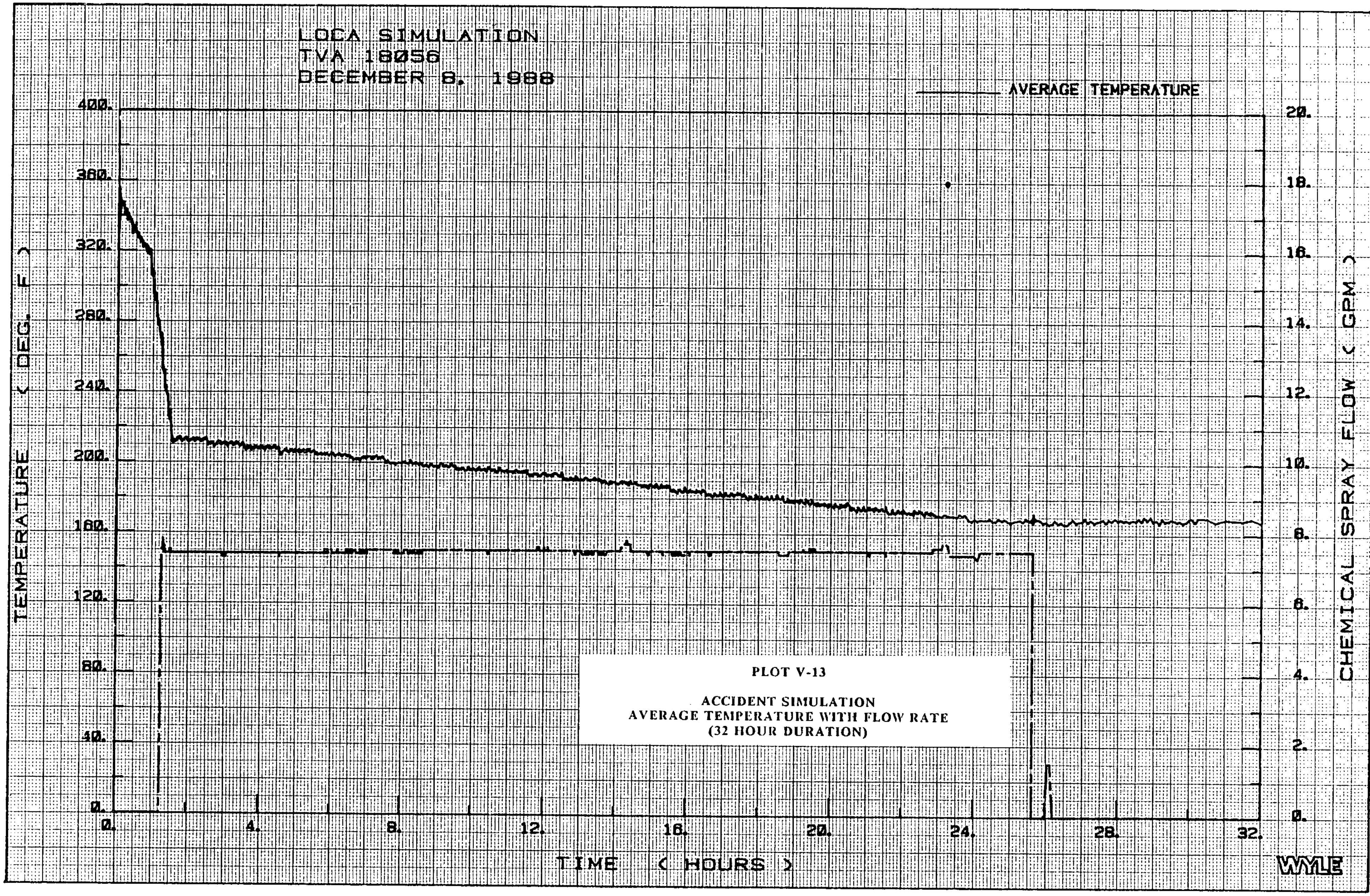
PLOT V-11

ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH FLOW RATE
(80 MINUTE DURATION)



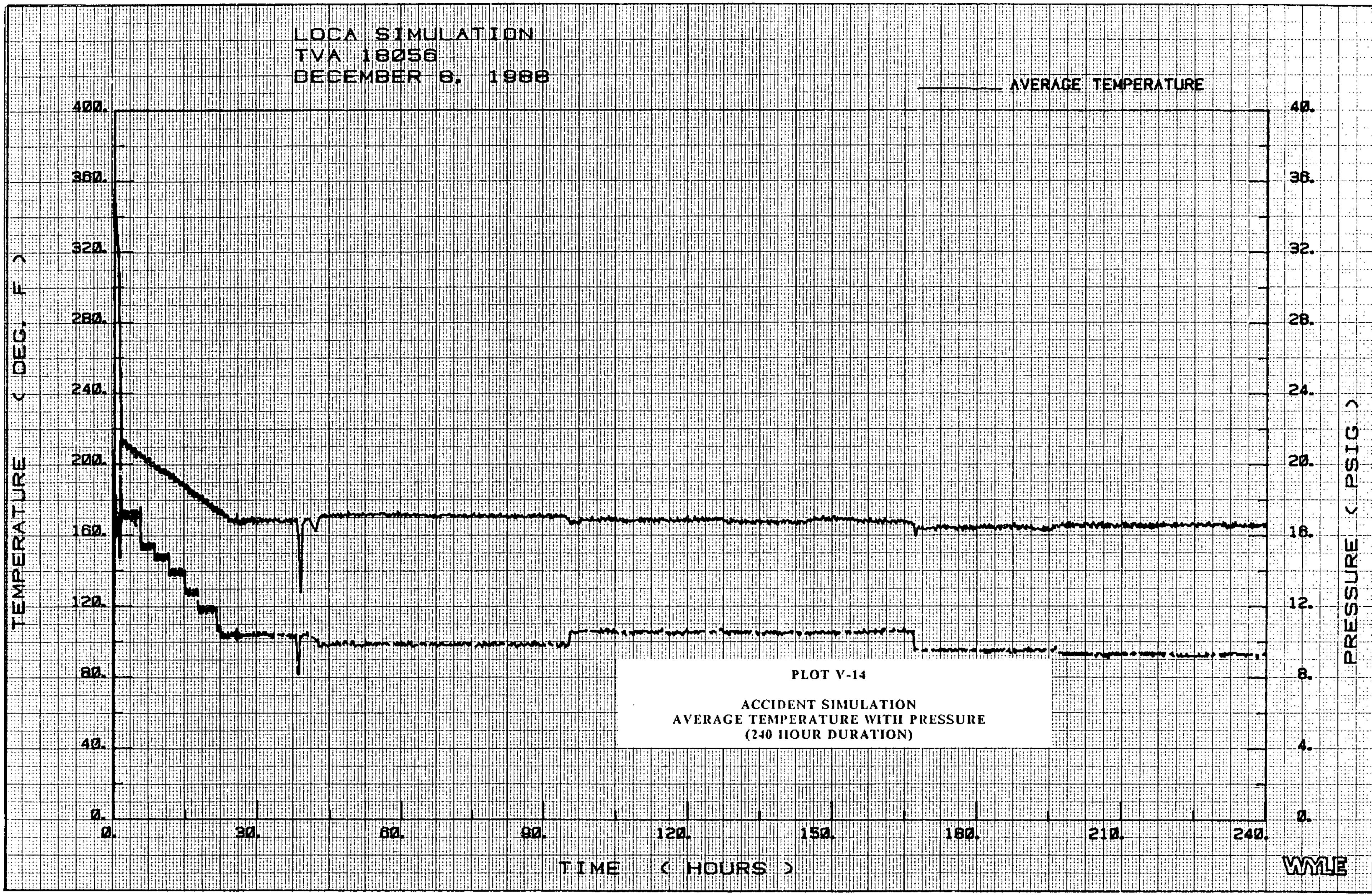
PLOT V-12

ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(24 HOUR DURATION)



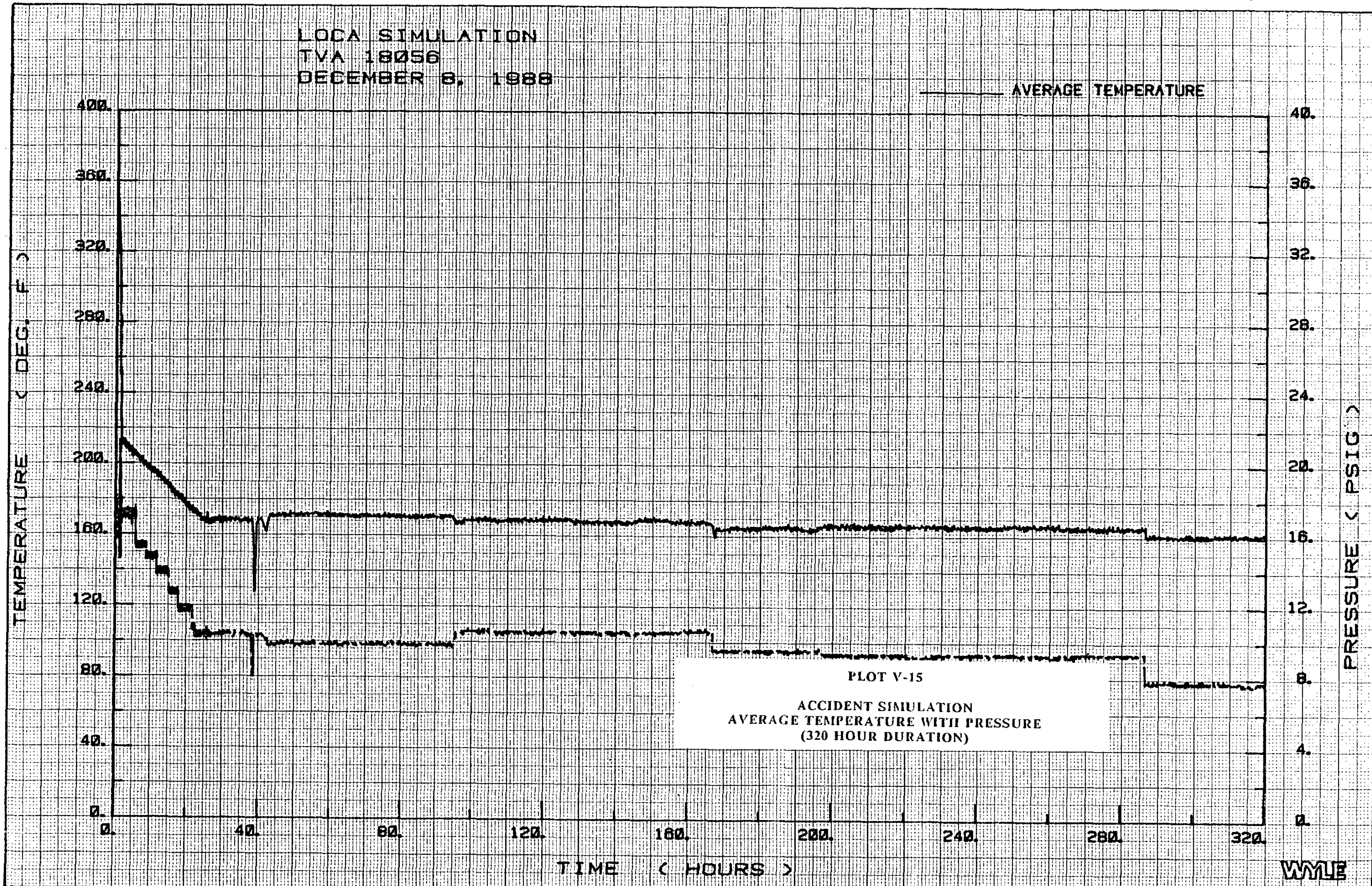
PLOT V-13

ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH FLOW RATE
(32 HOUR DURATION)



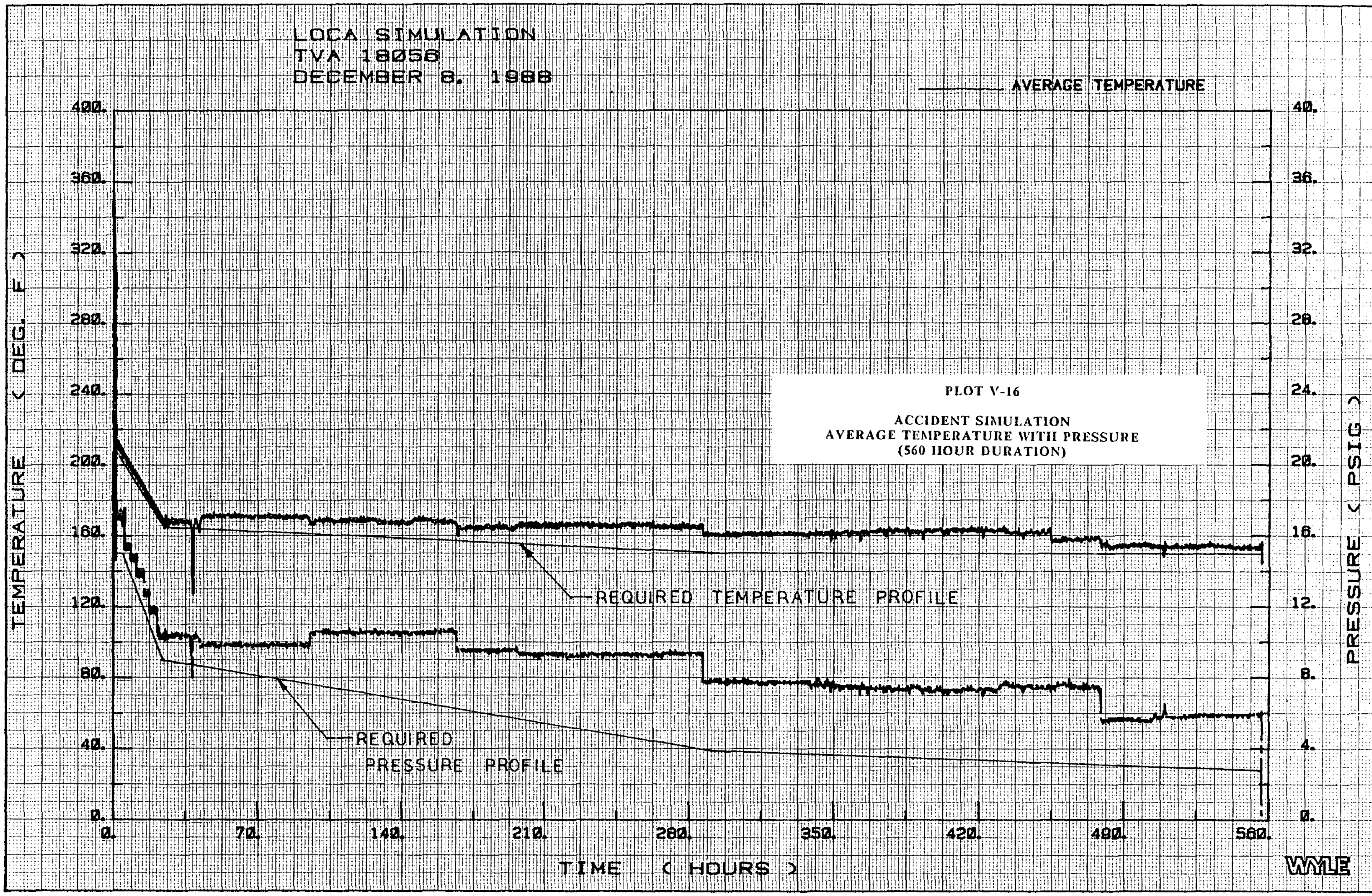
PLOT V-14

ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(240 HOUR DURATION)



PLOT V-15

ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(320 HOUR DURATION)

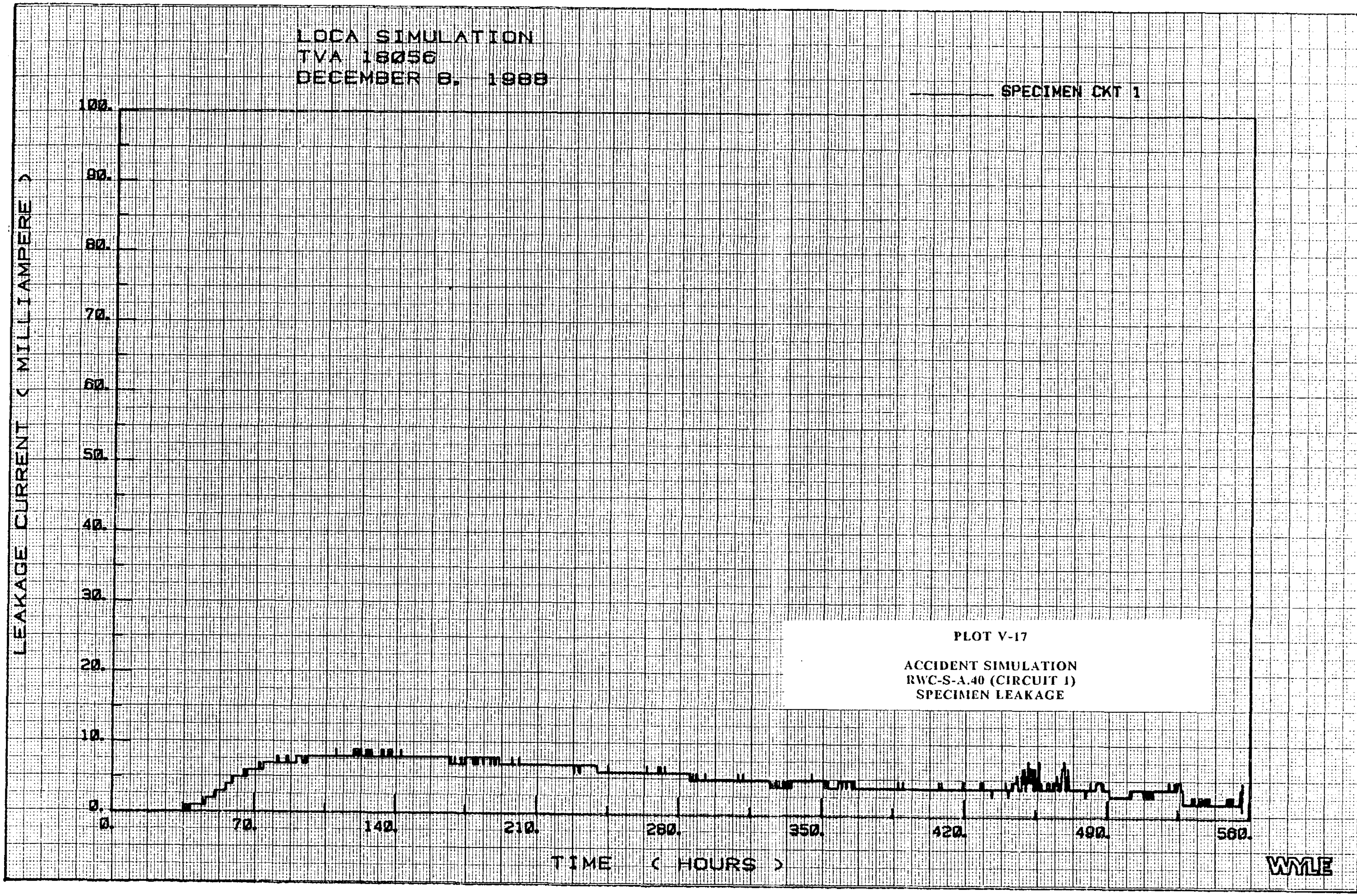


PLOT V-16

ACCIDENT SIMULATION
AVERAGE TEMPERATURE WITH PRESSURE
(560 HOUR DURATION)

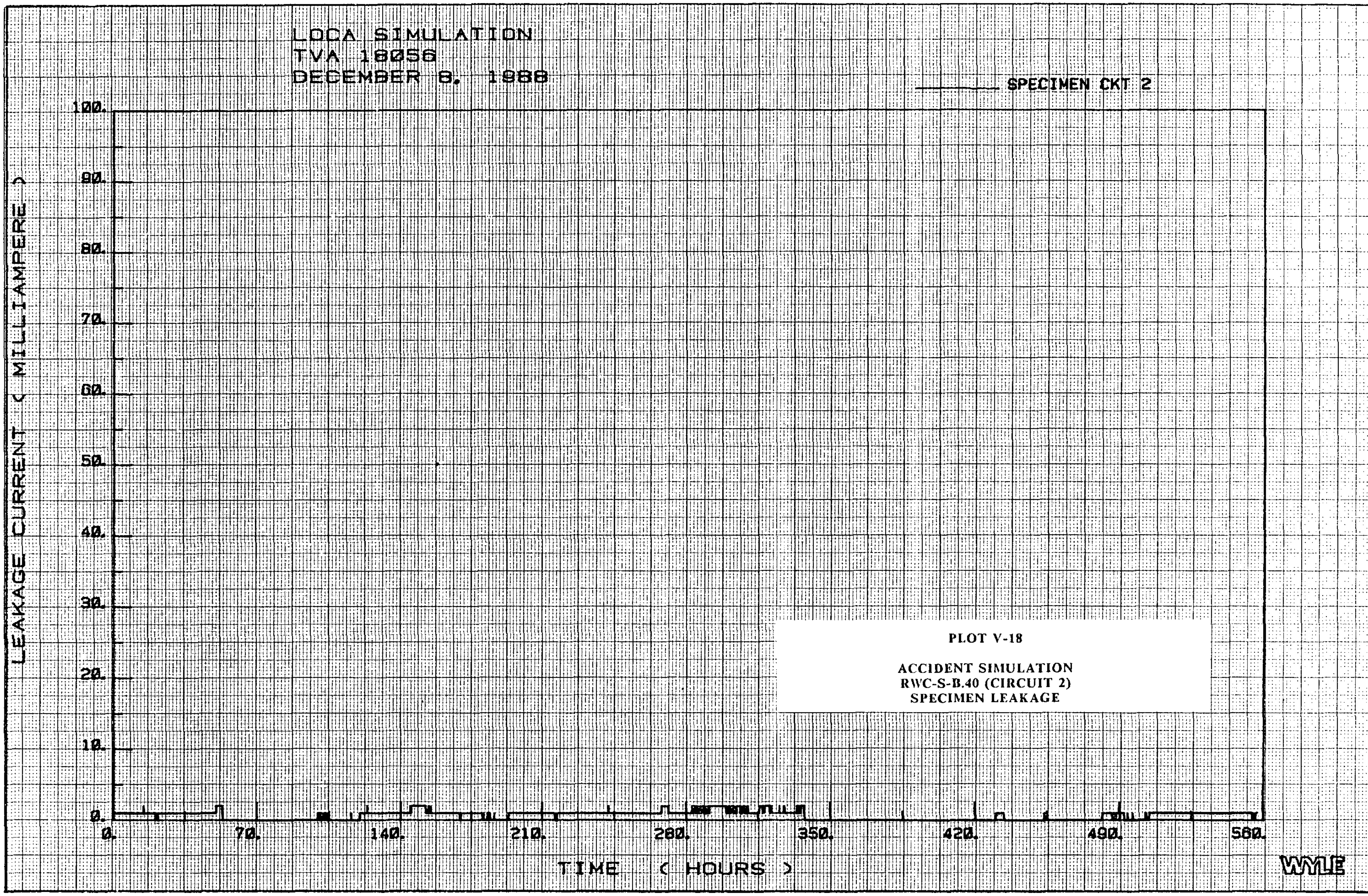
SPECIMEN CIRCUIT LEAKAGE PLOTS

THIS PAGE INTENTIONALLY LEFT BLANK



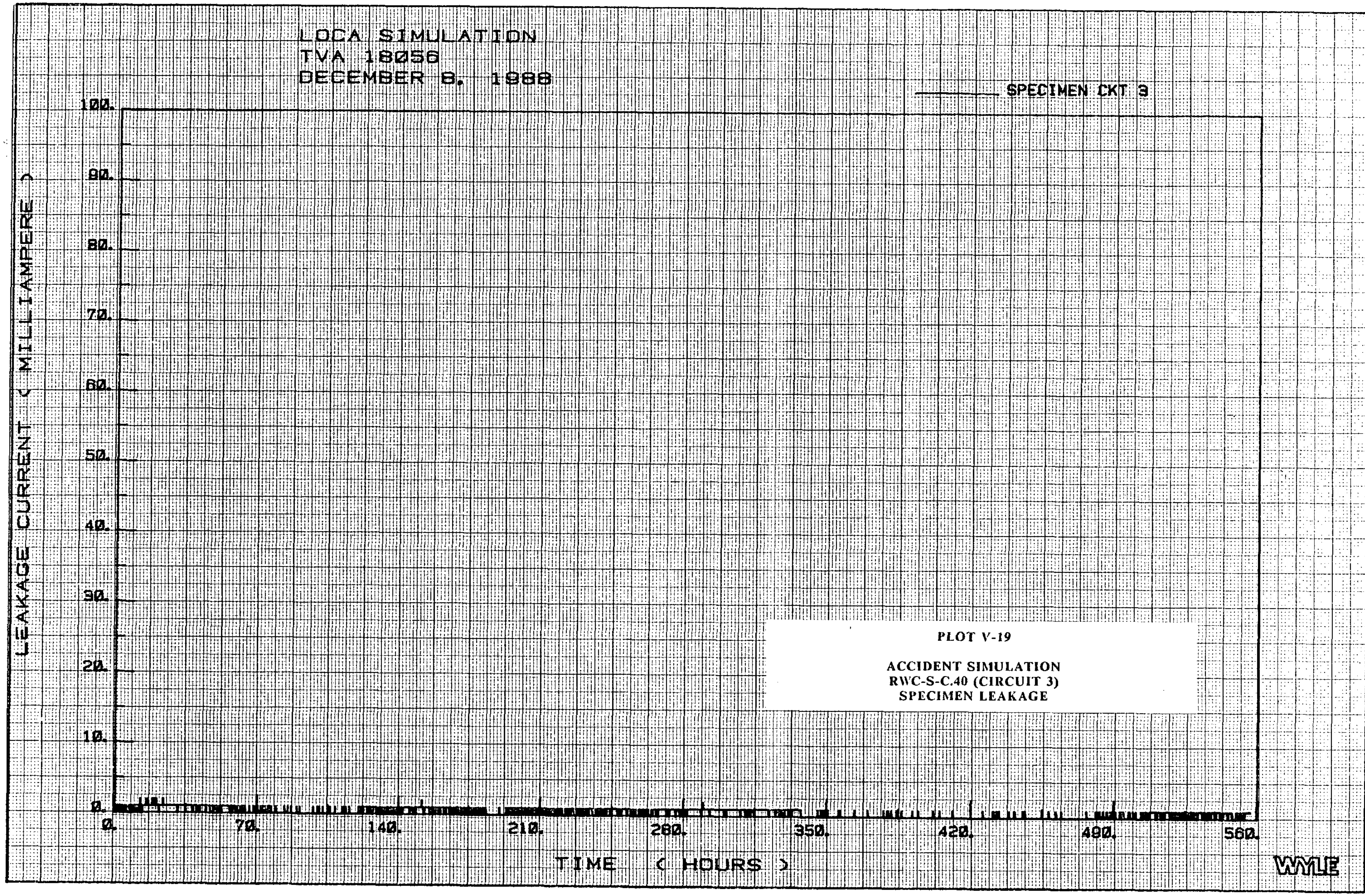
PLOT V-17

ACCIDENT SIMULATION
RWC-S-A.40 (CIRCUIT 1)
SPECIMEN LEAKAGE



PLOT V-18

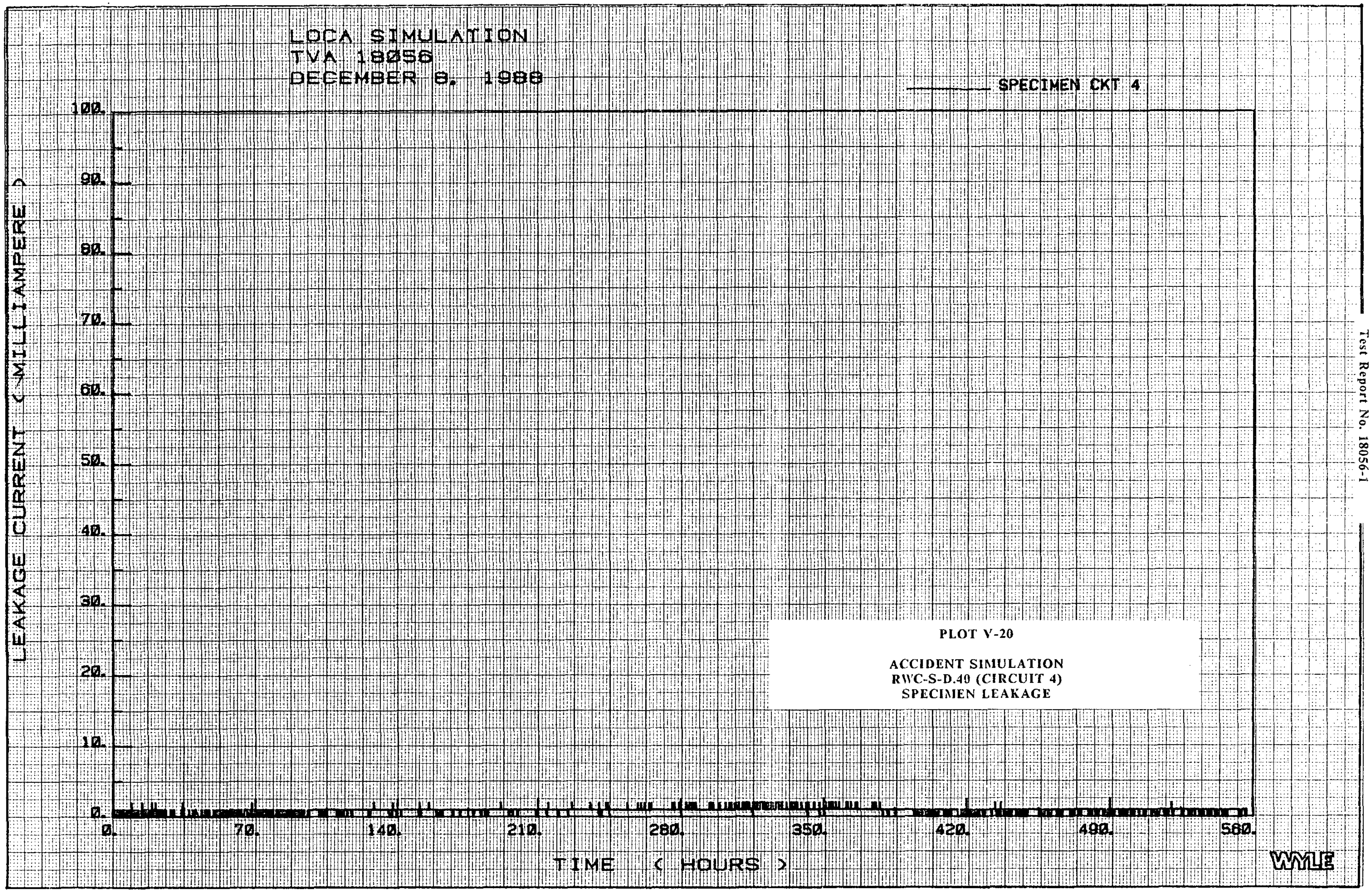
ACCIDENT SIMULATION
RWC-S-B.40 (CIRCUIT 2)
SPECIMEN LEAKAGE



PLOT V-19

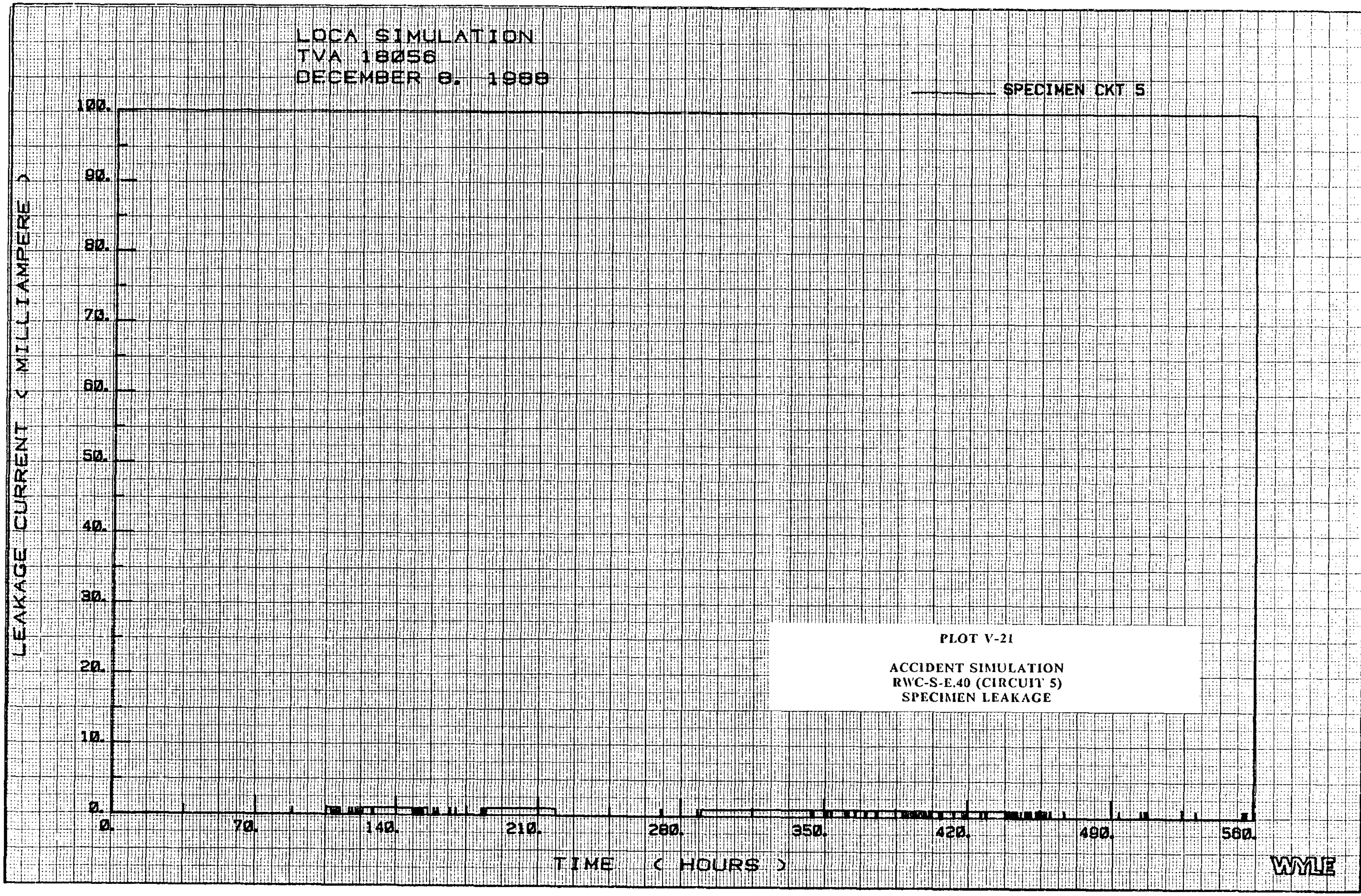
ACCIDENT SIMULATION
RWC-S-C.40 (CIRCUIT 3)
SPECIMEN LEAKAGE

10 X 10 TO THE CENTIMETER 425 X 38 CM



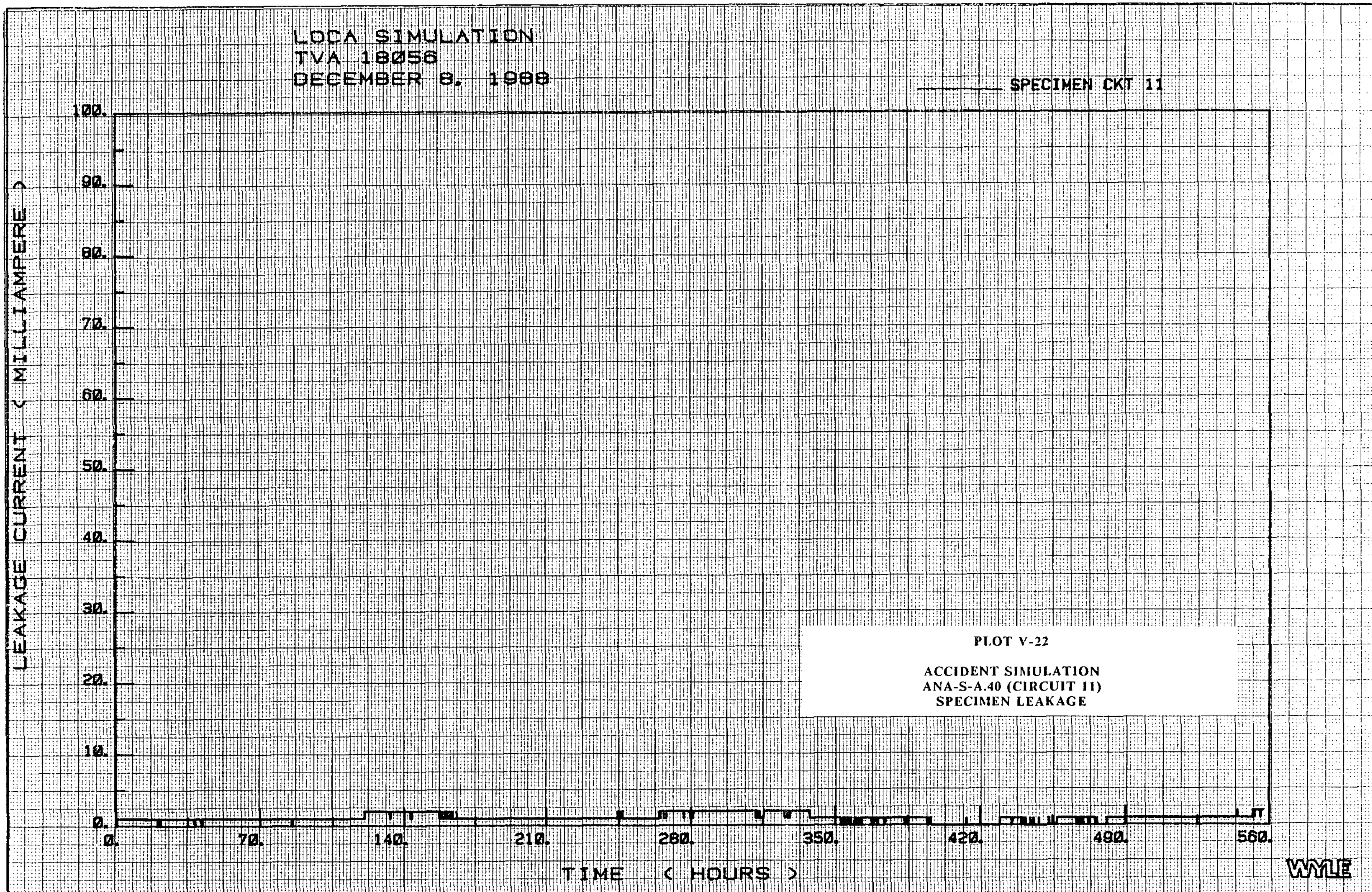
PLOT V-20

ACCIDENT SIMULATION
RWC-S-D.40 (CIRCUIT 4)
SPECIMEN LEAKAGE



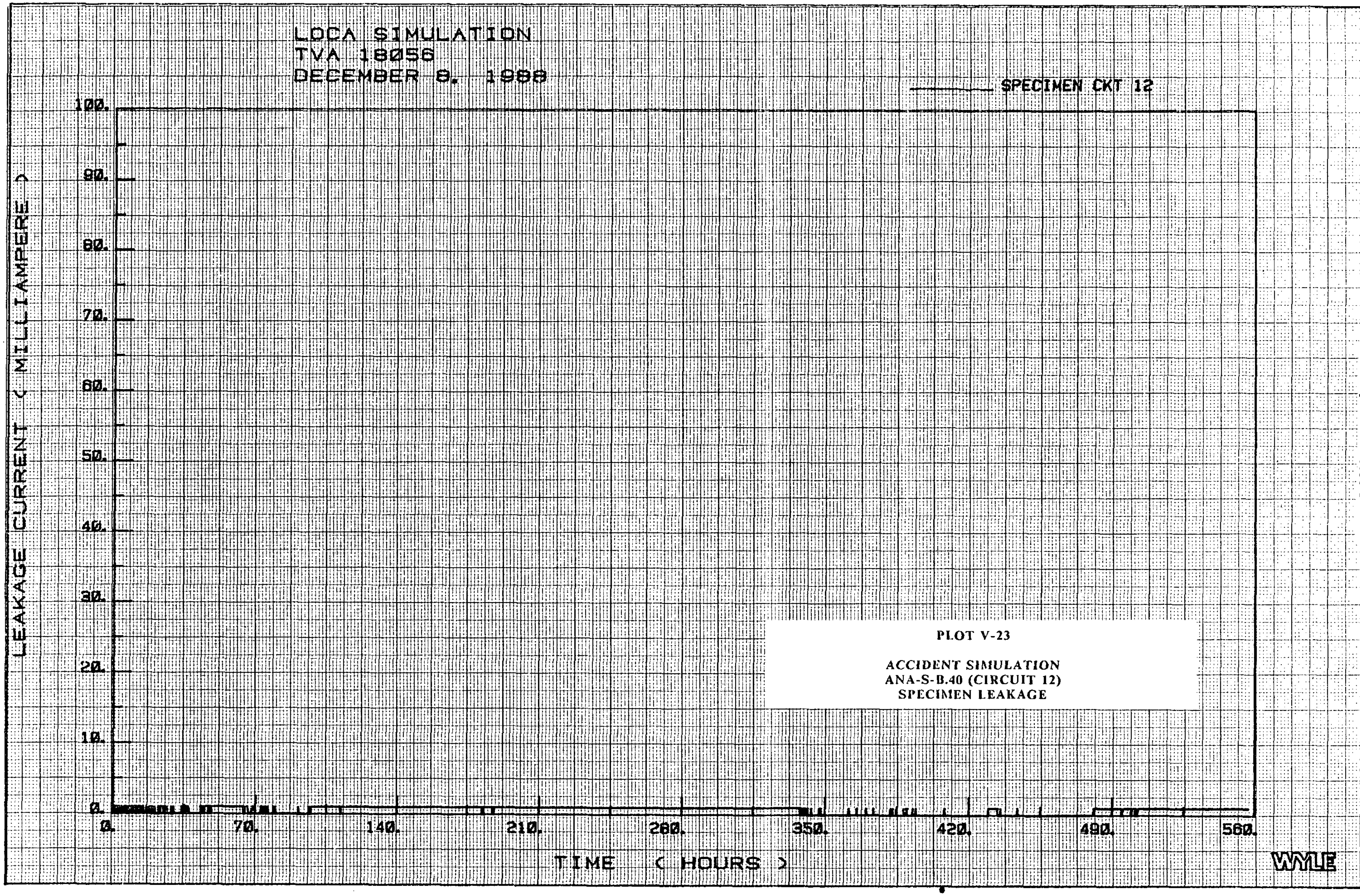
PLOT V-21

ACCIDENT SIMULATION
RWC-S-E.40 (CIRCUIT 5)
SPECIMEN LEAKAGE



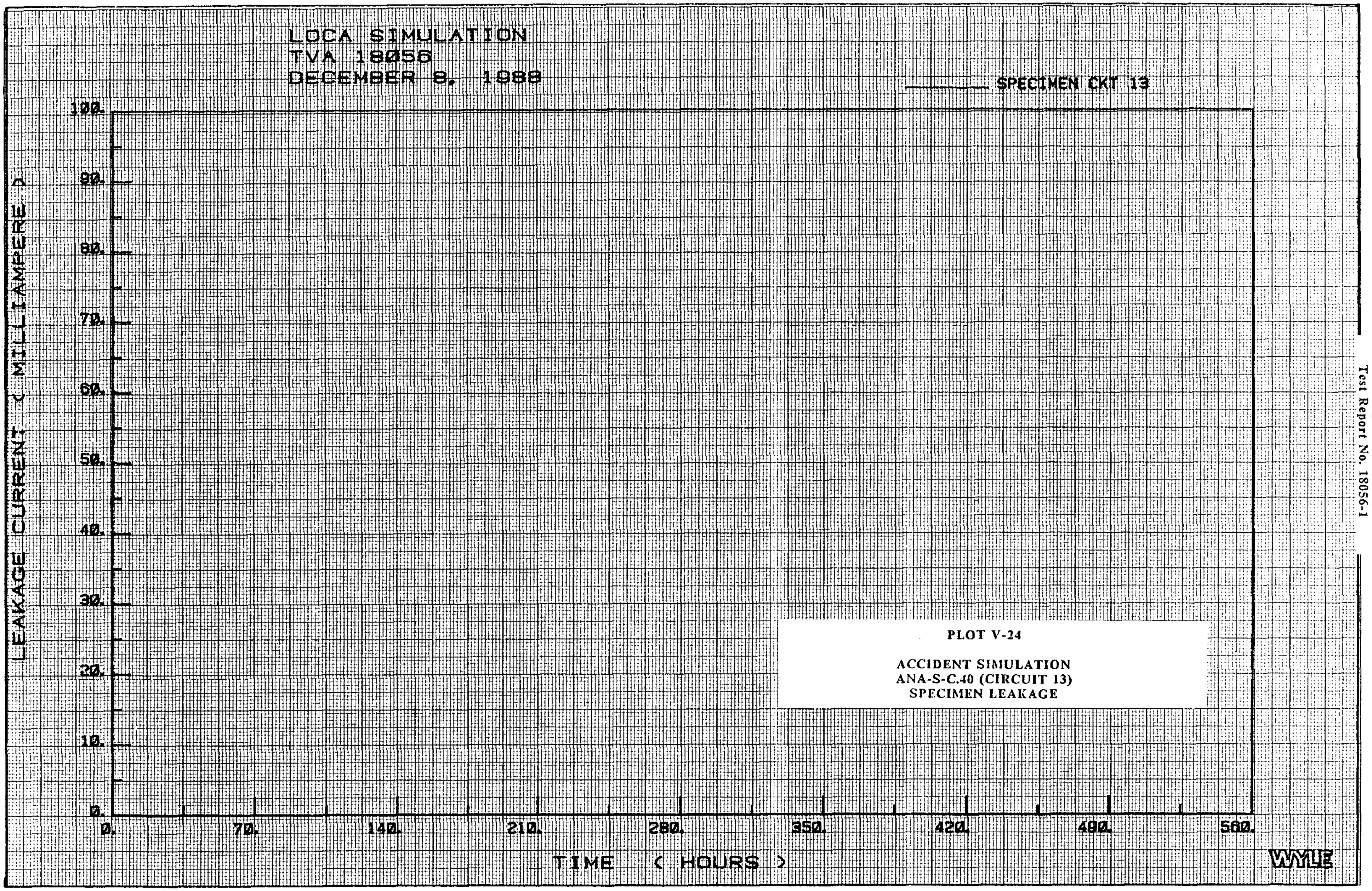
PLOT V-22

ACCIDENT SIMULATION
ANA-S-A.40 (CIRCUIT 11)
SPECIMEN LEAKAGE



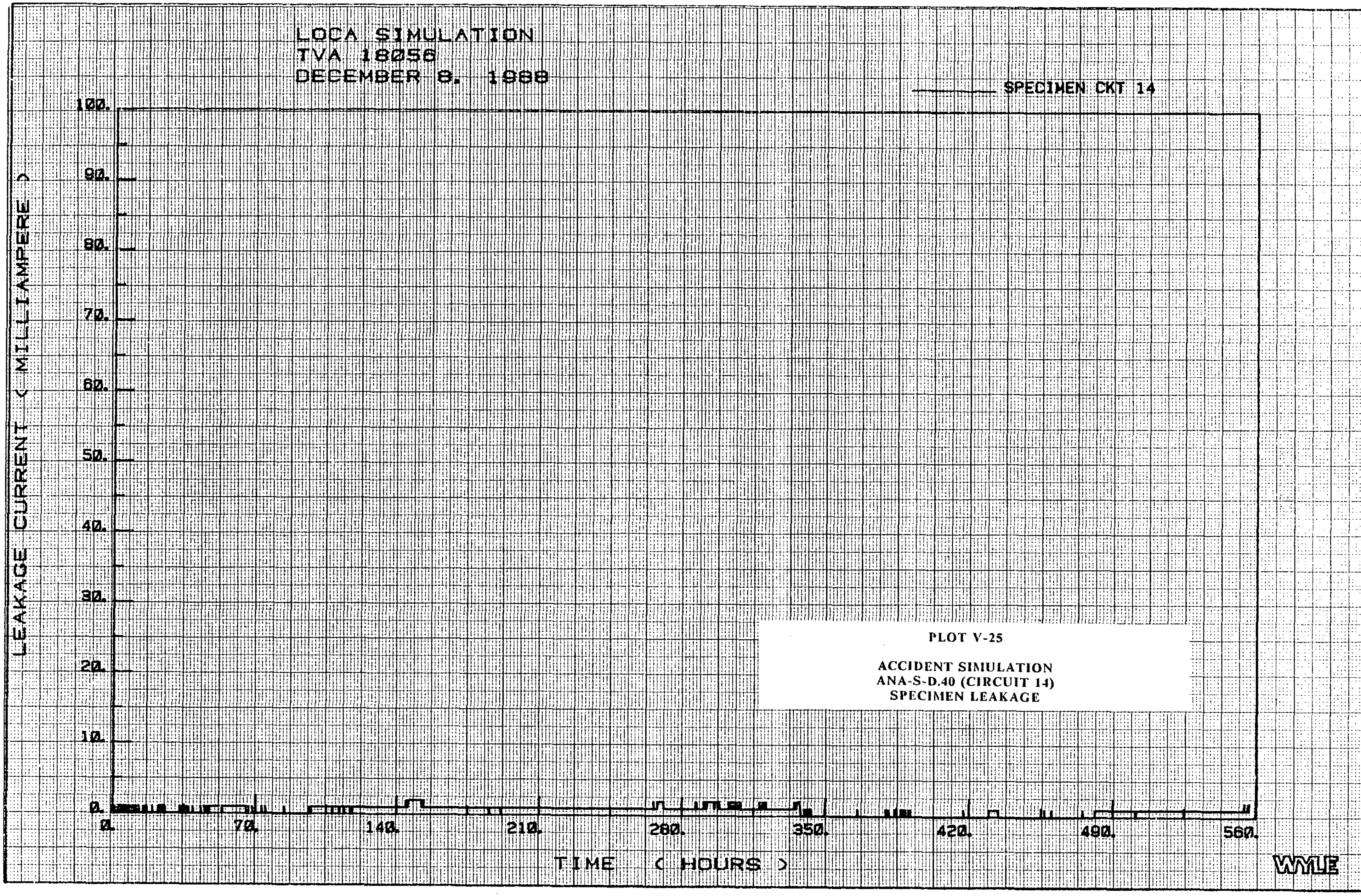
PLOT V-23

ACCIDENT SIMULATION
ANA-S-B.40 (CIRCUIT 12)
SPECIMEN LEAKAGE



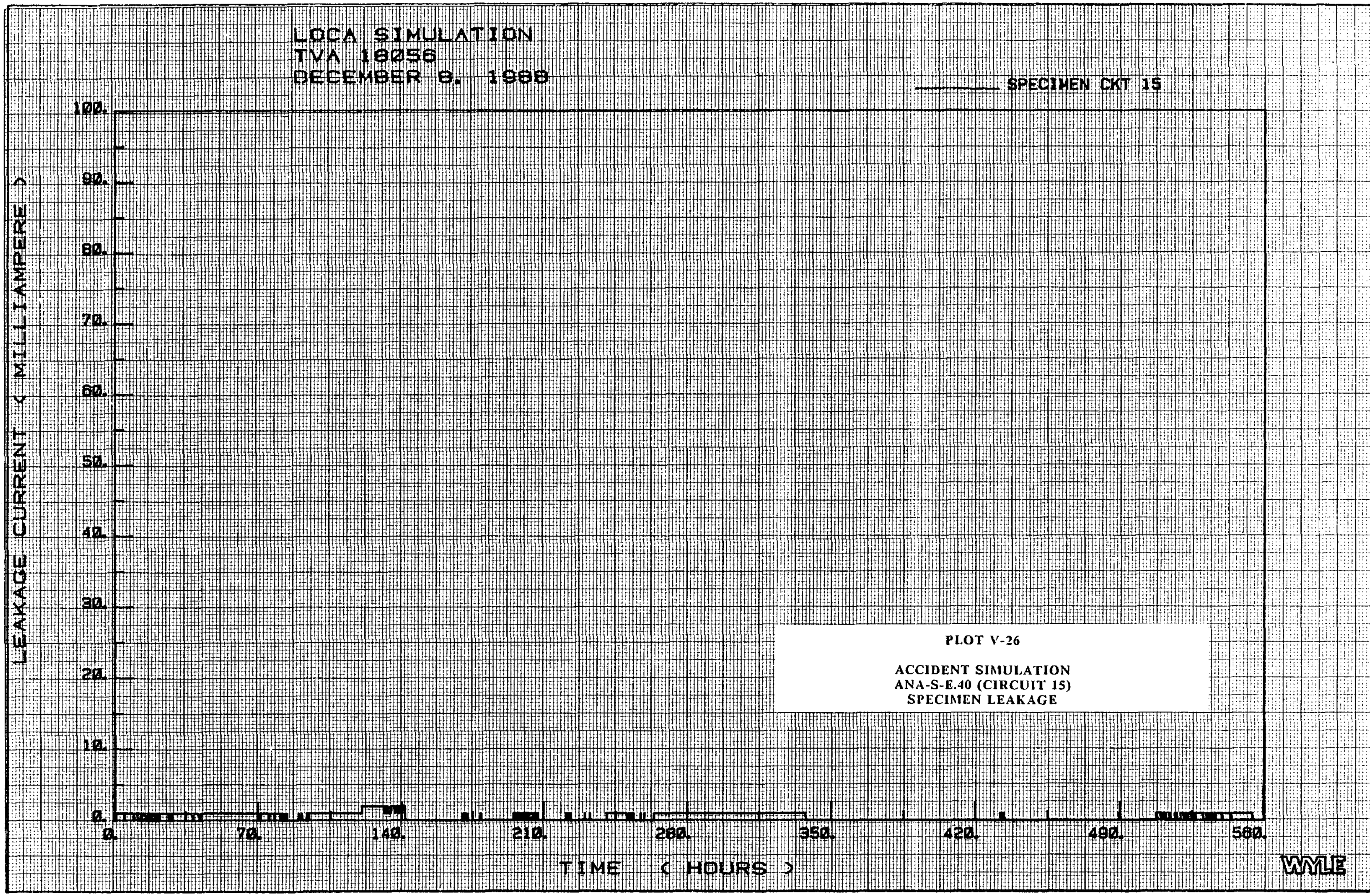
PLOT V-24

ACCIDENT SIMULATION
ANA-S-C.40 (CIRCUIT 13)
SPECIMEN LEAKAGE



PLOT V-25

ACCIDENT SIMULATION
ANA-S-D.40 (CIRCUIT 14)
SPECIMEN LEAKAGE



PLOT V-26

ACCIDENT SIMULATION
ANA-S-E.40 (CIRCUIT 15)
SPECIMEN LEAKAGE

ACCIDENT SIMULATION (LOCA) TEST DATA

THIS PAGE INTENTIONALLY LEFT BLANK

TYPICAL LINE PRINTER OUTPUT OF ENVIRONMENTAL AND ELECTRICAL CHANNELS

```
T/C #1   151.2 DEG  T/C #2   157.8 DEG  T/C #3   153.1 DEG  AVERAGE 154.0 DEG  PRESS     5.7 PSI  FLOW      0.0 GPM
SP 1 V     308 VAC  SP 2 V     309 VAC  SP 3 V     309 VAC  SP 4 V    309 VAC  SP 5 V    309 VAC  SP 6 V      0 VAC
SP 7 V       0 VAC  SP 8 V       0 VAC  SP 9 V       0 VAC  SP 10V      0 VAC  SP 11V    311 VAC  SP 12V    311 VAC
SP 13V     311 VAC  SP 14V     310 VAC  SP 15V     311 VAC.
SP 1CUR   15.9 ACA  SP 2CUR   15.9 ACA  SP 3CUR   15.8 ACA  SP 4CUR  15.8 ACA  SP 5CUR  16.0 ACA  SP 6CUR     0 ACA
SP 7CUR      0 ACA  SP 8CUR      0 ACA  SP 9CUR      0 ACA  SP10CUR     0 ACA  SP11CUR  22.0 ACA  SP12CUR  15.9 ACA
SP13CUR   22.5 ACA  SP14CUR   15.7 ACA  SP15CUR   22.4 ACA.
SP 1 LK      4 MA   SP 2 LK      0 MA   SP 3 LK      0 MA   SP 4 LK     0 MA   SP 5 LK     0 MA   SP 6 LK     0 MA
SP 7 LK      0 MA   SP 8 LK      0 MA   SP 9 LK      0 MA   SP10 LK     0 MA   SP11 LK     1 MA   SP12 LK     1 MA
SP13 LK      0 MA   SP14 LK      1 MA   SP15 LK      0 MA.
     TVA 18056    T. WALTER    12/28/88 16:10:39
```

```
T/C #1   151.0 DEG  T/C #2   158.0 DEG  T/C #3   153.5 DEG  AVERAGE 154.4 DEG  PRESS     5.7 PSI  FLOW      0.0 GPM
SP 1 V     308 VAC  SP 2 V     309 VAC  SP 3 V     309 VAC  SP 4 V    309 VAC  SP 5 V    309 VAC  SP 6 V      0 VAC
SP 7 V       0 VAC  SP 8 V       0 VAC  SP 9 V       0 VAC  SP 10V      0 VAC  SP 11V    310 VAC  SP 12V    310 VAC
SP 13V     310 VAC  SP 14V     310 VAC  SP 15V     310 VAC.
SP 1CUR   15.9 ACA  SP 2CUR   15.9 ACA  SP 3CUR   15.8 ACA  SP 4CUR  15.8 ACA  SP 5CUR  16.0 ACA  SP 6CUR     0 ACA
SP 7CUR      0 ACA  SP 8CUR      0 ACA  SP 9CUR      0 ACA  SP10CUR     0 ACA  SP11CUR  22.0 ACA  SP12CUR  15.8 ACA
SP13CUR   22.5 ACA  SP14CUR   15.7 ACA  SP15CUR   22.4 ACA.
SP 1 LK      4 MA   SP 2 LK      1 MA   SP 3 LK      0 MA   SP 4 LK     1 MA   SP 5 LK     0 MA   SP 6 LK     0 MA
SP 7 LK      0 MA   SP 8 LK      0 MA   SP 9 LK      0 MA   SP10 LK     0 MA   SP11 LK     1 MA   SP12 LK     1 MA
SP13 LK      0 MA   SP14 LK      1 MA   SP15 LK      0 MA.
     TVA 18056    T. WALTER    12/28/88 16:25:39
```

```
T/C #1   151.2 DEG  T/C #2   157.1 DEG  T/C #3   152.9 DEG  AVERAGE 153.7 DEG  PRESS     5.7 PSI  FLOW      0.0 GPM
SP 1 V     308 VAC  SP 2 V     309 VAC  SP 3 V     309 VAC  SP 4 V    309 VAC  SP 5 V    309 VAC  SP 6 V      0 VAC
SP 7 V       0 VAC  SP 8 V       0 VAC  SP 9 V       0 VAC  SP 10V      0 VAC  SP 11V    312 VAC  SP 12V    312 VAC
SP 13V     312 VAC  SP 14V     311 VAC  SP 15V     311 VAC.
SP 1CUR   15.9 ACA  SP 2CUR   16.0 ACA  SP 3CUR   15.9 ACA  SP 4CUR  15.8 ACA  SP 5CUR  16.0 ACA  SP 6CUR     0 ACA
SP 7CUR      0 ACA  SP 8CUR      0 ACA  SP 9CUR      0 ACA  SP10CUR     0 ACA  SP11CUR  22.1 ACA  SP12CUR  15.9 ACA
SP13CUR   22.5 ACA  SP14CUR   15.8 ACA  SP15CUR   22.5 ACA.
SP 1 LK      5 MA   SP 2 LK      0 MA   SP 3 LK      0 MA   SP 4 LK     1 MA   SP 5 LK     0 MA   SP 6 LK     0 MA
SP 7 LK      0 MA   SP 8 LK      0 MA   SP 9 LK      0 MA   SP10 LK     0 MA   SP11 LK     1 MA   SP12 LK     1 MA
SP13 LK      0 MA   SP14 LK      1 MA   SP15 LK      0 MA.
     TVA 18056    T. WALTER    12/28/88 16:40:39
```

```
T/C #1   151.9 DEG  T/C #2   157.1 DEG  T/C #3   153.8 DEG  AVERAGE 154.3 DEG  PRESS     5.7 PSI  FLOW      0.0 GPM
SP 1 V     306 VAC  SP 2 V     307 VAC  SP 3 V     307 VAC  SP 4 V    307 VAC  SP 5 V    307 VAC  SP 6 V      0 VAC
SP 7 V       0 VAC  SP 8 V       0 VAC  SP 9 V       0 VAC  SP 10V      0 VAC  SP 11V    309 VAC  SP 12V    309 VAC
SP 13V     309 VAC  SP 14V     309 VAC  SP 15V     309 VAC.
SP 1CUR   15.8 ACA  SP 2CUR   15.9 ACA  SP 3CUR   15.7 ACA  SP 4CUR  15.7 ACA  SP 5CUR  15.9 ACA  SP 6CUR     0 ACA
SP 7CUR      0 ACA  SP 8CUR      0 ACA  SP 9CUR      0 ACA  SP10CUR     0 ACA  SP11CUR  21.9 ACA  SP12CUR  15.8 ACA
SP13CUR   22.3 ACA  SP14CUR   15.7 ACA  SP15CUR   22.3 ACA.
SP 1 LK      4 MA   SP 2 LK      0 MA   SP 3 LK      1 MA   SP 4 LK     1 MA   SP 5 LK     0 MA   SP 6 LK     0 MA
SP 7 LK      0 MA   SP 8 LK      0 MA   SP 9 LK      0 MA   SP10 LK     0 MA   SP11 LK     1 MA   SP12 LK     1 MA
SP13 LK      0 MA   SP14 LK      1 MA   SP15 LK      0 MA.
     TVA 18056    T. WALTER    12/28/88 16:55:39
```

DATA SHEET

Customer T.V.A.
WYLE LABORATORIES
Specimen SILICONE RUBBER INSULATED CABLES
Part No. VARIOUS
Amb. Temp. 75°F
Job No. 18056
Spec. WLQP 18057-00, IPR 01
Photo No
Report No. 18056-1
Para. 3.10.7
Test Med. WATER
Start Date 12-8-88
S/N TEST SPECIMENS
Specimen Temp. VARIOUS
GSI N/A

Test Title CHEM SPRAY FLOW RATE & PH LEVEL

TIME	FLOW RATE	PH	INITIALS
0945	N/A	9.0	BJ
10.20	7.5 gpm	9.0	BJ
10.35	7.5 gpm	9.0	BJ
11:05	7.4 gpm	9.0	JJ
12:00	7.4 gpm	9.0	JJ
13:00	7.4 gpm	9.0	JJ
14:00	7.4 gpm	9.0	JJ
15:00	7.4 gpm	9.0	JJ
16:00	7.5 gpm	9.0	JJ
17:00	7.5 gpm	9.0	JJ
18:00	7.4 gpm	9.0	JJ
1900	7.5 gpm	9.0	BHB
2000	7.5 gpm	9.0	BHB
2100	7.5 gpm	9.0	BHB
2200	7.5 gpm	9.0	BHB
2300	7.5 gpm	9.0	BHB
0000 12/9/88	7.5 gpm	8.9	BHB
0100	7.5 gpm	8.9	BHB
0200	7.5 gpm	8.8	BHB
0300	7.5 gpm	8.8	BHB

Tested By [signature] Date: 12-8-88
Witness [signature] Date: 12-9-88
Sheet No. 1 of 2
Approved Robert Todd Walts 12-28-88

Notice of Anomaly ~~None~~ RTW #4

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer TVA
Specimen SILICONE RUBBER INSULATED CABLES
Part No. VARIOUS
Spec. WLQP 18057-00, IPR 01
Para. 3.10.7
S/N TEST SPECIMENS
GSI N/A

Amb. Temp. 75°F
Photo NO
Test Med. WATER
Specimen Temp. VARIOUS

Job No. 18056
Report No. 18056-1
Start Date 12/9/88

Test Title CHEM SPRAY FLOWRATE & PH Level

Time	Flow/Rate	P.H.	Initials
0400	7.5 gpm	8.7	BHB
0500	7.5 gpm	8.7	BHB
06:00	7.5 gpm	8.7	JJ
07:00	7.5 gpm	8.7	JJ
08:00	7.5 gpm	8.6	JJ
	08:15 ADDED CAUSTIC TO BOOST PH up TO 9.5		JJ
09:00	7.4 gpm	9.5	JJ
10:00	7.5	9.5	JJ
10:40	7.5	9.5	JJ
10:40	END OF CHEM SPRAY. SHUT DOWN @ THIS TIME		JJ

Notice of Anomaly ~~NONE~~ RTW #4

Tested By [signature] Date: 12/9/88
Witness [signature] Date: 12-9-88
Sheet No. 2 of 2
Approved Robert [signature] 12-28-88

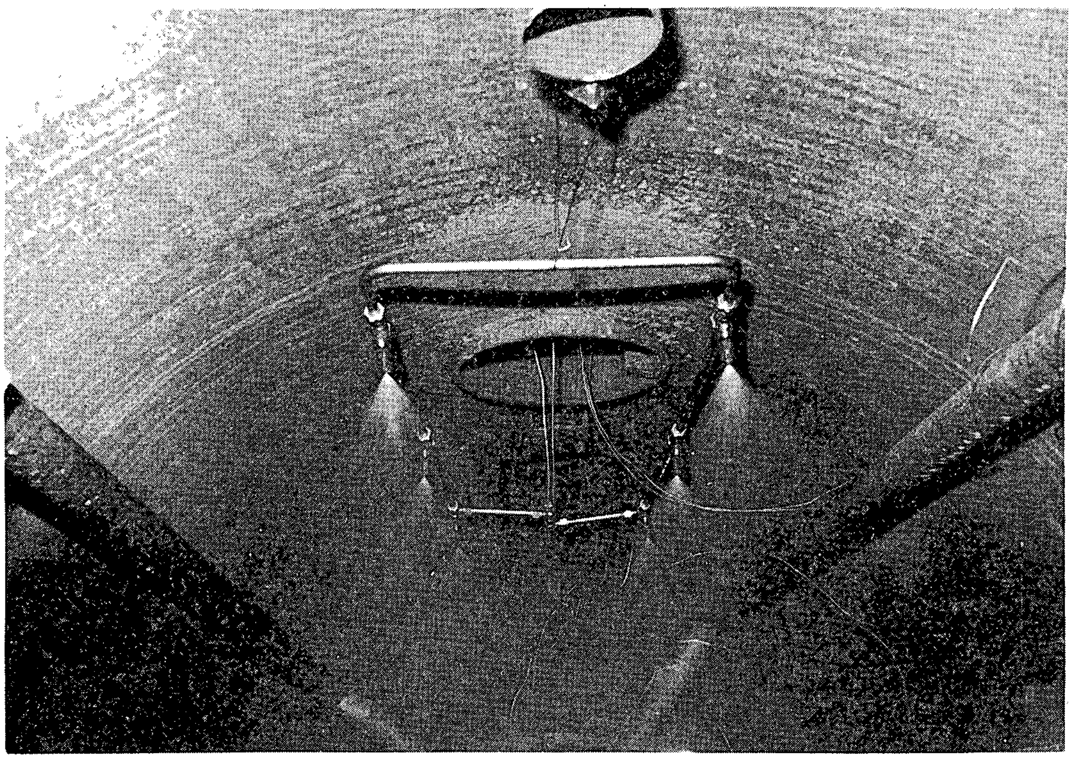
Wyle Form WH 614A, Rev. APR '84

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX V

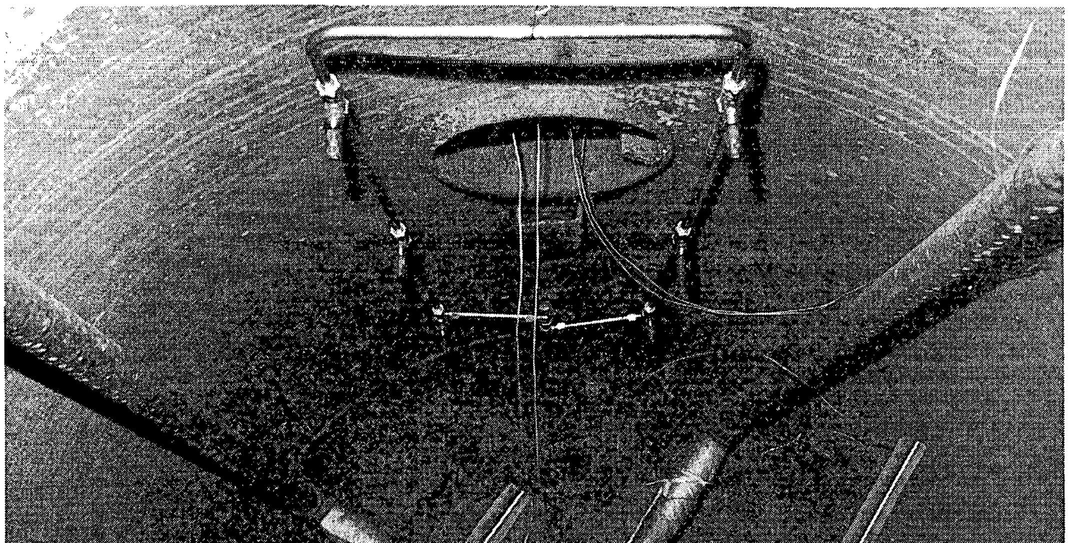
PHOTOGRAPHS

THIS PAGE INTENTIONALLY LEFT BLANK



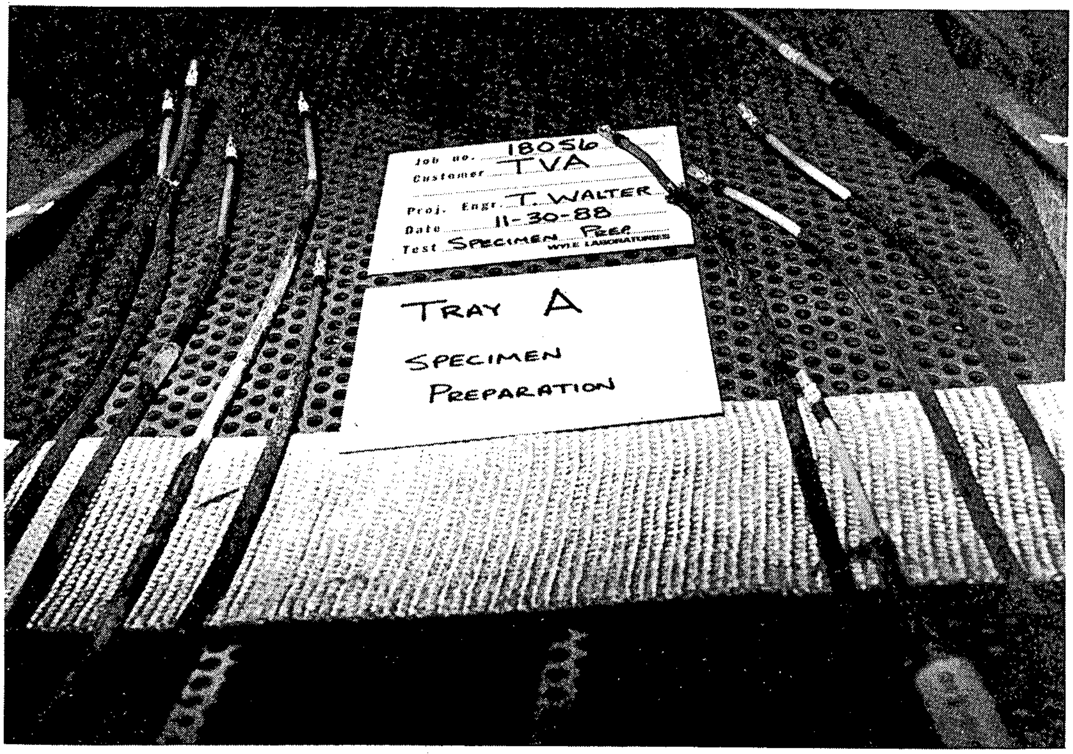
PHOTOGRAPH V-1

TRIAL RUN TEST SETUP
TEST OF CHEMICAL SPRAY SYSTEM USING DI WATER



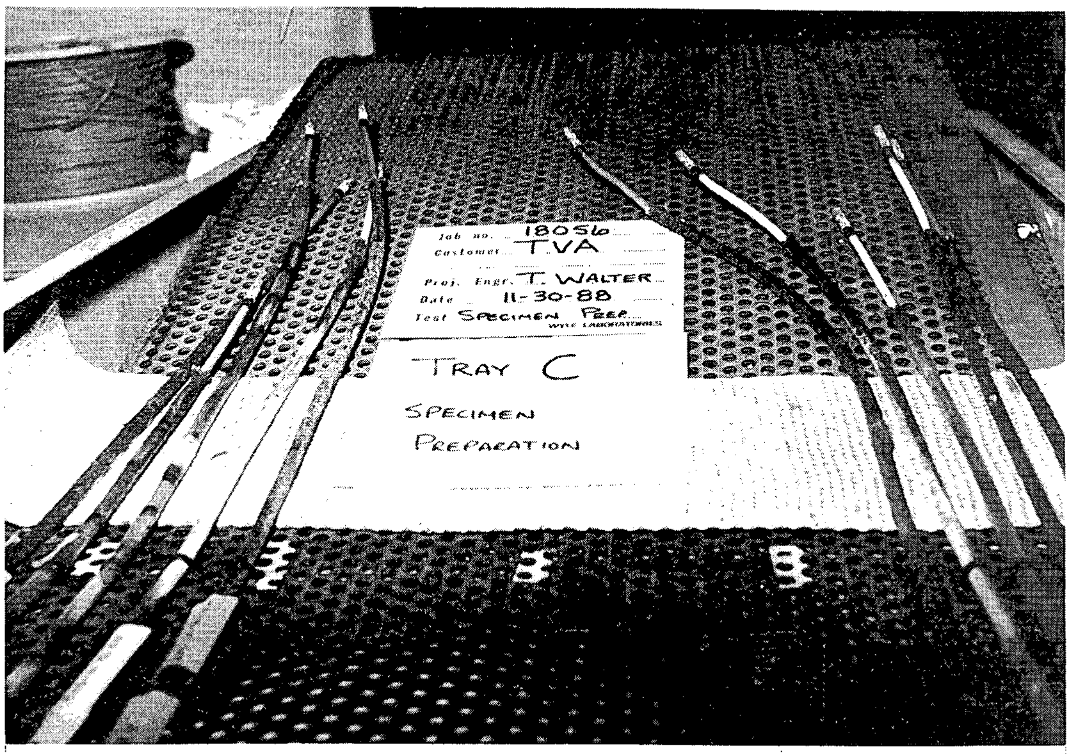
PHOTOGRAPH V-2

TRIAL RUN TEST SETUP
DUMMY LOAD CABLE TRAYS WITH THERMOCOUPLES ATTACHED



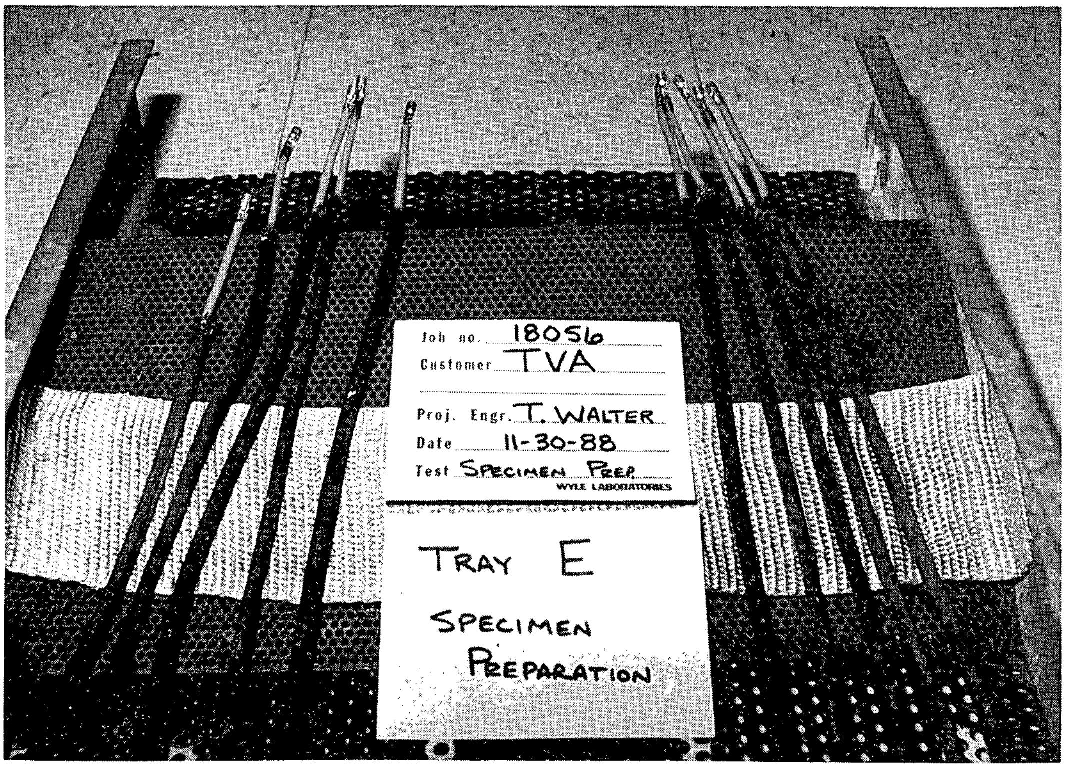
PHOTOGRAPH V-3

SPECIMEN PREPARATION
CABLE TRAY A TEST SPECIMENS WITH BUTT SPLICES
AND ADAPTERS CRIMPED TO 14AWG LEAD ENDS



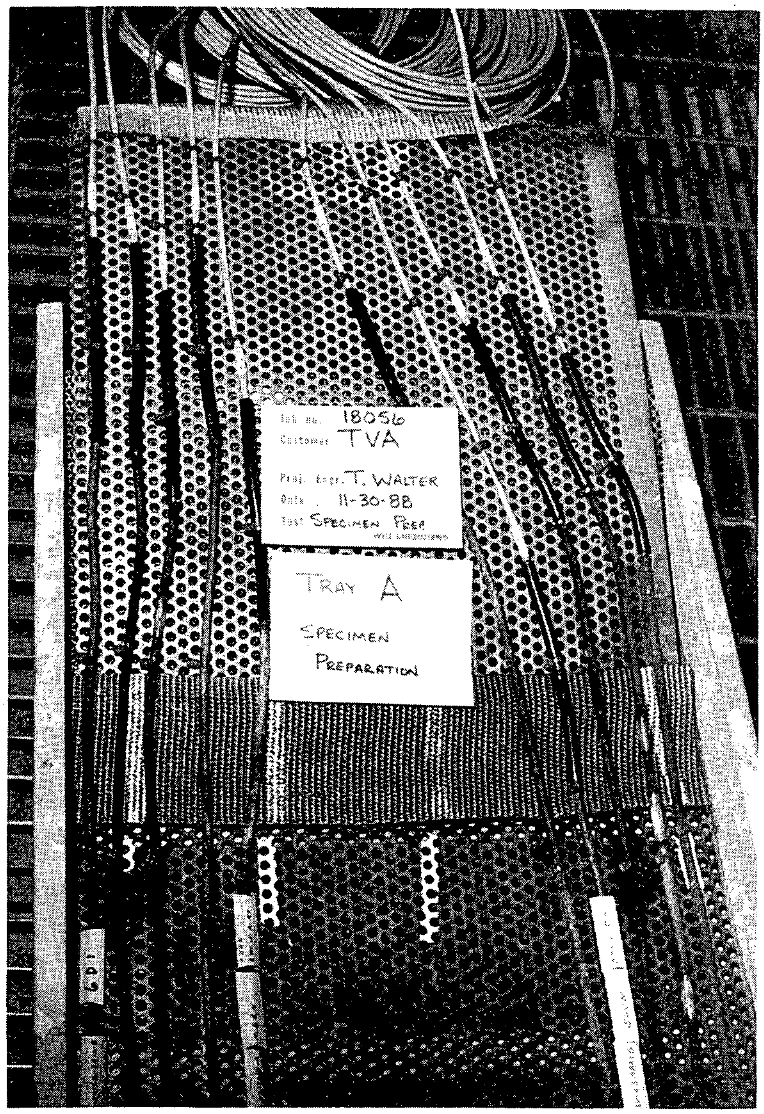
PHOTOGRAPH V-4

SPECIMEN PREPARATION
CABLE TRAY C TEST SPECIMENS WITH BUTT SPLICES
AND ADAPTERS CRIMPED TO 14AWG LEAD ENDS



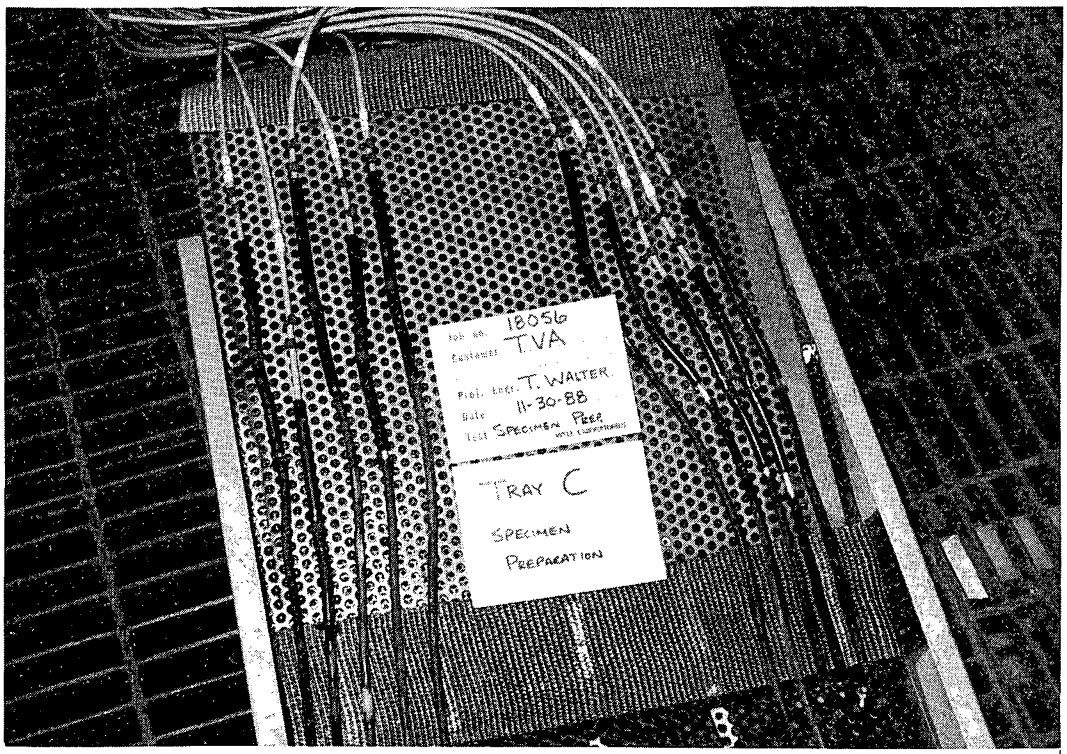
PHOTOGRAPH V-5

SPECIMEN PREPARATION
CABLE TRAY E TEST SPECIMENS WITH BUTT SPLICES CRIMPED TO 12AWG LEAD ENDS AND BUTT SPLICES WITH ADAPTERS CRIMPED TO 14AWG LEAD ENDS



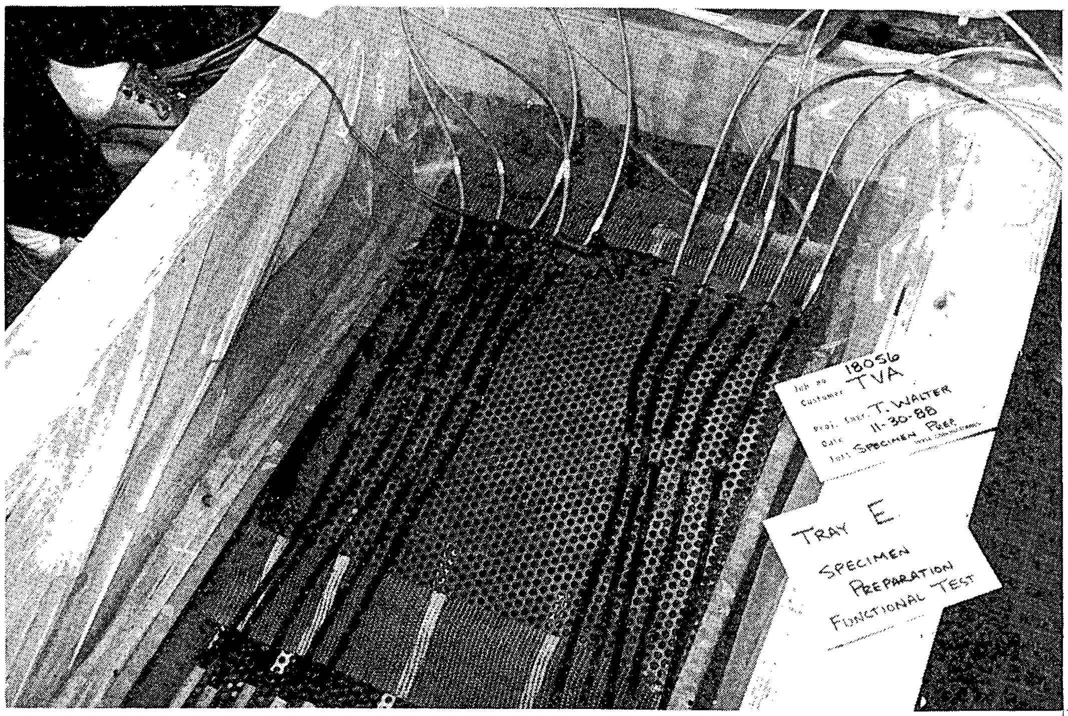
PHOTOGRAPH V-6

SPECIMEN PREPARATION
CABLE TRAY A TEST SPECIMENS WITH SPLICES AND TEST LEADS SECURED TO THE INCLINED SECTION OF THE CABLE TRAY



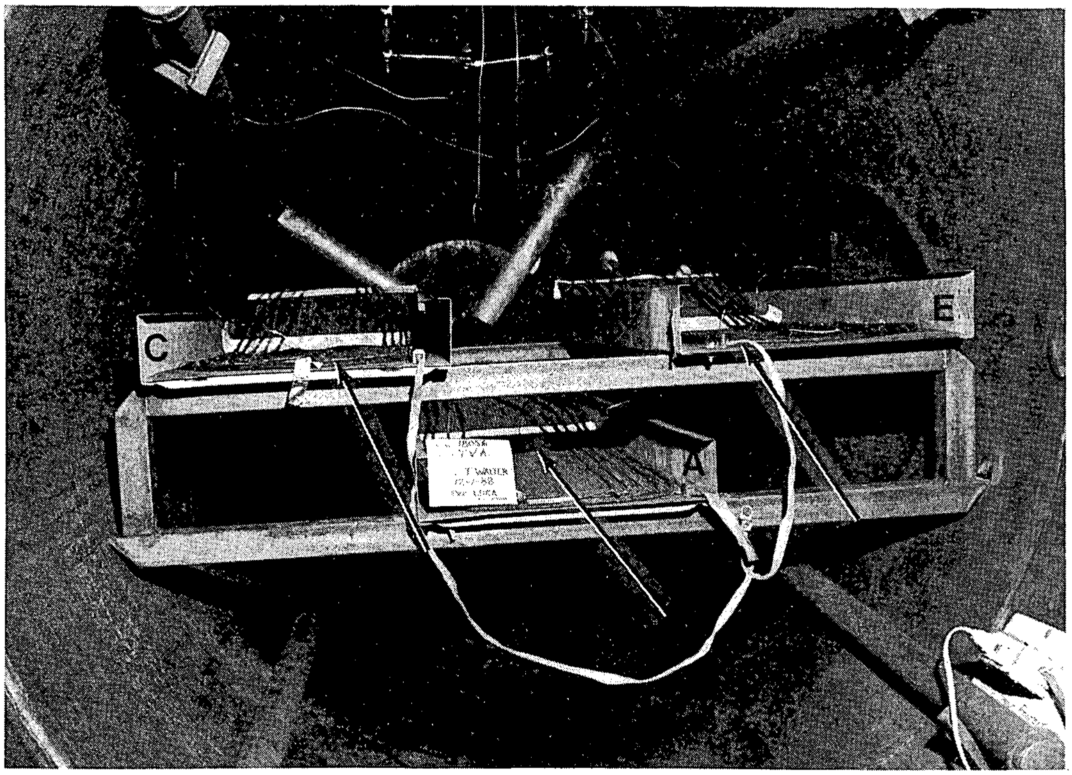
PHOTOGRAPH V-7

SPECIMEN PREPARATION
CABLE TRAY C TEST SPECIMENS WITH SPLICES AND TEST LEADS SECURED TO THE INCLINED SECTION OF THE CABLE TRAY



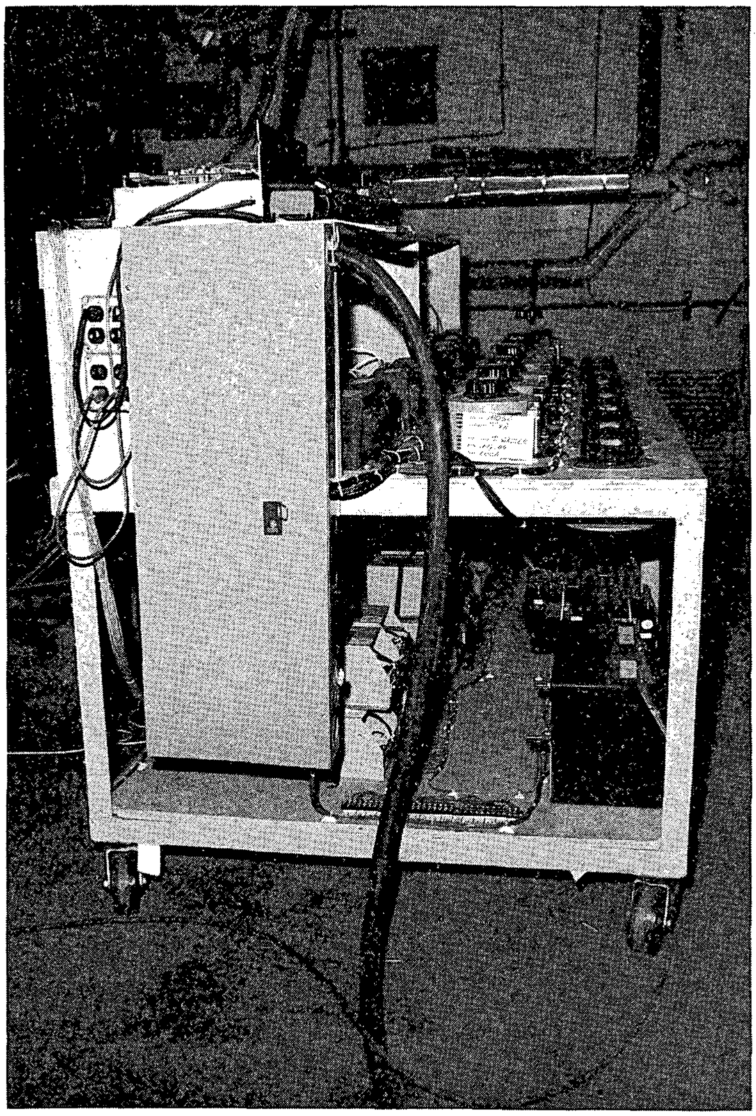
PHOTOGRAPH V-8

SPECIMEN PREPARATION
CABLE TRAY E WITH SPLICES AND TEST LEADS SECURED TO THE INCLINED SECTION OF THE CABLE TRAY DURING POST-SPECIMEN PREPARATION FUNCTIONAL TEST



PHOTOGRAPH V-9

ACCIDENT SIMULATION TEST SETUP
CABLE TRAYS A, C, AND E AS MOUNTED IN THE TEST CHAMBER
WITH THERMOCOUPLES ATTACHED

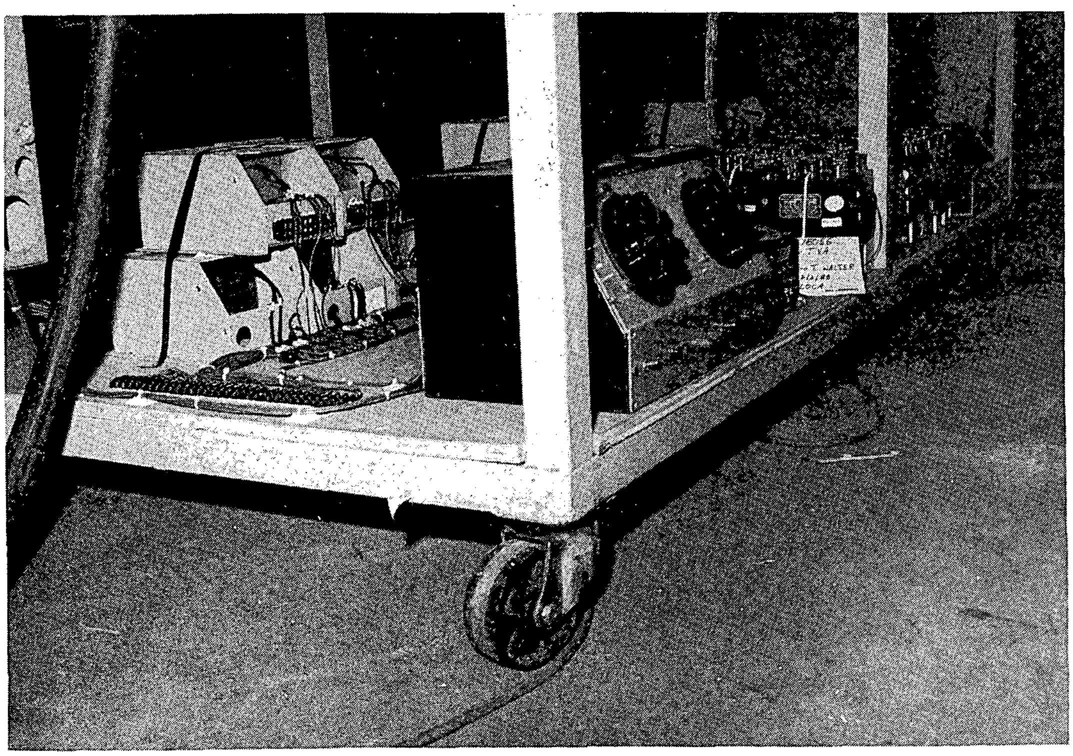


PHOTOGRAPH V-10

ACCIDENT SIMULATION TEST SETUP
TEST BENCH FOR CURRENT AND VOLTAGE SOURCES

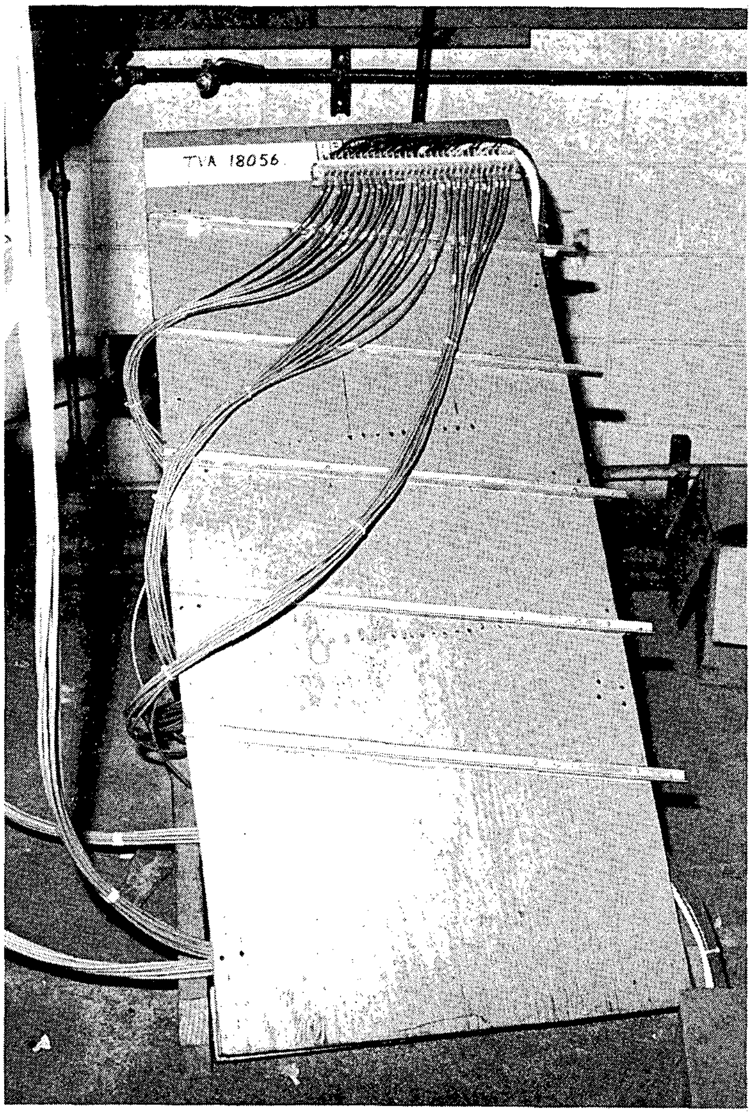
PHOTOGRAPH V-11

ACCIDENT SIMULATION TEST SETUP
CURRENT CIRCUITS WITH TRANSFORMERS AND VARIACS



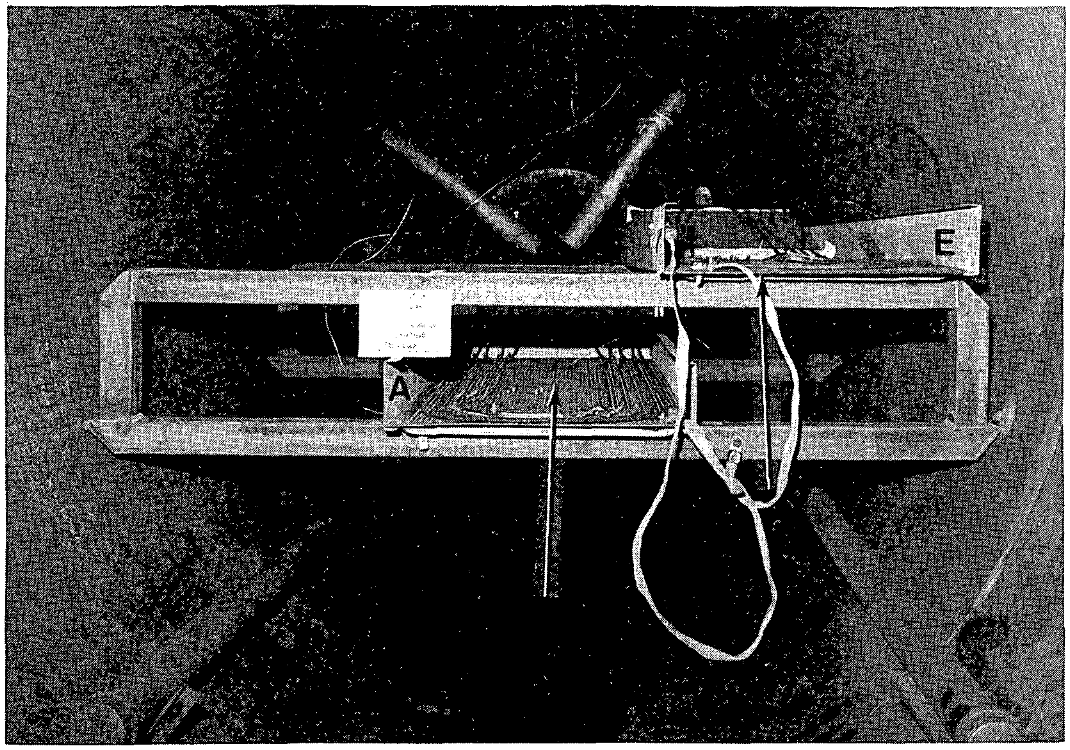
PHOTOGRAPH V-12

ACCIDENT SIMULATION TEST SETUP
VOLTAGE SOURCES FOR SPECIMEN CIRCUITS



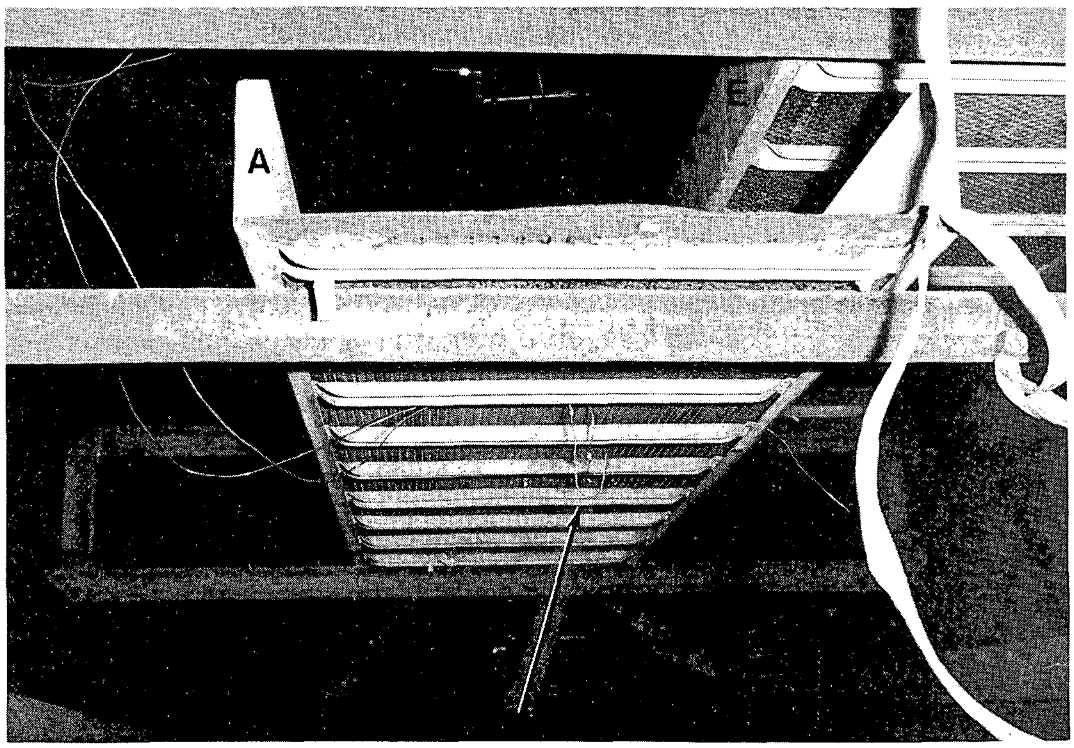
PHOTOGRAPH V-13

ACCIDENT SIMULATION TEST SETUP
TEST LEAD CONNECTIONS TO TEST BENCH CIRCUITRY



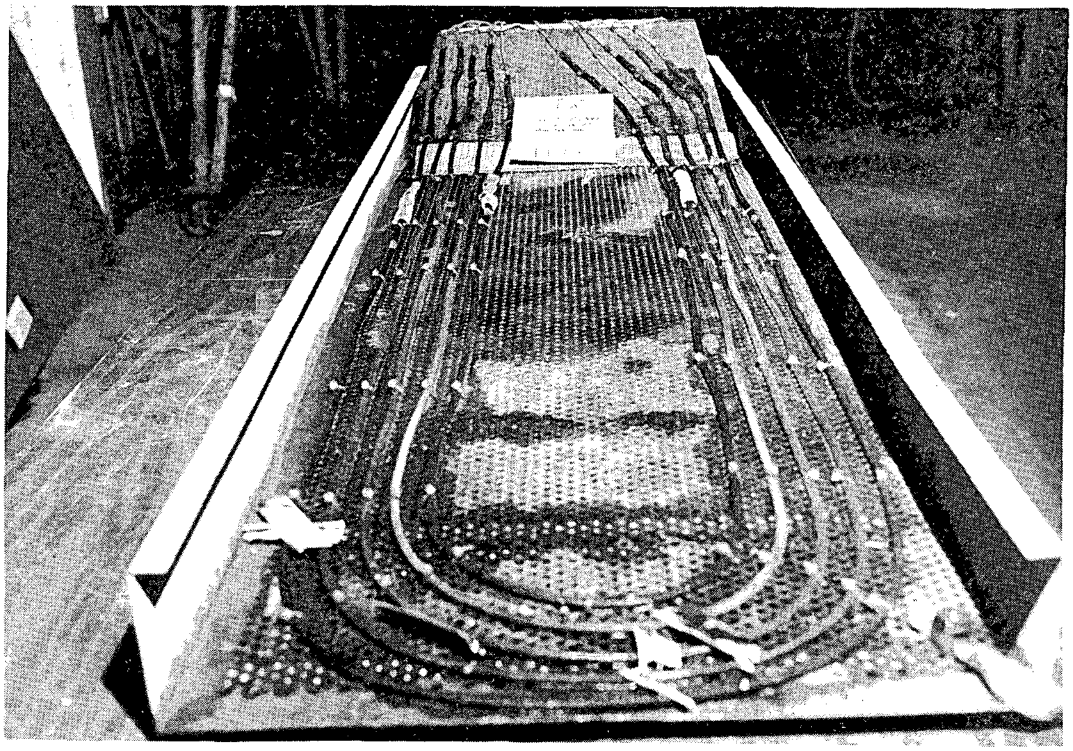
PHOTOGRAPH V-14

ACCIDENT SIMULATION TEST SETUP
CABLE TRAYS A AND E AS MOUNTED IN THE TEST CHAMBER
WITH THERMOCOUPLES ATTACHED



PHOTOGRAPH V-15

ACCIDENT SIMULATION TEST SETUP
CABLE TRAY A AS MOUNTED IN THE TEST CHAMBER
WITH THERMOCOUPLES ATTACHED

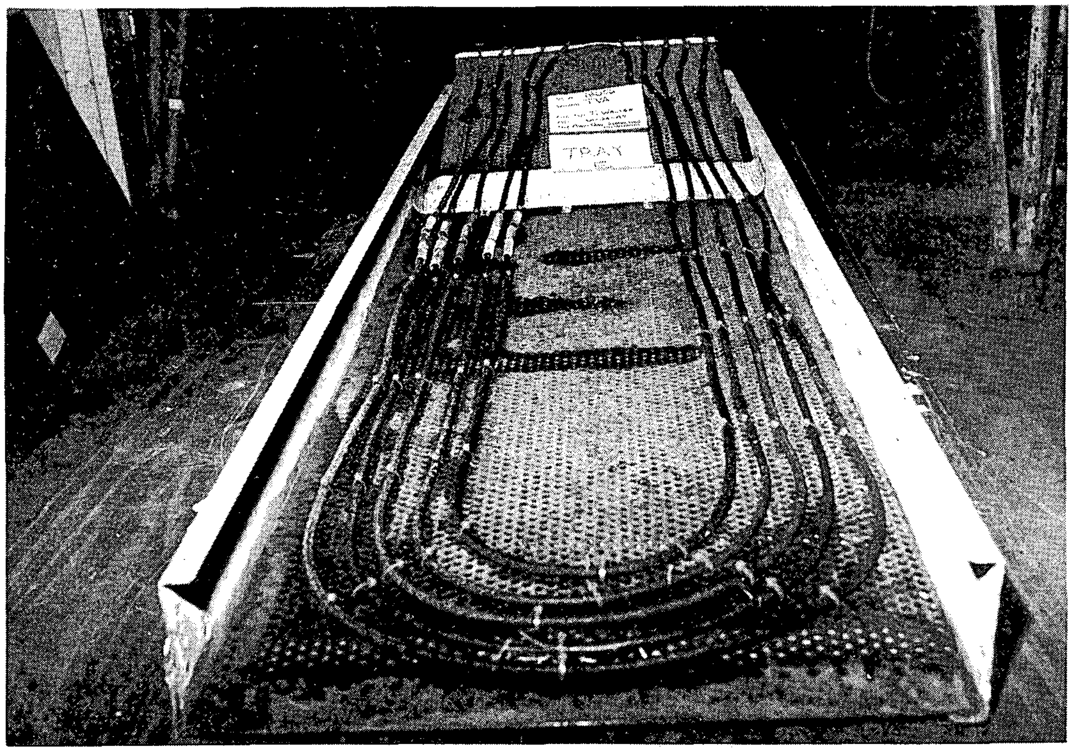


PHOTOGRAPH V-16

POST-TEST FUNCTIONAL TEST VISUAL INSPECTION
CABLE TRAY A RWC 40-YEAR SPECIMENS

PHOTOGRAPH V-17

POST-TEST FUNCTIONAL TEST VISUAL INSPECTION
CABLE TRAY A TEST LEAD SPLICES



PHOTOGRAPH V-18

POST-TEST FUNCTIONAL TEST VISUAL INSPECTION
CABLE TRAY E ANA 40-YEAR SPECIMENS

PHOTOGRAPH V-19

POST-TEST FUNCTIONAL TEST VISUAL INSPECTION
CABLE TRAY E TEST LEAD SPLICES

APPENDIX VI

DATA SHEETS

THIS PAGE INTENTIONALLY LEFT BLANK

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLOP 18057-00, IPR 01
Para.: N/A
S/N: Listed
GSI: N/A

Amb. Temp.: 72°F
Photo: No
Test Med.: Water
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 11-30-88

Test Title: Post-Specimen Preparation Functional Test (Prior to installation in test chamber)

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	$4.0 \times 10^{12}\,\Omega$	RWC-W-A.15	N/A
RWC-S-B.40	$3.0 \times 10^{12}\,\Omega$	RWC-W-B.15	
RWC-S-C.40	$2.8 \times 10^{12}\,\Omega$	RWC-W-C.15	
RWC-S-D.40	$2.4 \times 10^{12}\,\Omega$	RWC-W-D.15	
RWC-S-E.40	$3.5 \times 10^{12}\,\Omega$	RWC-W-E.15	N/A
RWC-S-A.15	N/A	ANA-S-A.40	$1.1 \times 10^{12}\,\Omega$
RWC-S-B.15		ANA-S-B.40	$6.0 \times 10^{11}\,\Omega$
RWC-S-C.15		ANA-S-C.40	$8.6 \times 10^{11}\,\Omega$
RWC-S-D.15		ANA-S-D.40	$1.4 \times 10^{12}\,\Omega$
RWC-S-E.15	N/A	ANA-S-E.40	$4.5 \times 10^{11}\,\Omega$
RWC-W-A.40	$2.6 \times 10^{12}\,\Omega$	ANA-S-A.15	N/A
RWC-W-B.40	$6.8 \times 10^{11}\,\Omega$	ANA-S-B.15	
RWC-W-C.40	$4.0 \times 10^{10}\,\Omega$	ANA-S-C.15	
RWC-W-D.40	$1.4 \times 10^{12}\,\Omega$	ANA-S-D.15	
RWC-W-E.40	$2.2 \times 10^{12}\,\Omega$	ANA-S-E.15	N/A

Notice of Anomaly: NONE

Tested By: D. Compton Date: 11/30/88
Witness: N/A Date:
Sheet No. 1 of 1
Approved: Robert [signature] 12-01-88

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLOP 18057-00, IPR 01
Para.: 3.10.6
S/N: Listed
GSI: N/A

Amb. Temp.: 66°F
Photo: No
Test Med.: Water
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 12/3/88

Test Title: SUBMERGED IR Functional Test SPECIMENS Sub. MOUNTED IN TEST CHAMBER RTW

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	1.7E12 Ω	RWC-W-A.15	N/A
RWC-S-B.40	1.4E12 Ω	RWC-W-B.15	
RWC-S-C.40	1.7E12 Ω	RWC-W-C.15	
RWC-S-D.40	1.7E12 Ω	RWC-W-D.15	
RWC-S-E.40	1.6E12 Ω	RWC-W-E.15	N/A
RWC-S-A.15	N/A	ANA-S-A.40	8.8E11 Ω
RWC-S-B.15		ANA-S-B.40	6.1E11 Ω
RWC-S-C.15		ANA-S-C.40	3.3E11 Ω
RWC-S-D.15		ANA-S-D.40	1.2E12 Ω
RWC-S-E.15	N/A	ANA-S-E.40	5.2E11 Ω
RWC-W-A.40	1.3E12 Ω	ANA-S-A.15	N/A
RWC-W-B.40	3.5E11 Ω	ANA-S-B.15	
RWC-W-C.40	1.1E7 Ω 6.8E6 Ω*	ANA-S-C.15	
RWC-W-D.40	9.5E5 Ω 1.9E6 Ω*	ANA-S-D.15	
RWC-W-E.40	1.5E12 Ω	ANA-S-E.15	N/A

* REPEAT MEASUREMENTS AFTER APPROXIMATELY 5 MINUTES. RTW

Tested By: B. Hardy Date: 12/3/88
Witness: N/A Date:
Sheet No. 1 of 1
Approved: Robert [illegible] 12-05-88

Notice of Anomaly: NONE

DATA SHEET

Customer: Tennessee Valley Authority | WYLE LABORATORIES

Specimen: Silicone Rubber Insulated Cables

Part No.: Various | Amb. Temp.: 74°F | Job No.: 18056

Spec.: WLOP 18057-00, IPR 01 | Photo: No | Report No.: 18056-1

Para.: 3.10.6 | Test Med.: ~~Water~~ Dry Air | Start Date: 12-03-88

S/N: Listed | Specimen Temp.: Ambient

GSI: N/A

Test Title: Insulation Resistance Functional Test Specimens Unsub. Mounted in test chamber. Readings taken immediately after draining the test chamber

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	1.3E12Ω	RWC-W-A.15	N/A
RWC-S-B.40	1.2E12Ω	RWC-W-B.15	
RWC-S-C.40	1.3E12Ω	RWC-W-C.15	
RWC-S-D.40	1.3E12Ω	RWC-W-D.15	
RWC-S-E.40	1.2E12Ω	RWC-W-E.15	N/A
RWC-S-A.15	N/A	ANA-S-A.40	6.2E11Ω
RWC-S-B.15		ANA-S-B.40	4.6E11Ω
RWC-S-C.15		ANA-S-C.40	5.6E11Ω
RWC-S-D.15		ANA-S-D.40	8.2E11Ω
RWC-S-E.15	N/A	ANA-S-E.40	4.0E11Ω
RWC-W-A.40	8.4E11Ω	ANA-S-A.15	N/A
RWC-W-B.40	3.2E11Ω	ANA-S-B.15	
RWC-W-C.40	2.0E7Ω	ANA-S-C.15	
RWC-W-D.40	1.8E6Ω	ANA-S-D.15	
RWC-W-E.40	9.2E11Ω	ANA-S-E.15	N/A

Tested By: B. Hard Date: 12/3/88

Witness: N/A Date:

Sheet No. 1 of 1

Approved: Robert [illegible] 12-05-88

Notice of Anomaly: None

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLOP 18057-00, IPR 01
Para.: 3.10.6
S/N: Listed
GSI: N/A

Amb. Temp.: 74.2°F
Photo: No
Test Med.: Air
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 12-05-88

Test Title: INSULATION RESISTANCE Functional Test SPECIMENS IN TEST CHAMBER
READINGS TAKEN APPROX. 49 HOURS AFTER DRAINING TEST CHAMBER

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	N/A	RWC-W-A.15	N/A
RWC-S-B.40		RWC-W-B.15	
RWC-S-C.40		RWC-W-C.15	
RWC-S-D.40		RWC-W-D.15	
RWC-S-E.40		RWC-W-E.15	
RWC-S-A.15		ANA-S-A.40	
RWC-S-B.15		ANA-S-B.40	
RWC-S-C.15		ANA-S-C.40	
RWC-S-D.15		ANA-S-D.40	
RWC-S-E.15	N/A	ANA-S-E.40	
RWC-W-A.40	6.3E11 Ω	ANA-S-A.15	
RWC-W-B.40	5.8E11 Ω	ANA-S-B.15	
RWC-W-C.40	1.4E5 Ω @ 10V	ANA-S-C.15	
RWC-W-D.40	6.0E5 Ω	ANA-S-D.15	
RWC-W-E.40	5.7E11 Ω	ANA-S-E.15	N/A

Tested By: B. Hanf Date: 12/5/88
Witness: N/A Date:
Sheet No. 1 of 1
Approved: Robert [signature] 12-05-88

Notice of Anomaly: NONE

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLOP 18057-00 , PR 01
Para.: N/A
S/N: Listed
GSI: N/A
Amb. Temp.: 85°F
Photo: No
Test Med.: Air
Specimen Temp.: Ambient
Job No.: 18056
Report No.: 18056-1
Start Date: 12-06-88

Test Title: INSULATION RESISTANCE Functional Test - SPECIMENS IN CHAMBER PRIOR TO OPENING CHAMBER TO REMOVE / INSPECT CABLE TRAY C

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	9.0 x 10" Ω	RWC-W-A.15	N/A
RWC-S-B.40	5.8 x 10" RTW Ω	RWC-W-B.15	
RWC-S-C.40	6.0 x 10" RTW Ω	RWC-W-C.15	
RWC-S-D.40	6.4 x 10" Ω	RWC-W-D.15	
RWC-S-E.40	7.2 x 10" Ω	RWC-W-E.15	N/A
RWC-S-A.15	N/A	ANA-S-A.40	3.7 x 10" Ω
RWC-S-B.15		ANA-S-B.40	3.5 x 10" Ω
RWC-S-C.15		ANA-S-C.40	3.5 x 10" Ω
RWC-S-D.15		ANA-S-D.40	5.0 x 10" Ω
RWC-S-E.15	N/A	ANA-S-E.40	2.6 x 10" Ω
RWC-W-A.40	4.0 x 10⁷ Ω	ANA-S-A.15	N/A
RWC-W-B.40	3.5 x 10" Ω	ANA-S-B.15	
RWC-W-C.40	3.0 x 10⁵ Ω @ 100V	ANA-S-C.15	
RWC-W-D.40	1.0 x 10⁶ Ω	ANA-S-D.15	
RWC-W-E.40	1.1 x 10⁸ Ω *	ANA-S-E.15	N/A

* ERRATIC READING

Tested By: D. Compton Date: 12/6/88
Witness: N/A Date:
Sheet No. 1 of 1
Approved: [illegible] 12-06-88

Notice of Anomaly: NONE

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

Customer Tennessee Valley Authority
Specimen Silicone Rubber Insulated Cables

WYLE LABORATORIES

Part No. Various | Amb. Temp. 64°F | Job No. 18056
Spec. WLCP 18057-00 [illegible] | Photo No | Report No. 18056-1
Para. [illegible] | Test Med. Water | Start Date [illegible]
S/N Listed | Specimen Temp. Ambient
GSI N/A

Test Title [illegible] IR Functional Test [illegible]

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	$1.6 \times 10^{12} \Omega$	RWC-W-A.15	N/A
RWC-S-B.40	$1.4 \times 10^{12} \Omega$	RWC-W-B.15	
RWC-S-C.40	$1.5 \times 10^{12} \Omega$	RWC-W-C.15	
RWC-S-D.40	$1.3 \times 10^{12} \Omega$	RWC-W-D.15	
RWC-S-E.40	$1.6 \times 10^{12} \Omega$	RWC-W-E.15	N/A
RWC-S-A.15	N/A	ANA-S-A.40	$8.0 \times 10^{11} \Omega$
RWC-S-B.15		ANA-S-B.40	$7.4 \times 10^{11} \Omega$
RWC-S-C.15		ANA-S-C.40	$6.4 \times 10^{11} \Omega$
RWC-S-D.15		ANA-S-D.40	$8.8 \times 10^{11} \Omega$
RWC-S-E.15		ANA-S-E.40	$6.6 \times 10^{11} \Omega$
RWC-W-A.40		ANA-S-A.15	N/A
RWC-W-B.40		ANA-S-B.15	
RWC-W-C.40		ANA-S-C.15	
RWC-W-D.40		ANA-S-D.15	
RWC-W-E.40	N/A	ANA-S-E.15	N/A

Tested By D Compton Date: 12/7/88
Witness N/A Date:
Sheet No. 1 of 1
Approved [illegible]

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLOP 18057-00, IPR 01
Para.: N/A
S/N: Listed
GSI: N/A

Amb. Temp.: 72.1°F
Photo: No
Test Med.: Air
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 01-03-89

Test Title: POST-TEST Functional Test (UPON COMPLETION OF LOCA) (CABLE TRAYS A & E MOUNTED IN TEST CHAMBER)

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	$5.0 \times 10^4 \Omega$ @190VDC	RWC-W-A.15	N/A
RWC-S-B.40	$2.4 \times 10^8 \Omega$	RWC-W-B.15	│
RWC-S-C.40	$8.4 \times 10^7 \Omega$	RWC-W-C.15	│
RWC-S-D.40	$3.5 \times 10^6 \Omega$	RWC-W-D.15	│
RWC-S-E.40	$1.0 \times 10^5 \Omega$ @190VDC	RWC-W-E.15	N/A
RWC-S-A.15	N/A	ANA-S-A.40	$8.8 \times 10^{10} \Omega$
RWC-S-B.15	│	ANA-S-B.40	$1.0 \times 10^{11} \Omega$
RWC-S-C.15	│	ANA-S-C.40	$7.8 \times 10^{10} \Omega$
RWC-S-D.15	│	ANA-S-D.40	$1.1 \times 10^{11} \Omega$
RWC-S-E.15	│	ANA-S-E.40	$1.0 \times 10^{11} \Omega$
	│		
RWC-W-A.40	│	ANA-S-A.15	N/A
RWC-W-B.40	│	ANA-S-B.15	│
RWC-W-C.40	│	ANA-S-C.15	│
RWC-W-D.40	│	ANA-S-D.15	│
RWC-W-E.40	N/A	ANA-S-E.15	N/A

Tested By: D. Compton Date: 1/3/89
Witness: N/A Date:
Sheet No. 1 of 1
Approved: Robert [illegible] Watt 01-03-89

Notice of Anomaly: NONE

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

Customer Tennessee Valley Authority

Specimen Silicone Rubber Insulated Cables

WYLE LABORATORIES

Part No. Various

Spec. WLOP 18057-00, IPR 01

Para. 3.11

S/N Listed

GSI N/A

Amb. Temp. 62.5°F

Photo No

Test Med. Water

Specimen Temp. Ambient

Job No. 18056

Report No. 18056-1

Start Date 01-03-88

Test Title Post-Test Functional Test
(CABLE TRAYS A & E MOUNTED IN TEST CHAMBER)

Specimen No.	Reading	Specimen No.	Reading
RWC-S-A.40	SHORT @ 10VDC	RWC-W-A.15	N/A
RWC-S-B.40	$2.0 \times 10^8 \Omega$	RWC-W-B.15	
RWC-S-C.40	$9.6 \times 10^6 \Omega$	RWC-W-C.15	
RWC-S-D.40	$3.5 \times 10^6 \Omega$	RWC-W-D.15	
RWC-S-E.40	$5.8 \times 10^5 \Omega$ @ 190VDC	RWC-W-E.15	N/A
RWC-S-A.15	N/A	ANA-S-A.40	$4.0 \times 10^{10} \Omega$
RWC-S-B.15		ANA-S-B.40	$1.4 \times 10^{11} \Omega$
RWC-S-C.15		ANA-S-C.40	$1.1 \times 10^{11} \Omega$
RWC-S-D.15		ANA-S-D.40	$1.7 \times 10^{11} \Omega$
RWC-S-E.15		ANA-S-E.40	$1.6 \times 10^{11} \Omega$
RWC-W-A.40		ANA-S-A.15	N/A
RWC-W-B.40		ANA-S-B.15	
RWC-W-C.40		ANA-S-C.15	
RWC-W-D.40		ANA-S-D.15	
RWC-W-E.40	N/A	ANA-S-E.15	N/A

Tested By D Compton Date: 1/3/88

Witness N/A Date:

Sheet No. 1 of 1

Approved Robert Todd Watt 01-03-89

Notice of Anomaly NONE

APPENDIX VII

INSTRUMENTATION EQUIPMENT SHEETS

THIS PAGE INTENTIONALLY LEFT BLANK

INSTRUMENTATION EQUIPMENT SHEET

Test Report No. 18056-1

DATE: 11/30/88
TECHNICIAN: D. COMPTON

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: PRE-LOCA-TEST FUNCTIONAL

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	MEG MTR	GENERAL RADIO	1864	1864-9700-00	106840	50K-50T OHM	2-5% RANGE	10/03/88	03/31/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 11-30-88

CHECKED & RECEIVED BY Robert [illegible] 11-30-88

Q.A. R Hamilton 11-30-88 (Wyle QA 9)

INSTRUMENTATION EQUIPMENT SHEET

Page No. V-92
Test Report No. 18056-1

DATE: 12/02/88
TECHNICIAN: B. HARDY

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: LOCA

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CURRENT XFCR	FLUKE	80I-600	102190	102190	2000A	3%	08/03/88	01/30/89
2	XFORMER	METERMASTER	7SFT101	N/A	103445	RATIO 100:5	2%	11/02/88	05/01/89
3	XFORMER	METERMASTER	7SFT101	N/A	103446	RATIO 100:5	2%	11/02/88	05/01/89
4	XFORMER	METERMASTER	7SFT101	N/A	103449	RATIO 100:5	2%	11/02/88	05/01/89
5	XFORMER	METERMASTER	7SFT101	N/A	103443	RATIO 100:5	2%	11/02/88	05/01/89
6	XFORMER	METERMASTER	7SFT101	N/A	103447	RATIO 100:5	2%	11/02/88	05/01/89
7	XFORMER	METERMASTER	7SFT101	N/A	103441	RATIO 100:5	2%	11/02/88	05/01/89
8	XFORMER	METERMASTER	7SFT101	N/A	103444	RATIO 100:5	2%	11/02/88	05/01/89
9	XFORMER	METERMASTER	7SFT101	N/A	103448	RATIO 100:5	2%	11/02/88	05/01/89
10	XFORMER	METERMASTER	7SFT101	N/A	103440	RATIO 100:5	2%	11/02/88	05/01/89
11	XFORMER	METERMASTER	7SFT101	N/A	103451	RATIO 100:5	2%	11/02/88	05/01/89
12	XFORMER	METERMASTER	7SFT101	N/A	103439	RATIO 100:5	2%	11/02/88	05/01/89
13	XFORMER	METERMASTER	7SFT101	N/A	103450	RATIO 100:5	2%	11/02/88	05/01/89
14	XFORMER	METERMASTER	7SFT101	N/A	103438	RATIO 100:5	2%	11/02/88	05/01/89
15	XFORMER	METERMASTER	7SFT101	N/A	103437	RATIO 100:5	2%	11/02/88	05/01/89
16	XFORMER	WESTON	461	17534	103281	800:5 RATIO	1%	11/02/88	05/01/89
17	XFORMER	WESTON	461-2	17754	103106	10-100 AMP	1%	11/02/88	05/01/89
18	XFORMER	WESTON	461	N/A	103340	2.5KV/15VA	1%	11/02/88	05/01/89
19	XFORMER	WESTON	461	18435	102379	RATIO 800:5	1%	11/02/88	05/01/89
20	XFORMER	WESTON	461-2	22304	104415	25-500	.25%	11/02/88	05/01/89
21	XFORMER	WESTON	461-1	24979	097428	100/15A	1%	11/02/88	05/01/89
22	XFORMER	WESTON	461-5	25679	103148	.5-50AMPS	1%	11/02/88	05/01/89
23	XFORMER	WESTON	461-5	22869	103147	.5-50AMPS	1%	11/02/88	05/01/89
24	XFORMER CURRENT	WESTON	461-2	22054	104416	25-500	.25%	11/02/88	05/01/89
25	XFORMER	WESTON	461-2	17770	103104	10-100 AMP	1%	11/02/88	05/01/89
26	XFORMER	WESTON	461-2	22055	104417	25-500	.25%	11/02/88	05/01/89
27	XFORMER	WESTON	461-1	7963	103145	100/5AMPS	1%	11/02/88	05/01/89
28	XFORMER	WESTON	461-5	22870	103146	.5-50AMPS	.25%	11/02/88	05/01/89
29	XFORMER	WESTON	461	17755	102377	RATIO 800:5	1%	11/02/88	05/01/89
30	XFORMER	WESTON	461-1	13132	003022	100/5AMP	1%	11/02/88	05/01/89
31	DIG MTR	FLUKE	8060A	4510534	104886	DC VOLTS	.04%	07/26/88	07/26/89
32	DIG MTR	FLUKE	77	35751665	102117	AC	2%	06/30/88	12/27/88
33	DIG MTR	FLUKE	77	45312151	104881	DC VOLTS	.3%	07/26/88	07/26/89
34	RES DECADE	CLAROSTAT	240C	4885	011423	0-999.999 OHMS	2%	11/21/88	11/21/89
35	DIG MTR	FLUKE	77	45314286	104882	DC VOLTS	.3%	07/26/88	07/26/89
36	DIGITAL TEMP	FLUKE	2190A	208	094906	MULT	.03%	12/01/88	03/01/89
37	DATA SYS	DAYTRONIC	10K6	N/A	101936	MULTI	MFG	07/27/88	07/27/89
38	TERMINAL	H/P	2648A	1931A05363	100615	SYSTEM	PM	10/18/88	04/14/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 12-2-88

CHECKED & RECEIVED BY [signature] 12-02-88

Q.A. R Hamilton 12-2-88 (9 Wyle A)

INSTRUMENTATION EQUIPMENT SHEET

Page No. V-93

Test Report No. 18056-1

DATE: 12/02/88
TECHNICIAN: B. HARDY

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: LOCA

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
39	TEMP IND	DORIC	402A	106717	011831	-50+2552*F K	2.5*f	07/26/88	01/20/89
40	STRAIN PWR	VISHAY	2110	21804	011603	15VDC	1%REG	11/01/88	01/30/89
41	COND STRAIN	VISHAY	2120	22889	011709	DC-5KHZ	2%G	11/01/88	01/30/89
42	AMPL TEMP MV	AGM ELECTRONICS	EA4002	70-509	000680	0+1000*F K	1%	08/09/88	02/03/89
43	AMPL TEMP MV	AGM ELECTRONICS	EA4002	70-510	000681	0+1000*F K	1%	08/09/88	02/03/89
44	AMPL TEMP MV	AGM ELECTRONICS	EA4002	70-512	000683	0+1000*F K	1%	08/09/88	02/03/89
45	CONTR TEMP.	RESEARCH	61011	102360	100316	-175+375*F T	.5%	09/26/88	03/24/89
46	TEMP ALARM	RESEARCH	61034	240158	000716	-175+375*F T	.5%	09/06/88	03/03/89
47	GEN SIG	EXACT	340	25656	003150	1MSEC-99.900	+-0.01%	10/28/88	04/26/89
48	RECORD TEMP	HONEYWELL	45	8009283019001	092815	0-400*F T	.5%	10/20/88	01/18/89
49	PRINTER	LEAR	310	9039	104401	MULT	PM	09/27/88	03/24/89
50	PRINTER	LEAR	310	4661	104402	MULT	PM	10/18/88	04/14/89
51	FLOW MTR	POTTER	1/2	83475	103286	0-10GPM	SEE CERT	01/04/88	01/03/89
52	PRESS GAUGE	USG	N/A	N/A	100689	0-30 PSI	1%	10/24/88	01/20/89
53	PRESS XDUCER	B/H	0001	3059	101317	0-25PSIG	.05%	08/01/88	01/27/89
54	XFORMER	METERMASTER	SFT-101	N/A	102396	RATIO 100:5	2%	11/02/88	05/01/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 12-2-88

CHECKED & RECEIVED BY [illegible] 12-02-88

Q.A. TR Hamilton 12-2-88 (9 Wyle A)

INSTRUMENTATION EQUIPMENT SHEET

Page No. V-94
Test Report No. 18056-1

DATE: 12/02/88
TECHNICIAN: B. HARDY

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: PRE-TEST FUNCTIONAL

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	MEG MTR	GENERAL RADIO	1864	1864-9700-00	106840	50K-50T OHM	2-5% RANGE	10/03/88	03/31/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 12-2-88

CHECKED & RECEIVED BY Robert [illegible] 12-2-88

Q.A. T R Hamilton 12-2-88

INSTRUMENTATION EQUIPMENT SHEET

Page No. V-95

Test Report No. 18056-1

DATE: 01/03/89
TECHNICIAN: D. COMPTON

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: POST-LOCA FUNCTIONAL

	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	MEG MTR	GENERAL RADIO	1864	1864-9700-00	106840	50K-50T OHM	2-5% RANGE	10/03/88	03/31/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS.

INSTRUMENTATION R.E. Archer 1-4-89

CHECKED & RECEIVED BY Robert [signature] 01-03-89

Q.A. Kevin M Turner 1-4-89 (5 Wyle A)

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION VI

VOLTAGE WITHSTAND TEST AND POST-TEST INSPECTION

1.0 **REQUIREMENTS**

1.1 **Voltage Withstand Test**

The test specimens shall be subjected to a Voltage Withstand Test as specified in Paragraph 3.12 of Section VII. The Voltage Withstand Test shall be performed for margin assessment.

1.2 **Post-Test Inspection**

The test specimens shall be subjected to a Post-Test Inspection upon completion of the Voltage Withstand Test. The Post-Test Inspection shall be performed as specified in Paragraph 3.13 of Section VII.

2.0 **PROCEDURES**

2.1 **Voltage Withstand Test**

The test specimens of Cable Trays A and E were removed from the perforated steel bottoms of the cable trays by cutting the Tefzel cable ties. The curved section of each test specimen was individually straightened prior to wrapping the test specimens around metal mandrels. The test specimens were secured to the metal mandrels in a configuration which allowed the lead ends to remain elevated above the middle sections of each specimen. Photographs are presented in the Appendices of this Section. The test specimens were grouped and mounted to the metal mandrels as follows:

Test Specimen	Mandrel Size (outer diameter)
RWC-S-A.40, RWC-S-B.40, and RWC-S-C.40	8.63 inches
RWC-S-D.40 and RWC-S-E.40	8.63 inches
ANA-S-A.40 and ANA-S-B.40	8.88 inches
ANA-S-C.40, ANA-S-D.40, and ANA-S-E.40	9.0 inches

The test specimens, as mounted to the metal mandrels, were immersed in tap water for performance of the Voltage Withstand Tests. The lead ends of each test specimen were suspended out of the tap water. One lead end of each test specimen was individually connected to the DC Hi-Pot device and the test voltage was increased at a constant rate to 6600 VDC. Each test specimen was held at 6600 VDC and the leakage current between each specimen and ground was recorded every minute for five minutes. Test specimens that would not maintain 6600 VDC were held at the maximum current of the DC Hi-Pot device (10 milliAmps) and the applied DC voltage was recorded every minute for five minutes.

2.0 **PROCEDURES (Continued)**

2.2 **Post-Test Inspection**

Upon completion of the Voltage Withstand Test, the test specimens were subjected to a Post-Test Inspection. The test specimens were visually inspected and photographed. Test specimen conditions were noted and recorded.

3.0 **RESULTS**

The test specimens were subjected to the Voltage Withstand Tests and Post-Test Inspection of Paragraph 2.0 and met the requirements of Paragraph 1.0. During the application of each test specimen to the metal mandrels, cracking and popping sounds were heard as the test specimens were physically bent around the mandrel. A determination could not be made as to whether the audible sounds were a result of silicone rubber insulation breaking or braided jacket material separating from the silicone rubber insulation. During the Voltage Withstand Test, the following abnormal conditions were noted:

RWC-S-A.40 developed breakdowns at the lead end of the test specimen that was connected to the DC Hi-Pot device (positive lead). The breakdowns occurred at the water level and at two inches below the water level. The breakdowns occurred as the voltage was being raised from 0 VDC to 6600 VDC. The test specimen was able to maintain a maximum of 750 VDC over the five-minute period of the test.

RWC-S-B.40 was noted to have severe voltage fluctuations while raising the voltage to, and holding at, 6600 VDC. The voltage fluctuations were intermittent and were not attributable to excessive leakage currents.

RWC-S-C.40 exhibited arcing and smoke residue at a point approximately three inches from the Raychem tubing splice connection (out of the water). The area of arcing was on the lead end away from the DC Hi-Pot connection and self-extinguished after approximately three minutes. The 6600 VDC applied voltage was maintained throughout the test.

RWC-S-D.40 developed a breakdown as the applied voltage reached 4000 VDC. From the time of breakdown, the test specimen maintained a maximum of 700 VDC during the five minute test. The breakdown occurred in the area of TVA applied identification tape and was situated approximately one inch below the surface of the water.

RWC-S-E.40 developed a breakdown as the applied voltage reached 5000 VDC. From the time of breakdown, the test specimen maintained a maximum of 1000 VDC during the five-minute test. The breakdown occurred in the area of TVA applied identification tape and was situated approximately eight inches below the surface of the water.

3.0 RESULTS (Continued)

Observations recorded during the Post-Test Inspection are presented in the following paragraphs.

RWC-S-A.40 was noted to have rust on what was the bottom side of the test specimen when mounted on the cable tray. The rust had impregnated the jacket material and left permanent marks in every area where the test specimen had made contact with the perforated steel bottom of the cable tray. The rust that had migrated onto the braided asbestos jacket material left the appearance of a flattened semi-smooth surface in the area where contact had been made with the metal cable tray.

RWC-S-B.40 and RWC-S-C.40 were noted to exhibit the same rust markings as those described in the previous paragraph. The braided jacket material of RWC-S-B.40 was a lighter shade of gray than the RWC-S-A.40 test specimen. The braided jacket material of RWC-S-C.40 exhibited a dark green-gray color. Both test specimens exhibited the same worn appearance as discussed in the previous paragraph.

RWC-S-D.40 and RWC-S-E.40 were noted to exhibit the same rust markings as those described for Test Specimen RWC-S-A.40. The appearance of both test specimens was worn as described in the previous paragraphs. RWC-S-D.40 jacket material exhibited a darker shade of green-gray color than RWC-S-C.40, whereas RWC-S-E.40 jacket material was a dark black color.

ANA-S-A.40 was noted to have significantly less rust deposits on the braided jacket material than the corresponding Rockbestos test specimens. The braided jacket seemed to have "shed" a very thin layer of material that was ash colored. Sections of the test specimen jacket material that were not ash colored were very black.

ANA-S-B.40, ANA-S-C.40, ANA-S-D.40, and ANA-S-E.40 were noted to have exhibited the same resistance to rust as discussed in the previous paragraph. All of the specimens maintained an ash coloring over the majority of the cable lengths. The physical condition of the specimens appeared to be very good.

The approximate outer diameters of each test specimen were measured and are as listed below:

RWC-S-A.40	0.252"	ANA-S-A.40	0.310"
RWC-S-B.40	0.239"	ANA-S-B.40	0.273"
RWC-S-C.40	0.245"	ANA-S-C.40	0.293"
RWC-S-D.40	0.241"	ANA-S-D.40	0.286"
RWC-S-E.40	0.262"	ANA-S-E.40	0.300"

Photographs and data recorded during this phase of the test program are presented in Appendices I through III of this Section as noted below:

- Appendix I contains Photographs VI-1 through VI-8 which show the test specimens during the Voltage Withstand Test and the Post-Test Inspection.

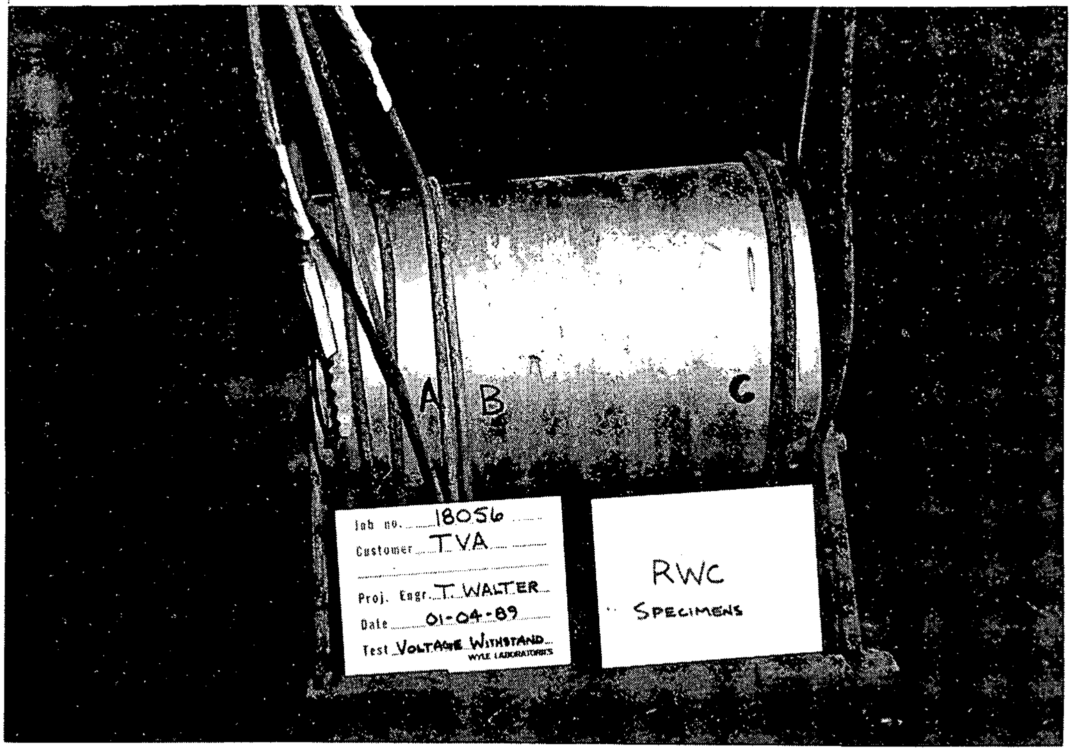
3.0 RESULTS (Continued)

- Appendix II contains the Data Sheets generated during the Voltage Withstand Tests.
- Appendix III contains the Instrumentation Equipment Sheet generated for the Voltage Withstand Test.

APPENDIX I

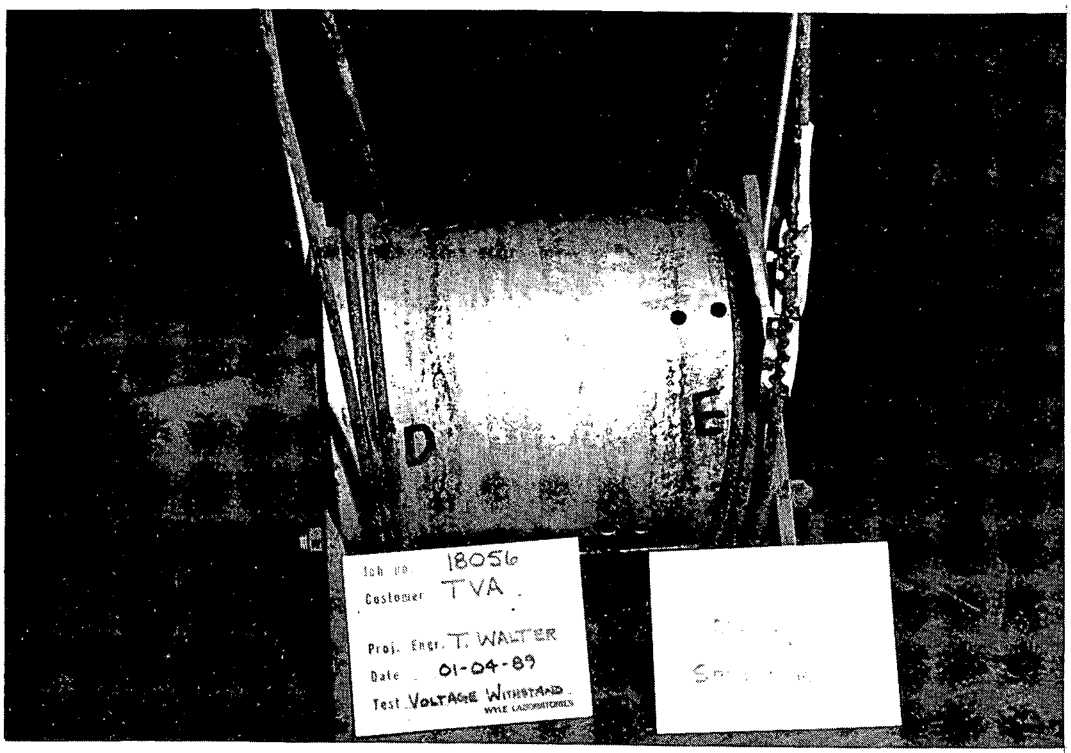
PHOTOGRAPHS

THIS PAGE INTENTIONALLY LEFT BLANK



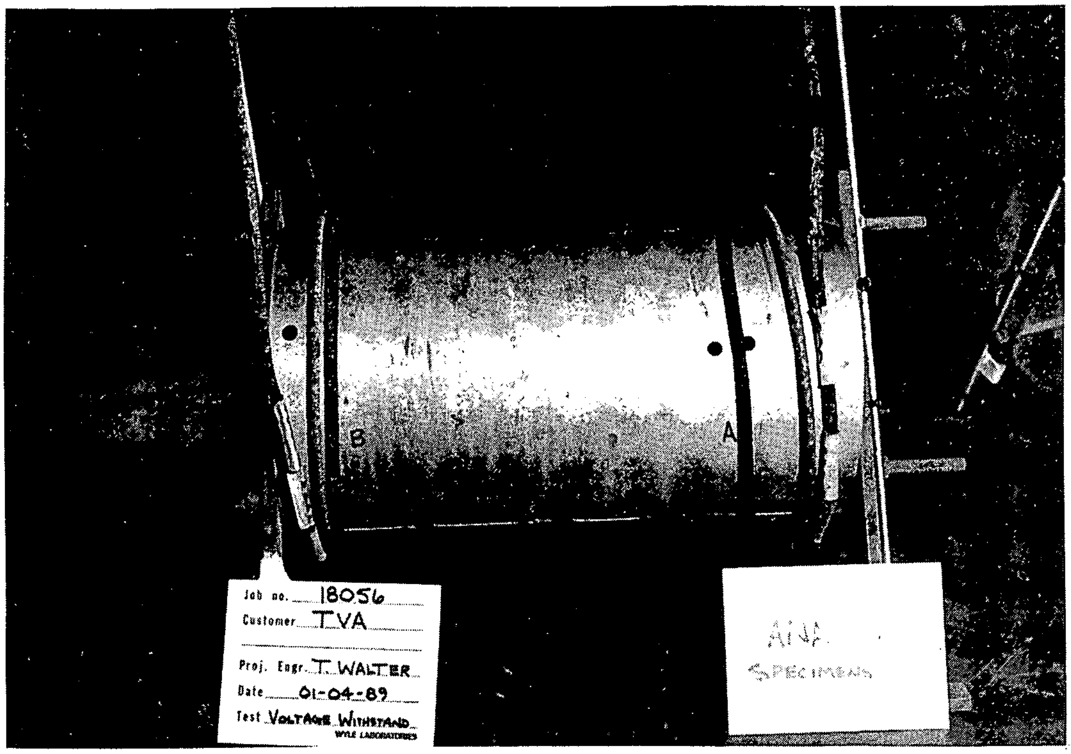
PHOTOGRAPH VI-1

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
RWC 40-YEAR SPECIMENS A, B, AND C



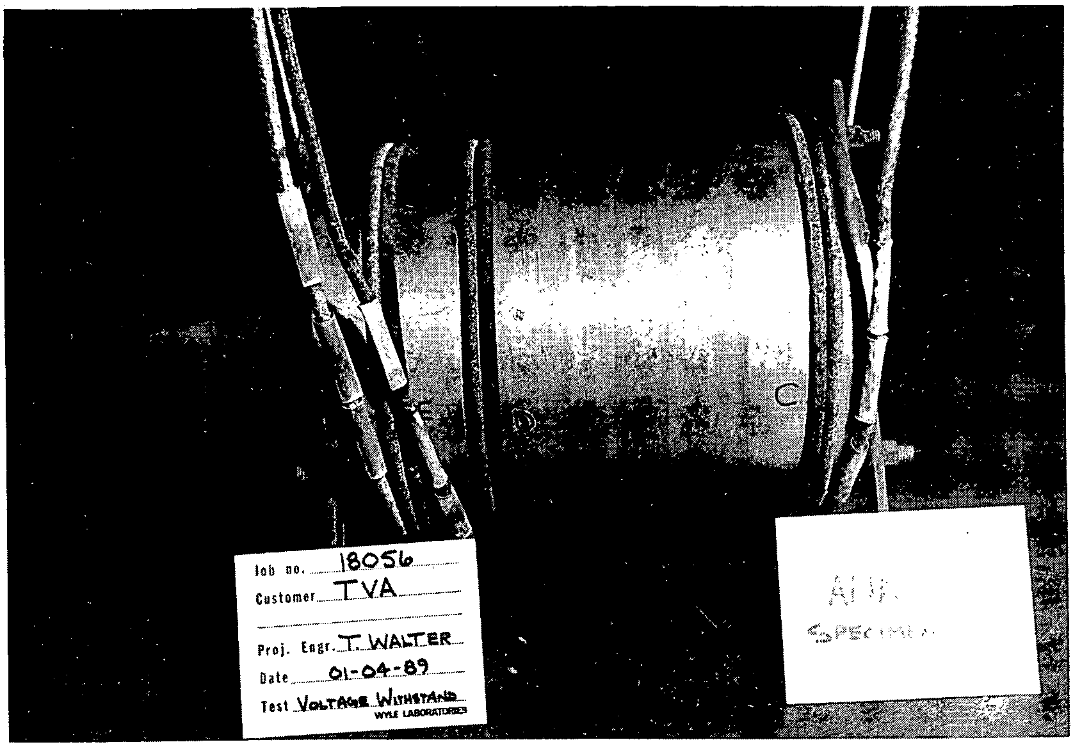
PHOTOGRAPH VI-2

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
RWC 40-YEAR SPECIMENS D AND E



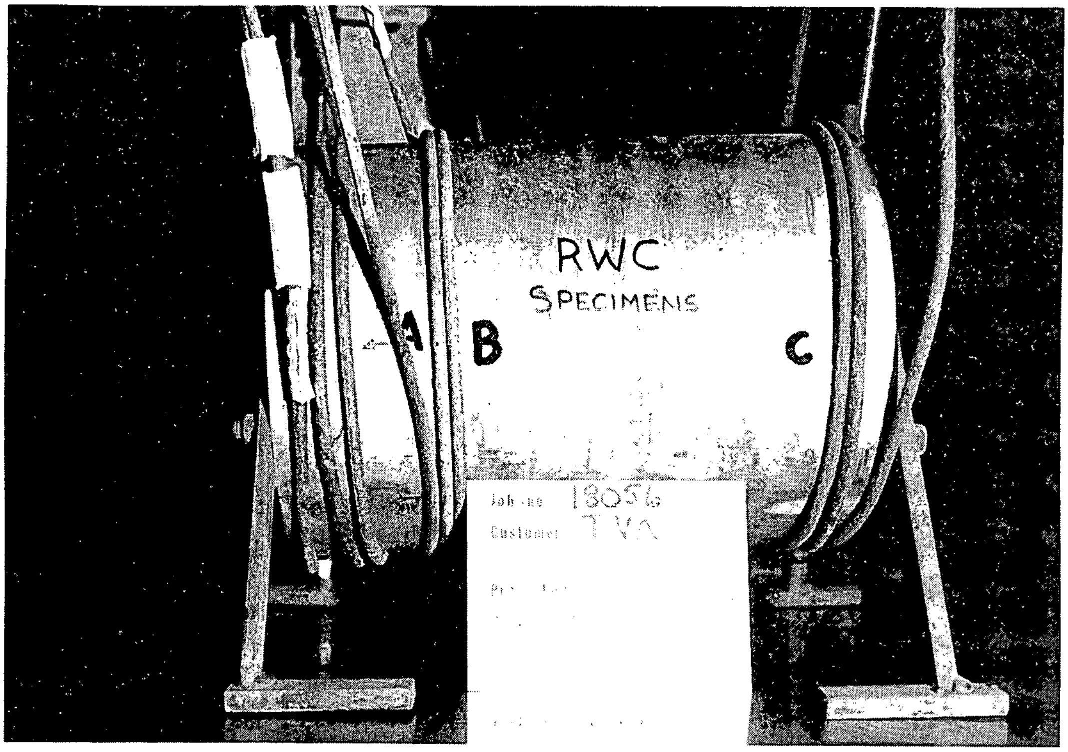
PHOTOGRAPH VI-3

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
ANA 40-YEAR SPECIMENS A AND B



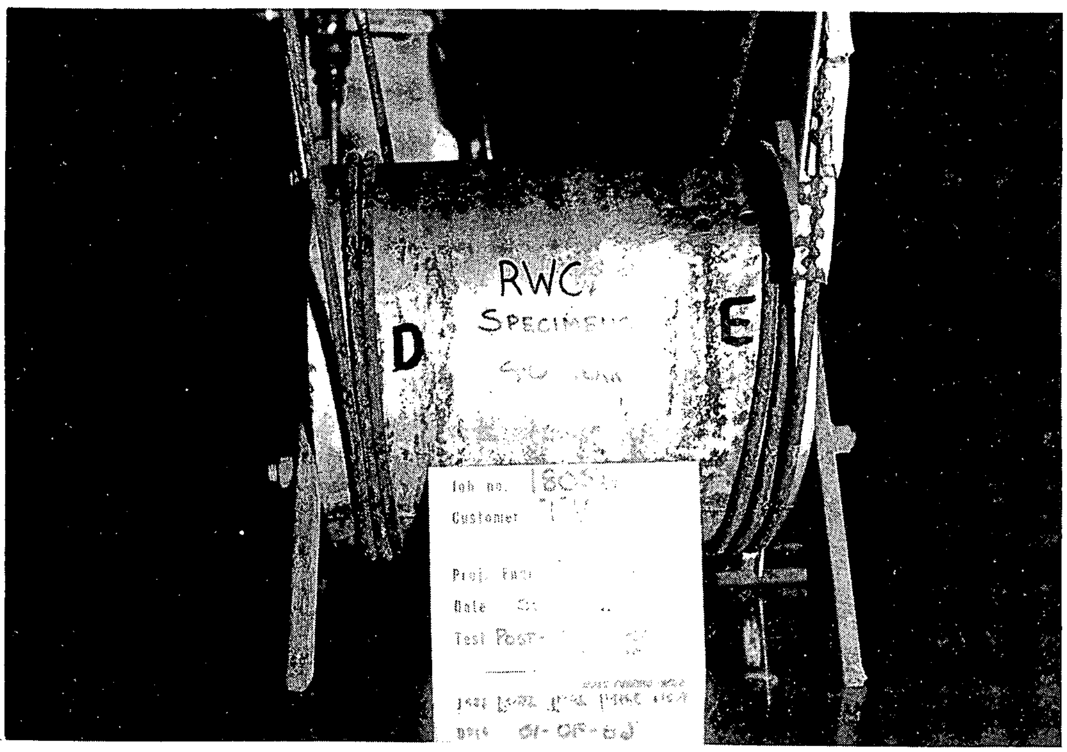
PHOTOGRAPH VI-4

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
ANA 40-YEAR SPECIMENS C, D, AND E



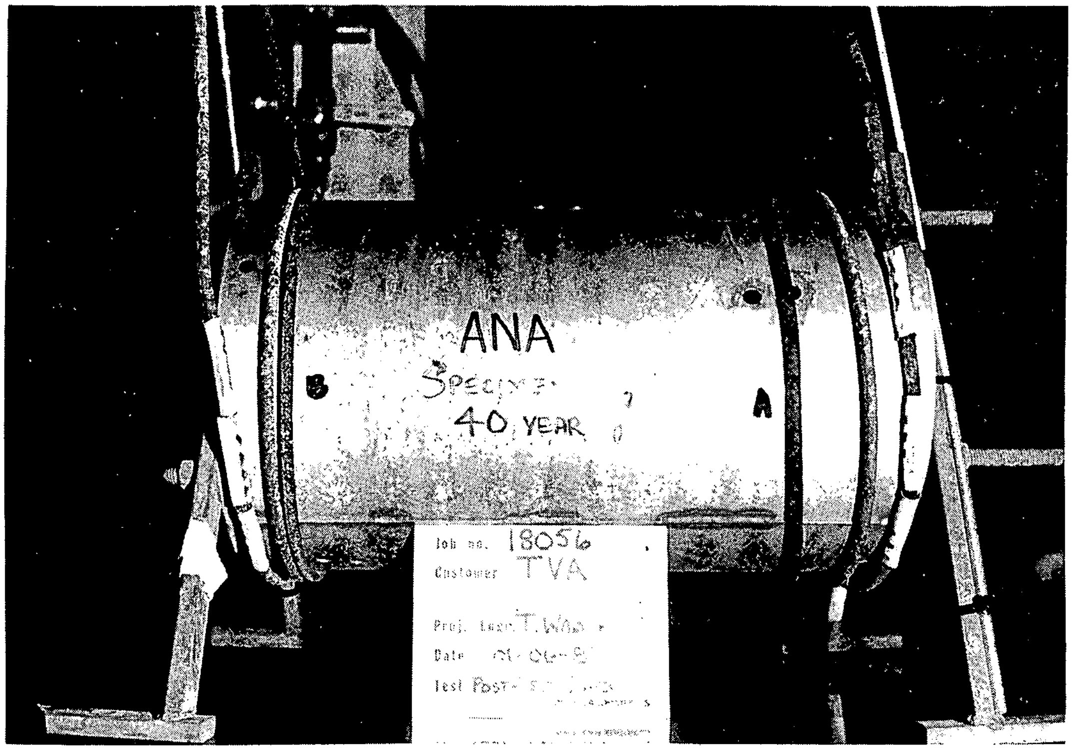
PHOTOGRAPH VI-5

POST-TEST INSPECTION
RWC 40-YEAR SPECIMENS A, B, AND C



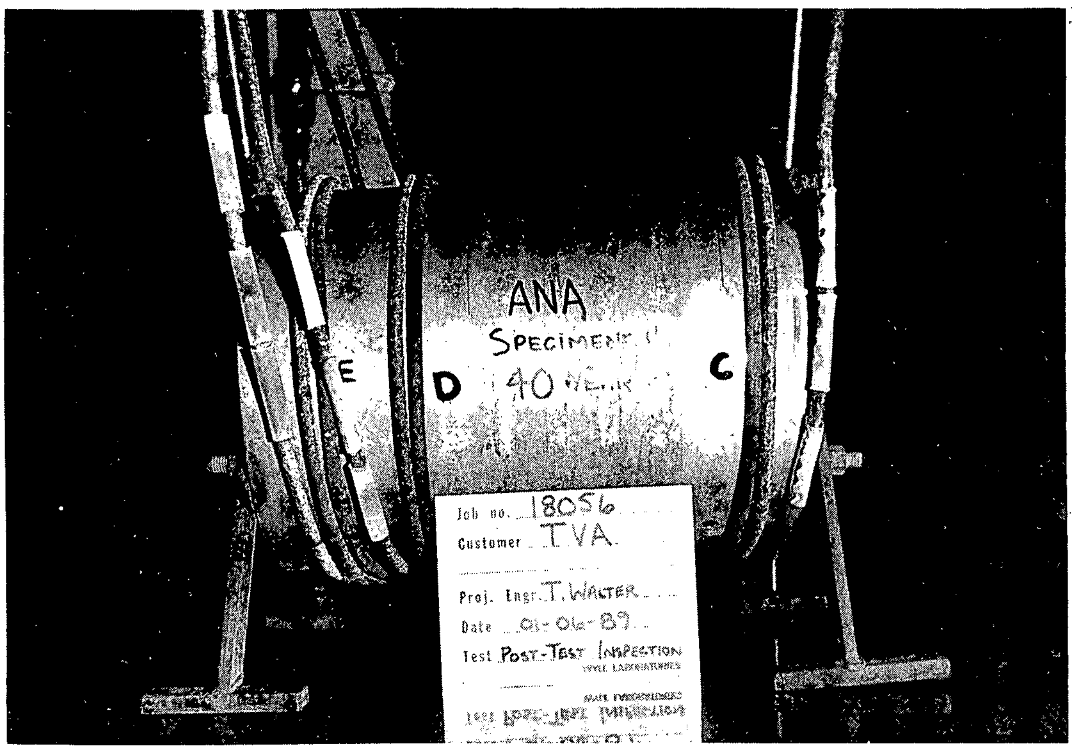
PHOTOGRAPH VI-6

POST-TEST INSPECTION
RWC 40-YEAR SPECIMENS D AND E



PHOTOGRAPH VI-7

**POST-TEST INSPECTION
ANA 40-YEAR SPECIMENS A AND B**



PHOTOGRAPH VI-8

**POST-TEST INSPECTION
ANA 40-YEAR SPECIMENS C, D, AND E**

APPENDIX II

DATA SHEETS

THIS PAGE INTENTIONALLY LEFT BLANK

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLQP 18057-00, IPR 01
Para.: 3.12
S/N: Listed
GSI: N/A

Amb. Temp.: 64°F
Photo: No
Test Med.: Water
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 01-04-89

Test Title: Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
RWC-S-A.40	600 VDC	1	10 mA
	600 VDC	2	10 mA
	750 VDC	3	10 mA
	750 VDC	4	10 mA
	750 VDC	5	10 mA
RWC-S-B.40	6.6 KVDC	1	.5 mA
	6.6 KVDC	2	.43 mA
	6.6 KVDC	3	.41 mA
	6.6 KVDC	4	.38 mA
	6.6 KVDC	5	.38 mA
RWC-S-C.40	6.6 KVDC	1	.34 mA
	6.6 KVDC	2	.28 mA
	6.6 KVDC	3	.22 mA
	6.6 KVDC	4	.34 mA
	6.6 KVDC	5	.16 mA

Notice of Anomaly: NONE

Tested By: D. Compton Date: 1/4/89
Witness: N/A Date:
Sheet No. 1 of 4
Approved: Robert [illegible] 01-04-89

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

Customer Tennessee Valley Authority

WYLE LABORATORIES

Specimen Silicone Rubber Insulated Cables

Part No. Various
Amb. Temp. 64 °F
Job No. 18056

Spec. WLQP 18057-00, IPR 01
Photo No
Report No. 18056-1

Para. 3.12
Test Med. Water
Start Date 1/4/89

S/N Listed
Specimen Temp. Ambient

GSI N/A

Test Title Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
RWC-S-~~D~~E.40	750VDC	1	10mA
	1.0KVDC	2	10mA
	1.0KVDC	3	10mA
	1.0KVDC	4	10mA
	1.0KVDC	5	10mA
RWC-S-~~E~~D.40	500VDC	1	10mA
	600VDC	2	10mA
	700VDC	3	10mA
	600VDC	4	10mA
	600VDC	5	10mA
ANA-S-A.40	6.6KVDC	1	.1mA
	6.6KVDC	2	.08mA
	6.6KVDC	3	.06mA
	6.6KVDC	4	.08mA
	6.6KVDC	5	.08mA

Tested By D. Compton Date: 1/4/89
Witness N/A Date:
Sheet No. 2 of 4
Approved Robert Todd Walter 01-04-89

Notice of Anomaly NONE

Wyle Form WH 614A, Rev. APR '84

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLQP 18057-00, IPR 01
Para.: 3.12
S/N: Listed
GSI: N/A

Amb. Temp.: 64°F
Photo: No
Test Med.: Water
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 1/4/89

Test Title: Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
ANA-S-B.40	~~6.6KVDC~~ KVDC	1	.1mA
	6.6KVDC	2	.08mA
	6.6KVDC	3	.06mA
	6.6KVDC	4	.06mA
	6.6KVDC	5	.06mA
ANA-S-C.40	6.6 KVDC	1	.04 mA
	6.6 KVDC	2	.06mA
	6.6KVDC	3	.05mA
	6.6KVDC	4	.04mA
	6.6KVDC	5	.04mA
ANA-S-D.40	6.6KVDC	1	~~.02mA~~ DC .04mA
	6.6KVDC	2	.04mA
	6.6KVDC	3	.04mA
	6.6KVDC	4	.04 mA
	6.6KVDC	5	.04mA

Notice of Anomaly: NONE

Tested By: D. Compton Date: 1/4/89
Witness: N/A Date:
Sheet No. 3 of 4
Approved: Robert ... Walter 01-04-89

DATA SHEET

WYLE LABORATORIES

Customer: Tennessee Valley Authority
Specimen: Silicone Rubber Insulated Cables
Part No.: Various
Spec.: WLQP 18057-00, IPR 01
Para.: 3.12
S/N: Listed
GSI: N/A

Amb. Temp.: 64°F
Photo: No
Test Med.: Water
Specimen Temp.: Ambient

Job No.: 18056
Report No.: 18056-1
Start Date: 1/4/89

Test Title: Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
ANA-S-E.40	6.6KVDC	1	.02 mA
	6.6KVDC	2	.02 mA
	6.6 KVDC	3	<.01 mA
	6.6KVDC	4	<.01mA
	6.6 KVDC	5	<.01mA

Notice of Anomaly: NONE

Tested By: D. Compton Date: 1/4/89
Witness: N/A Date:
Sheet No. 4 of 4
Approved: Robert M. De Witt 01-04-89

APPENDIX III

INSTRUMENTATION EQUIPMENT SHEET

THIS PAGE INTENTIONALLY LEFT BLANK

INSTRUMENTATION EQUIPMENT SHEET

: 01/04/89
NICIAN: D. COMPTON

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: VOLTAGE WITHSTAND

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	PWR SUPPLY	SORENSEN	1061	283	098745	0-60KV	MFG	01/04/89	07/03/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL ~~BUREAU OF~~ STANDARDS.

INSTRUMENTATION [signature]

CHECKED & RECEIVED BY [signature] 01-04-89

Q.A. [signature] 1-4-89

5 Wyle A

THIS PAGE INTENTIONALLY LEFT BLANK

QUALIFICATION PLAN

QUAL. PLAN 18057-00

DATE: October 18, 1988

Revision A 1/17/89

WYLE LABORATORIES
SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

ENVIRONMENTAL QUALIFICATION FOR SILICONE RUBBER INSULATED CABLES FOR USE IN TENNESSEE VALLEY AUTHORITY'S SEQUOYAH AND WATTS BAR NUCLEAR PLANTS

APPROVED BY: F M Sittason 10-21-88
PROJECT MANAGER: F. M. Sittason

APPROVED BY: Robert W. Walter 10-20-88
FOR: ENVIRONMENTAL QUALIFICATION
R. T. Walter

APPROVED BY: TR Hamilton 10-21-88
QUALITY ASSURANCE: for G. W. Hight

APPROVED BY: Janice K Smith 10-21-88
FOR: QUALIFICATION PLAN DEVELOPMENT
Jan Smith

PREPARED BY: Nipon T. Boonarkat 10/20/88
PROJECT ENGINEER: N. T. Boonarkat

REVISIONS

FORM 1109-1/8-81

REV. NO.	DATE	PAGE OR PARAGRAPH AFFECTED	BY	APP'L	DESCRIPTION OF CHANGES
A	1/17/89	Page 14, Para 3.10.7, Fourth	NTB	ERS 1/17/89	Revised the last sentence to read
		Subparagraph	NTB 1/17/89 RTW 01-17-89	1-17	"...flow rate. pH shall be
				1/17/89	verified and recorded each hour."
A	1/17/89	Page III-2	NTB	ERS 1/17/89	Added a note under Paragraph 5.0.
			NTB 1/17/89 RTW 01-17-89	1-17 1/17/89	
		NOTE: The above changes are to incorporate IPR No. 18057-IPR-1 dated 11/21/88 to document.			

FOREWORD

This document is divided into three (3) major sections:

- o Scope
- o Qualification Requirements
- o Qualification Program

The section on Scope defines the objectives, tasks, applicable qualification standards and specifications, and an equipment description. The equipment description includes performance and functional specifications, along with the number of each to be tested. This section also includes a test sequence listing.

The section on Qualification Requirements defines all the parameters to which the equipment is to be qualified. These parameters are based on the equipment's location and application in the nuclear power generating station. Descriptions of the equipment's safety-related functions and acceptance criteria are provided.

The section entitled Qualification Program defines necessary test programs which meet the scope and qualification requirements defined in the first two sections. Any assumptions, basis for design basis event simulations, are explained in this section.

Table of Contents

1.0 SCOPE

This document has been prepared by Wyle Laboratories for the Tennessee Valley Authority (TVA), hereinafter referred to as customer, for nuclear environmental qualification of Class 1E silicone rubber insulated cables for use inside containment at TVA's Sequoyah (SQN) and Watts Bar (WBN) Nuclear Plants.

1.1 Objectives

The purpose of this qualification plan is to present the approach, methods, philosophies, and procedures for establishing 15-year and 40-year qualified lives of silicone rubber insulated cables (as specified in Paragraph 1.3) for use on 120 VAC and 125 VDC control circuits and 480 VAC power circuits at SQN and WBN.

Nuclear environmental qualification of any safety-related device to meet the requirements of 10 CFR 50.49 is usually a three-step process: 1) radiation exposure (including accident dose), 2) aging, and 3) design basis event qualification (accident). The purpose of the first two steps is to put the sample equipment to be used for qualification into a condition that represents the worst state of deterioration that a plant operator will permit prior to taking corrective action, i.e., its end-of-qualified-life condition. The next step demonstrates that it still has adequate integrity remaining to withstand the added environmental stresses of specified design basis events and still perform its safety-related functions.

It is incumbent on TVA to assure that the components and materials in the equipment actually placed into service are the same as those qualified.

1.2 Applicable Qualification Standards, Specifications, and Documents

- IEEE STD 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."
- IEEE STD 383-1974, "IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations."
- 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," U.S. Nuclear Regulatory Commission, 1973.
- 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, January 21, 1983.
- 10 CFR 21, "Reporting of Defects and Noncompliances," 1977.
- TVA Engineering Services Scope of Work ESSOW-SQN-E01, "Environmental Testing of Silicone Rubber Cable," Revision 4, dated August 22, 1988.
- TVA Contract No. TV-73743A.
- Wyle Laboratories Test Report No. 17905-1, "Qualification Test Program for Silicone Rubber Cables with Reduced Insulation Thicknesses for use in Tennessee Valley Authority's Sequoyah Nuclear Plant, Unit 2," dated November 19, 1987.
- Wyle Laboratories' (Eastern Operations) Quality Assurance Program Manual.

1.0 SCOPE (Continued)

1.3 Equipment Description

The equipment to be qualified consists of thirty Nos. 12 and 14 AWG, 1/C silicone rubber insulated cables as described below.

Specimen No.	Cable No.	RWC Mark No.*
RWC-S-A.40	1V4450A/CBBN	WPA
RWC-S-B.40	1V9841B/5SVN	WPA
RWC-S-C.40	1V3111B/9DG	WPA
RWC-S-D.40	1V3091A/9DG	WPA
RWC-S-E.40	1V2811B/6D1	WPA
RWC-S-A.15	1V4450A/CBB3	WPA
RWC-S-B.15	1V9841B/5SVG	WPA
RWC-S-C.15	1V3111B/9DR	WPA
RWC-S-D.15	1V3091A/9DR	WPA
RWC-S-E.15	1V2811B/6DG	WPA
RWC-W-A.40	1V4450A/CBB8	WPA
RWC-W-B.40	1V9841B/5SVR	WPA
RWC-W-C.40	1V3111B/9DX	WPA
RWC-W-D.40	1V3091A/9DX	WPA
RWC-W-E.40	1V2811B/6DR	WPA
RWC-W-A.15	1V4450A/CBB9	WPA
RWC-W-B.15	1V9841B/5SV1	WPA
RWC-W-C.15	1V3111B/9DY	WPA
RWC-W-D.15	1V3091A/9DY	WPA
RWC-W-E.15	1V2811B/6DC1	WPA

Specimen No.	Cable No.	ANA Mark No. **
ANA-S-A.40	1V1362B/VFL11	WPB
ANA-S-B.40	1V7168A/VBL1	WPA
ANA-S-C.40	2V1362B/VFL3	WPB
ANA-S-D.40	2PL4830A/A27AC3	WPA
ANA-S-E.40	2V2855B/T1	WPB
ANA-S-A.15	1V1362B/VFL3	WPB
ANA-S-B.15	1V7168A/VBLN	WPA
ANA-S-C.15	2V1362B/VFLN	WPB
ANA-S-D.15	2PL4830A/A27AA1	WPA
ANA-S-E.15	2V2855B/T2	WPB

*Note: RWC MARK NO. WPA: Single conductor, No. 14 AWG Class B stranded copper conductor, 45 mil (nominal), silicone rubber insulation (KS-500), Asbestos jacket, Mfg: Rockbestos. During LOCA testing, the cable shall be energized to the equivalent of 528 VAC (phase tc phase) and loaded to 15 amps.

1.0 SCOPE (Continued)

1.3 Equipment Description (Continued)

**Note: ANA MARK NO. WPA: Single conductor, No. 14 AWG Class B stranded copper conductor, 45 mil (nominal), silicone rubber insulation (CC-2193 Nuclesil), Asbestos jacket, Mfg: Anaconda-Continental. During LOCA testing, the cable shall be energized to the equivalent of 528 VAC (phase to phase) and loaded to 15 amps.

ANA MARK NO. WPB: Same as WPA except No. 12 AWG and loaded to 21 amps during the LOCA test.

1.4 Qualification Sequence

As specified by TVA, the qualification program shall be performed in the following sequence:

- Handling Procedure and Specimen Identification
- Specimen Preparation
- Baseline Functional Test
- Normal Radiation Exposure
- Functional Test
- Thermal Aging
- Functional Test
- Accident Radiation Exposure
- Functional Test
- Accident Simulation (LOCA)
- Functional Test
- Voltage Withstand Test (For Margin Assessment)
- Post-Test Inspection

2.0 QUALIFICATION REQUIREMENTS

2.1 Definition of Service Requirements

2.1.1 Margin

The normal and design basis event (DBE) conditions specified do not include margin. Therefore, to account for normal variations in commercial production of equipment and variations in service conditions, margin as per Paragraph 6.3.1.5 of IEEE 323-1974 shall be added as noted.

- o Temperature — +15 deg. F on accident transient
- o Pressure — +10% of gauge
- o Time — +10% of post-DBE operation
- o Voltage — +10% of nominal operating voltage
- o Radiation — +10% on accident dose

2.1.2 Inside Containment Service Conditions

The following service conditions are specified by TVA for the subject equipment.

	Normal	Abnormal	Accident (LOCA)
Temp.(°F)*	120 (99% of time)	130 (1% of time)	327
RH (%)	80	100	100
Press. (psia)	14.7	14.7	27.0
Chem. Spray	N/A	N/A	2000 ppm boron, pH 8.35

***Note:** A 60°C conductor operating temperature (50°C ambient plus 10°C heat rise) shall be used to establish an aging program as specified by TVA.

The following radiation requirements are specified by TVA.

Mfr.	15-Year TID (rads)	40-Year TID (rads)	Accident Dose TID (rads) w/ a 10% margin included
RWC (for SQN)	3.0E7	8.0E7	7.15E7
RWC (for WBN)	3.0E7	8.0E7	1.76E8
ANA (for SQN)	7.5E6	2.0E7	7.15E7

2.1.3 Design Basis Event Conditions

Design Basis Event (DBE) conditions, as specified by TVA, are presented as follows:

The accident conditions are documented in Paragraph 2.1.2. The LOCA/HELB combined accident profile for SQN and WBN is shown in Figure 1. This profile does not include margin.

2.0 QUALIFICATION REQUIREMENTS (Continued)

2.1.4 Other Service Conditions

o Voltage 120 VAC (60Hz) and 125 VDC for control circuits
480 VAC (60Hz), 3 phase, for power circuits

2.2 Safety-Related Function

The subject cables are installed in various Class 1E electrical circuits at SQN and WBN. Therefore, the safety classification of this equipment is Class 1E. The subject equipment provides essential services in support of emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or is otherwise essential in providing support to prevent significant release of radioactive material to the environment.

2.3 Acceptance Criteria

The acceptance criteria, as specified by TVA, is for the cables to maintain the following voltage while electrically loaded during the LOCA simulation. Blowing circuit fuses does not constitute failing of the specimens since the fuses are designed to protect measuring equipment.

Mfr./Mark No.	Applied Voltage (VAC) (+10, -0 VAC)*	Test Current (Amps) (+10, -0%)
RWC/Mark No. WPA	305	15
ANA/Mark No. WPA	305	15
ANA/Mark No. WPB	305	21

***Note:** A single phase 305 VAC (phase to ground) is equivalent to a 3-phase 528 VAC (phase to phase).

2.4 Safety-Related Component

For the purposes of this test program, only the silicone rubber insulation (excluding the first six inches on both ends) is considered to be the test specimen and serves a safety-related function. The first six inches on both ends of the specimens are handled, bent, and spliced for testing and are not to be considered part of the test specimens.

3.0 QUALIFICATION PROGRAM

3.1 Handling Procedure and Specimen Identification

Caution: Since the specimens have asbestos jacketing material, the safety procedure presented in Appendix III shall be followed in handling the specimens.

An inspection shall be performed upon receipt of the test specimens at Wyle. This inspection shall ensure that the specimens have no obvious physical damage. The specimens shall be labeled to facilitate identification, provided by TVA, of the specimens during all phases of the qualification program. The results of the inspection (manufacturer, type, etc.) shall be recorded.

3.2 Specimen Preparation

The test specimens shall be mounted in six open cable trays, as specified below, where adequate contacts between the specimens and the ground plane are provided.

Specimen No.	Cable Tray Designation
RWC-S-A.40	A
RWC-S-B.40	
RWC-S-C.40	
RWC-S-D.40	
RWC-S-E.40	
RWC-S-A.15	B
RWC-S-B.15	
RWC-S-C.15	
RWC-S-D.15	
RWC-S-E.15	
RWC-W-A.40	C
RWC-W-B.40	
RWC-W-C.40	
RWC-W-D.40	
RWC-W-E.40	
RWC-W-A.15	D
RWC-W-B.15	
RWC-W-C.15	
RWC-W-D.15	
RWC-W-E.15	
ANA-S-A.40	E
ANA-S-B.40	
ANA-S-C.40	
ANA-S-D.40	
ANA-S-E.40	

3.0 QUALIFICATION PROGRAM (Continued)

3.2 Specimen Preparation (Continued)

Specimen No.	Cable Tray Designation
ANA-S-A.15	F
ANA-S-B.15	
ANA-S-C.15	
ANA-S-D.15	
ANA-S-E.15	

If it is necessary to bend the specimens during mounting in the trays, the specimens shall not be bent to a radius less than forty times the specimen diameter. An approximately 1/2" specimen spacing shall be provided so that the specimens will not heat the others when powered. Provisions shall be provided for mounting both ends of each specimen approximately four inches above the bottom of the cable tray. This is to facilitate testing during wet insulation resistance measurements. Tefzel tie wraps shall be used to secure the specimens to the cable trays. No additional specimen preparation is required except for preparing the ends of the specimens to a proper length for electrical wiring during functional test and LOCA testing. Cable jacket shall be stripped approximately five inches.

Upon completion of the specimen preparation, photographs of the specimens on the cable trays shall be taken.

3.3 Baseline Functional Test

3.3.1 Visual Inspection

All test specimens shall undergo visual inspections at each step in the test program. All visual observations shall be recorded. Any damage shall be photographed and reported to TVA.

3.3.2 Wet Insulation Resistance Measurements (For Information Only)

The specimens mounted in the cable trays shall be immersed in tap water. Both leads of each specimen shall be suspended out of the water. While still immersed, the insulation resistance shall be measured by applying 500 VDC for a minimum of 1 minute prior to the reading of the resistance between conductor and ground (the cable tray). If a reading cannot be obtained at 500 VDC, the voltage shall be reduced until the insulation resistance is measurable. All results shall be recorded for information only.

3.4 Normal Radiation Exposure

3.4.1 Radiation Exposure Prior to Thermal Aging (Synergistic Effects)

Testing sponsored by the Nuclear Regulatory Commission (NRC) and reported by Sandia Laboratories (Library Code 0271-80) has shown radiation prior to thermal aging causes some polymers to degrade to a greater extent than when irradiated following thermal aging. The report states:

3.0 QUALIFICATION PROGRAM (Continued)

3.4.1 Radiation Exposure Prior to Thermal Aging (Synergistic Effects) (Continued)

> "The mechanistic postulate is that radiation cleaved bonds, in the form of radicals, react with oxygen to give degradation products, including peroxides. The peroxides are chemically weak links, which are susceptible to thermal cleavage. This thermal peroxide cleavage gives more radicals which, in the presence of oxygen lead to more degradation and more peroxides. Thermal aging prior to irradiation does not substantially disrupt the polymer's original molecular structure over the normal elevated temperature ranges which, in turn, results in a lesser degree of degradation than may be expected in actual plant applications. Thus, the amplification of the degradation process caused by thermal peroxide cleavage must be accounted for by performing radiation exposure prior to thermal aging."

Subsequent testing sponsored by Sandia Laboratories, as reported in SAND-80-2149C (Library Code 0474-81A), establishes performing thermal aging after irradiation as the only method in which to account for the strong synergism due to radiation found in some polymers.

> "The joint effect of gamma radiation and elevated temperature was also found to occur when the two environments were applied in sequential fashion, but only when the experiments were performed in that order, radiation at room temperature followed by elevated temperature."

Other NRC sponsored testing by Sandia Laboratories (Library Code 0474-81A) indicates that the mechanical damage resulting from a given total dose is dependent on dose rate for some polymers. Testing was performed at 1.0E3 and 1.0E6 rads/hour. For the polymers tested, more degradation occurred at the lower dose rate. However, no known synergistic effects and dose rate effects exist for the materials under consideration.

Therefore, the application of the radiation dose prior to thermal aging is conservative and accounts for any synergistic effects which may be applicable to the materials of the test specimens.

3.4.2 Irradiation

The test specimens (unpowered) shall be irradiated to normal radiation doses as described below.

Specimen No.	15-Year TID (rads)	40-Year TID (rads)
RWC-S-A.40, RWC-S-B.40, RWC-S-C.40, RWC-S-D.40, RWC-S-E.40	N/A	8.0E7
RWC-S-A.15, RWC-S-B.15, RWC-S-C.15, RWC-S-D.15, RWC-S-E.15	3.0E7	N/A

3.0 QUALIFICATION PROGRAM (Continued)

3.4.2 Irradiation (Continued)

Specimen No.	15-Year TID (rads)	40-Year TID (rads)
RWC-W-A.40, RWC-W-B.40, RWC-W-C.40, RWC-W-D.40, RWC-W-E.40	N/A	8.0E7
RWC-W-A.15, RWC-W-B.15, RWC-W-C.15, RWC-W-D.15, RWC-W-E.15	3.0E7	N/A
ANA-S-A.40, ANA-S-B.40, ANA-S-C.40, ANA-S-D.40, ANA-S-E.40	N/A	2.0E7
ANA-S-A.15, ANA-S-B.15, ANA-S-C.15, ANA-S-D.15, ANA-S-E.15	7.5E6	N/A

The radiation exposure shall be measured as air equivalent gamma using a Cobolt-60 source at a dose rate not to exceed 1.0E6 rads per hour. The dose rate shall be measured at the geometric centerline of the specimens. The specimens shall be rotated as necessary during the radiation exposure to ensure a uniform dose distribution.

Dosimetry utilized during the radiation exposure shall be traceable to the National Bureau of Standards.

3.5 Functional Test

Photographs of the specimens shall be taken upon completion of the normal radiation exposure and the functional test of Paragraph 3.3 shall be repeated.

3.6 Thermal Aging

The specimens (unpowered) shall be subjected to thermal aging as follows. Thermal aging calculations presented in Appendix I are based on the 60°C conductor operating temperature (ambient plus heat rise) and the activation energies of 1.63 eV (for the Anaconda specimens) and 1.73 eV (for the Rockbestos specimens) as specified by TVA.

3.0 QUALIFICATION PROGRAM (Continued)

3.6 Thermal Aging (Continued)

Specimen No.	Qualified Life	Aging Temperature/Time (+5, -0 deg C/+2, -0 hrs)
RWC-S-A.15, RWC-S-B.15, RWC-S-C.15, RWC-S-D.15, RWC-S-E.15, RWC-W-A.15, RWC-W-B.15, RWC-W-C.15, RWC-W-D.15, RWC-W-E.15	15 years	105°C for 101 hours
ANA-S-A.15, ANA-S-B.15, ANA-S-C.15, ANA-S-D.15, ANA-S-E.15	15 years	105°C for 101 hours, then 112°C for 21 hours
RWC-S-A.40, RWC-S-B.40, RWC-S-C.40, RWC-S-D.40, RWC-S-E.40, RWC-W-A.40, RWC-W-B.40, RWC-W-C.40, RWC-W-D.40, RWC-W-E.40	40 years	112°C for 102 hours
ANA-S-A.40, ANA-S-B.40, ANA-S-C.40, ANA-S-D.40, ANA-S-E.40	40 years	112°C for 102 hours, then 120°C for 23 hours

3.7 Functional Test

Photographs of the specimens, while still in the aging chambers, shall be taken upon completion of the thermal aging program and the functional test of Paragraph 3.3 shall be repeated.

3.0 QUALIFICATION PROGRAM (Continued)

3.8 Accident Radiation Exposure

The test specimens (unpowered) shall be irradiated to accident radiation doses as described below.

Specimen No.	Accident Dose TID (rads) with a 10% margin included
RWC-S-A.40,	7.15E7
RWC-S-B.40,	
RWC-S-C.40,	
RWC-S-D.40,	
RWC-S-E.40,	
RWC-S-A.15,	
RWC-S-B.15,	
RWC-S-C.15,	
RWC-S-D.15,	
RWC-S-E.15,	
ANA-S-A.40,	
ANA-S-B.40,	
ANA-S-C.40,	
ANA-S-D.40,	
ANA-S-E.40,	
ANA-S-A.15,	
ANA-S-B.15,	
ANA-S-C.15,	
ANA-S-D.15,	
ANA-S-E.15	
RWC-W-A.40,	1.76E8
RWC-W-B.40,	
RWC-W-C.40,	
RWC-W-D.40,	
RWC-W-E.40,	
RWC-W-A.15,	
RWC-W-B.15,	
RWC-W-C.15,	
RWC-W-D.15,	
RWC-W-E.15	

The radiation exposure shall be measured as air equivalent gamma using a Cobolt-60 source at a dose rate not to exceed 1.0E6 rads per hour. The dose rate shall be measured at the geometric centerline of the specimens. The specimens shall be rotated as necessary during the radiation exposure to ensure a uniform dose distribution.

Dosimetry utilized during the radiation exposure shall be traceable to the National Bureau of Standards.

3.0 QUALIFICATION PROGRAM (Continued)

3.9 Functional Test

Photographs of the specimens shall be taken upon completion of the accident radiation exposure and the functional test of Paragraph 3.3 shall be repeated.

Upon completion of the post-accident radiation functional test, the 15-year specimens shall be stored in an area to protect them from potential damage. These specimens are to be saved for possible future testing.

3.10 Accident Simulation (LOCA)

3.10.1 Requirements

The LOCA/HELB combined accident profile is shown in Figure 1. The test profile, which contains margins as specified in Paragraph 2.1.1, is shown in Figure 2.

Post-accident operation is considered to be from the 24-hour point at 165°F through 1,000 hours at 110°F (as extrapolated linearly on the log time scale of Figure 1) and through 100 days during which the temperature remains constant at 110°F. The pressure requirement is approximately 8.1 psig at 24 hours, 3.5 psig at 290.18 hours, and 2.5 psig at 550.18 hours (the end point of the LOCA test).

3.10.2 Chamber Calibration

The ramp rate requirement of peak temperature and pressure is within 30 seconds. Therefore, prior to the accident simulation, a trial run shall be performed to simulate the first 4 hours of the test profile in Figure 2. This is to determine the actual temperature and pressure ramps of which the chamber is capable. Dummy loads designed to simulate the test specimens (volume and mass) shall be placed in the test chamber to simulate the actual test configuration. A best-effort basis shall be given to meet the ramp requirement.

3.10.3 Test Setup and Preparation

New Tefzel tie wraps shall be used to secure the specimens to the cable trays. The specimens, mounted in their respective cable trays, shall be securely placed inside a Wyle Accident Simulation Chamber in a manner such that the specimens shall not be submerged in chemical solution during the chemical spray. TVA-supplied test leads shall be mounted through chamber penetrations and connected to the test specimens through uninsulated butt splices covered with Raychem WCSF-N heat shrink tubing. The chamber penetrations shall be sealed per Wyle Laboratories' standard practice.

3.10.4 Electrical Powering

The test specimens shall be connected in individual circuits. Typical specimen powering setup is shown in Figure 3. The following electrical powering, as specified by TVA, shall be provided for performance verification of the test specimens. The specimens shall be powered continuously throughout the accident simulation.

3.0 QUALIFICATION PROGRAM (Continued)

3.10.4 Electrical Powering (Continued)

Mfr/Mark No.	Applied Voltage (VAC)	Test Current (Amps)
RWC/Mark No. WPA	305	15
ANA/Mark No. WPA	305	15
ANA/Mark No. WPB	305	21

Allowable tolerances are as follows:

- o Voltage +10, -0 VAC
- o Current +10%, -0% of the specified value

3.10.5 Monitoring

The following parameters shall be monitored and recorded:

- o Applied Voltage
- o Circuit Current
- o Leakage Current to Ground (for information only)
- o Chamber Pressure
- o Chamber Temperature
- o Average Temperature
- o Chem. Spray Flow Rate
- o Chem. Spray pH

Chamber pressure shall be measured using an appropriate range pressure transducer. Chamber temperature shall be recorded using three thermocouples which shall be located in the environmental chamber within two inches of the surface of the test specimens. The chamber temperature, for control purposes, shall be the average of the values recorded by the three thermocouples. The average value shall also be recorded.

From initiation of the test until the first 5 minutes, the data acquisition system (DAS) shall print out all channels at maximum line printer speed. The data acquisition system shall be programmed to record all data at one-minute intervals during the first 8 hours, then at ten-minute intervals through twenty-four hours, and finally at one-hour intervals thereafter for the duration of the test. A pen chart recorder shall be used to continuously monitor the chamber temperature.

3.10.6 Wet Insulation Resistance Measurements

After interconnection of the test specimens to the TVA-supplied test leads, the wet insulation resistance measurements of Paragraph 3.3.2 shall be performed while the specimens are inside the chamber at ambient temperature.

3.0 QUALIFICATION PROGRAM (Continued)

3.10.7 Accident Exposure

Prior to initiation of the accident test, the test chamber shall be stabilized at 104°F for a minimum of 30 minutes using steam with the specimens energized. The specimens shall be subjected to the accident profile specified in Figure 2 which includes the appropriate margins.

Beginning at the initial conditions of 104°F and atmospheric pressure, the energized cables shall be subjected to the initial temperature and pressure transient of 30 seconds (on a best-effort basis) to the minimum peak conditions of 342°F and 15 psig. The temperature and pressure shall follow the Figure 2 profile after achieving peak conditions.

The post-DBE period is after the 24-hour point through 110 days (a 10% margin included). From the 24-hour point at 165°F, the temperature shall linearly decrease to 150°F at the 290.18-hour point. The post-DBE temperature ramp requirement of 150°F at 290.18 hours to 110°F at 1,000 hours (assume a linear decrease on the log time scale) and then 110°F from 1,000 hours through 110 days can be shortened by using the Arrhenius equation and elevating the temperature. The post-DBE accelerated aging time shall be 260 hours at 150°F based on an activation energy of 1.63 eV for the ANA specimens and a 10 deg C heat rise (18 deg F) as specified in Wyle Laboratories Test Report No. 17905-1, Page No. V-17. The post-DBE accelerated aging calculations are presented in Appendix I.

The chemical spray shall be initiated at the saturated condition point (250°F/15 psig) and shall continue for a duration of 24 hours. The spray rate shall be 0.30 gpm/ft^2. DAS shall be used to record flow rate. pH shall be verified and recorded each hour. A

The chemical spray requirement for SQN and WBN is as follows.

o	Boron:	2,000 ppm
o	pH:	8.35 at 25°C
o	Concentration:	0.1847 molar H_3BO_3
		0.033 molar NaOH

Accident simulation tolerances are:

- o +9, -0 deg. F on temperature (after steady state conditions have been achieved)
- o +5, -0 psi on pressure (after steady state conditions have been achieved)
- o +2, -0 hours on total test time
- o +20%, -0% on flow rate
- o +1, -0 on pH

3.11 Functional Test

Photographs of the specimens shall be taken upon completion of the accident simulation. The wet insulation resistance measurements of Paragraph 3.3.2 shall be performed at room ambient conditions while the specimens are inside the chamber.

Upon removal of the specimens from the chamber, the visual inspection of Paragraph 3.3.1 shall be performed.

3.0 QUALIFICATION PROGRAM (Continued)

3.12 Voltage Withstand Test (For Margin Assessment)

The specimens shall be subjected to the Voltage Withstand Tests (Wet Hi-Pots) for information only as described below.

1. The specimens shall be removed from the cable trays, straightened, and wound around mandrels whose outer diameters (OD) are approximately equal to 40 times the actual specimen OD.

2. The specimens shall be immersed in tap water. Both leads of each specimen shall be suspended out of the water.

3. While still immersed, the specimens shall be subjected to Voltage Withstand/Hi-Pots at 6600 VDC (twice the rated voltage plus 1000 volts) for five minutes as specified by TVA. Leakage current between each specimen and ground shall be measured and recorded every minute.

3.13 Post-Test Inspection

Upon completion of testing, the cables shall be visually inspected, photographed, and cable conditions shall be recorded.

3.14 In-Process Inspection

The cables shall be examined for possible damage following all tests. All important test effects shall be logged.

If any noticeable physical damage occurs, TVA shall be notified and photographs shall be taken.

3.15 Anomalies

Any test anomaly shall be reported to TVA within 24 hours after discovering the anomaly.

3.16 Quality Assurance

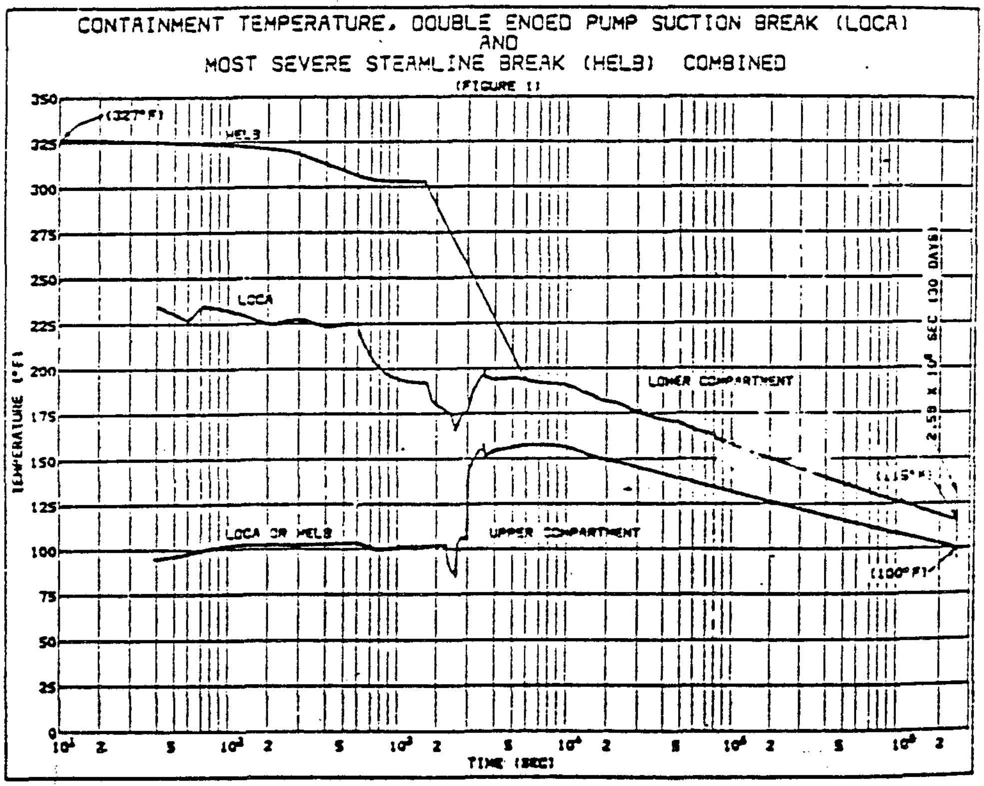
The qualification program shall be performed in accordance with Wyle Laboratories' (Eastern Operations) Quality Assurance Program which complies with the applicable portions of ANSI N-45.2, 10 CFR 50/Appendix B, 10 CFR 21, and Military Specification MIL-STD-45662.

All instrumentation to be used in the performance of this qualification program shall be calibrated in accordance with this manual. Standards used in performing all calibrations are traceable to the National Bureau of Standards. Instrumentation used during the qualification shall be listed in the test report.

3.17 Report

The final test report shall describe the qualification requirements, procedures, and results. The report shall also include rationale and justification required for the qualification. The report shall be prepared in accordance with the requirements of IEEE Standard 323-1974. TVA shall receive ten bound copies and one reproducible copy of the test report.

Figures



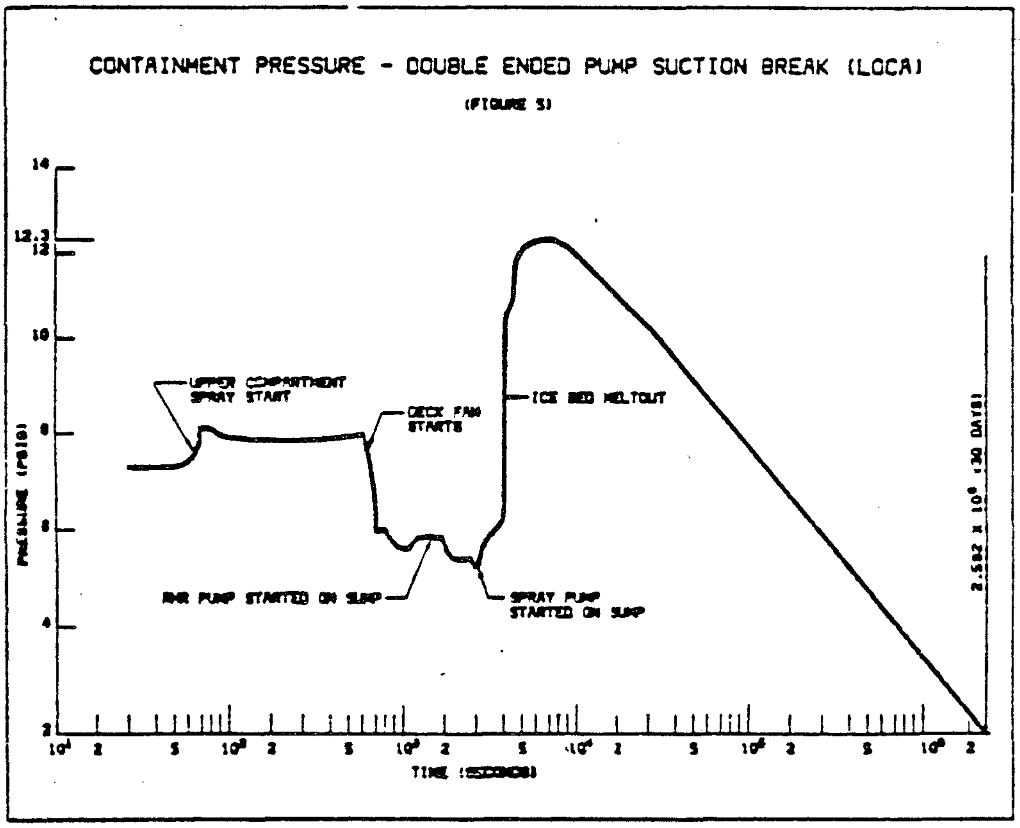


FIGURE 1: LOCA/HELB COMBINED ACCIDENT PROFILE FOR SQN AND WBN

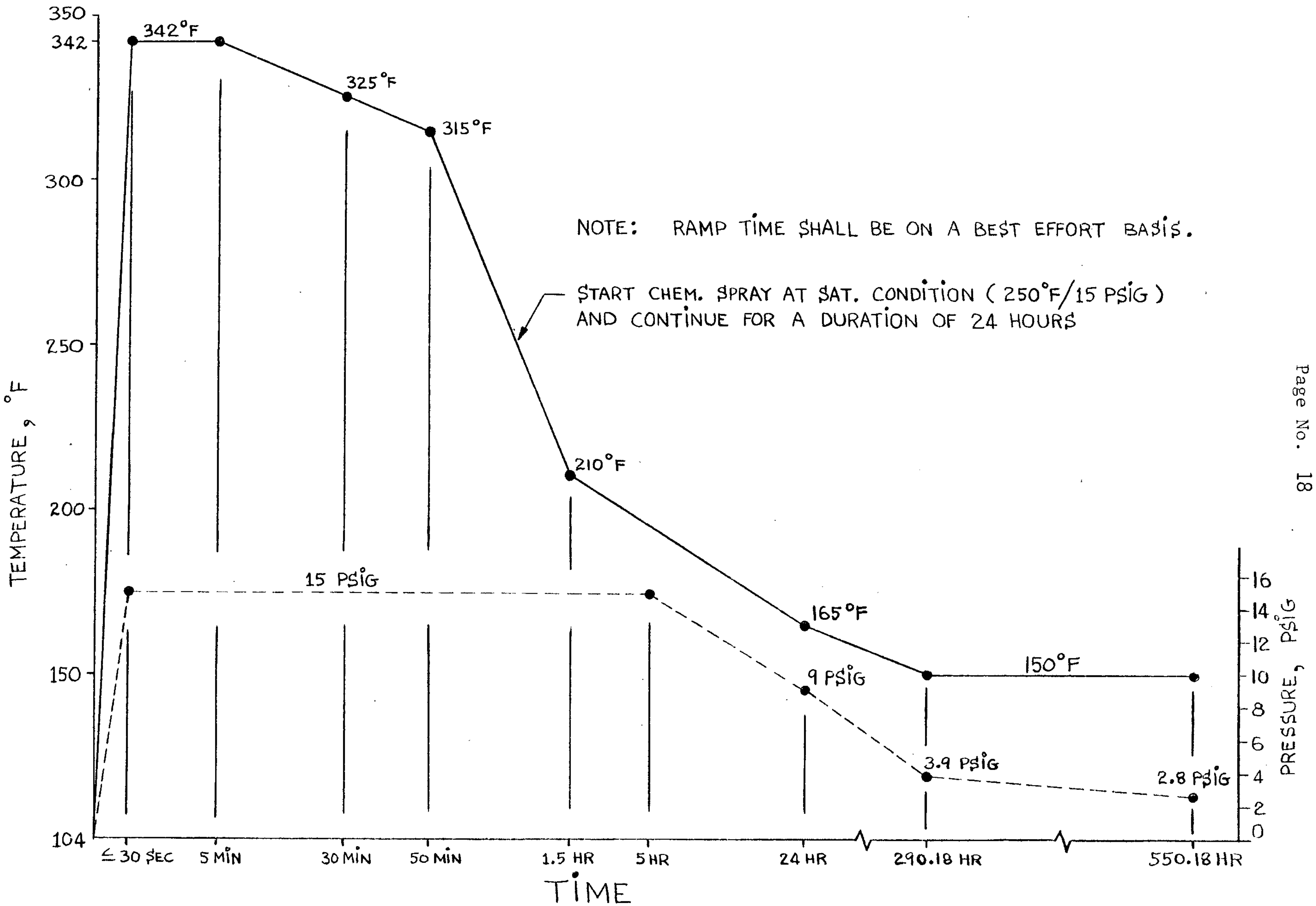


FIGURE 2: TEST PROFILE WITH MARGINS

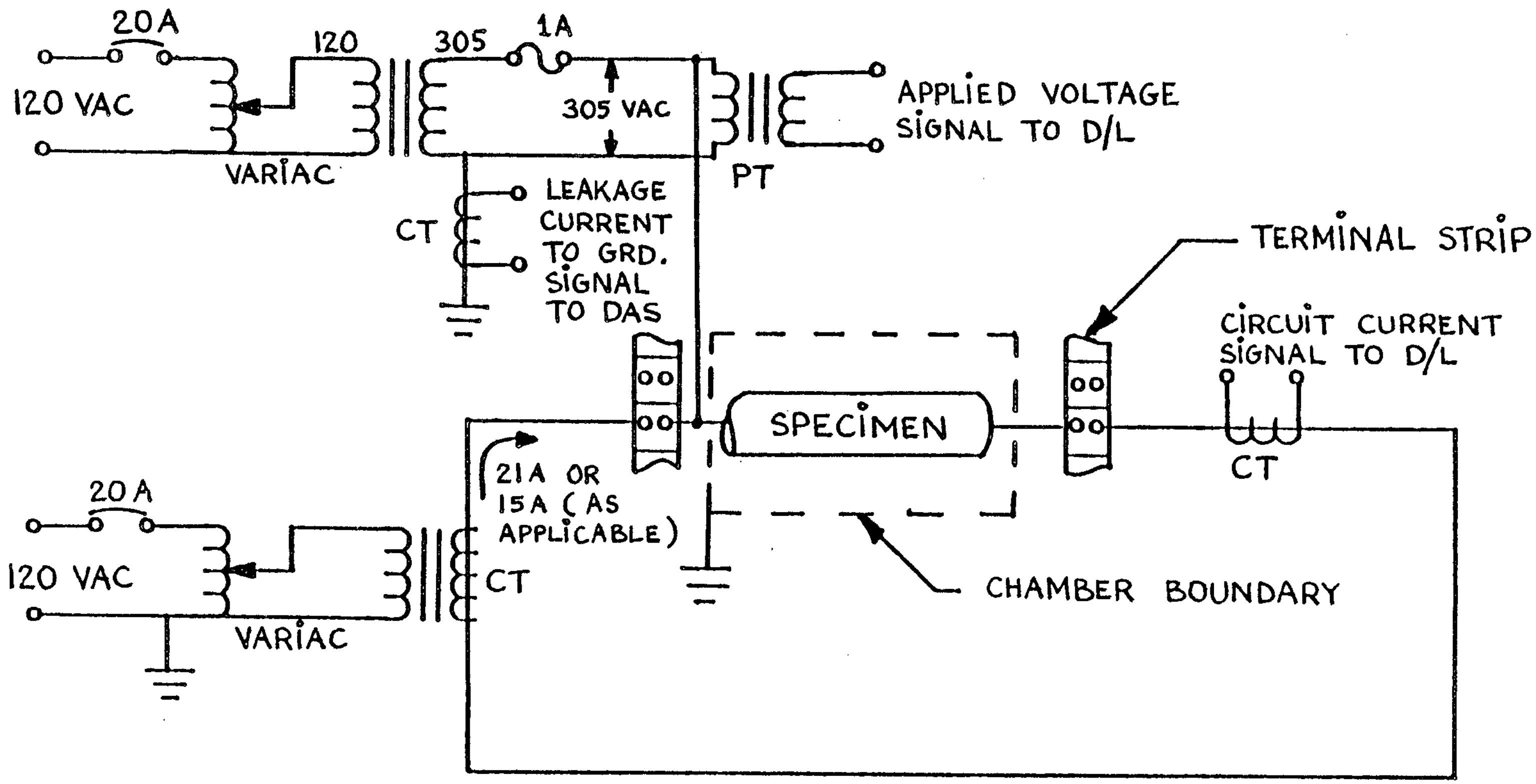


FIGURE 3: TYPICAL SPECIMEN POWERING

This page intentionally left blank.

APPENDIX I
Calculations

"THERMAL AGING PROGRAM"

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
ACCELERATED AGING

10/18/88

GENERIC NAME: 15-YEAR ROCKBESTOS SPECIMENS

ACTIVATION ENERGY 1.73

AGING TEMPERATURE (C) 105

TEMPERATURE [C]	TIME [H]
60	131400

TOTAL TIME= 131400.00 HOURS

ACCELERATED AGING TIME AT 105 C=
100.344 HOURS
4.18 DAYS

The 15-year Rockbestos specimens shall be thermally aged at 105°C for 101 hours to simulate a 15-year qualified life based on the activation energy of 1.73 eV.

"THERMAL AGING PROGRAM"

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
QUALIFIED LIFE 10/18/88

MATERIAL NAME: 15-YEAR ANACONDA SPECIMENS
ACTIVATION ENERGY: 1.63

TEST AGING TEMP (C): 105.00
TEST AGING TIME: 101

TEMPERATURE (C)	TIME (H)
60	131400

TOTAL TIME= 131400.00 HOURS

QUALIFIED LIFE =
87345.00 HOURS
9.9 YEARS

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
ACCELERATED AGING 10/18/88

GENERIC NAME: 15-YEAR ANACONDA SPECIMENS

ACTIVATION ENERGY 1.63

AGING TEMPERATURE (C) 112

TEMPERATURE [C]	TIME [H]
60	44676

TOTAL TIME= 44676.00 HOURS

ACCELERATED AGING TIME AT 112 C=
20.797 HOURS
0.86 DAYS

The 15-year Anaconda specimens shall be thermally aged with the 15-year Rockbestos specimens at 105°C for 101 hours which is equivalent to 9.9-year qualified life based on the activation energy of 1.63 eV. Therefore, upon removal of the 15-year Rockbestos specimens from the chamber, the 15-year Anaconda specimens shall be subjected to an additional thermal aging at 112°C for 21 hours to simulate an additional 5.1-year qualified life.

"THERMAL AGING PROGRAM"

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
ACCELERATED AGING

10/18/88

GENERIC NAME: 40-YEAR ROCKBESTOS SPECIMENS

ACTIVATION ENERGY 1.73 AGING TEMPERATURE (C) 112

TEMPERATURE [C]	TIME [H]
60	350400

TOTAL TIME= 350400.00 HOURS

ACCELERATED AGING TIME AT 112 C=
101.876 HOURS
4.24 DAYS

> The 40-year Rockbestos specimens shall be thermally aged at 112°C for 102 hours to simulate a 40-year qualified life based on the activation energy of 1.73 eV.

"THERMAL AGING PROGRAM"

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
QUALIFIED LIFE 10/18/88

MATERIAL NAME: 40-YEAR ANACONDA SPECIMENS
ACTIVATION ENERGY: 1.63

TEST AGING TEMP (C): 112.00
TEST AGING TIME: 102

TEMPERATURE (C)	TIME (H)
60	350400

TOTAL TIME= 350400.00 HOURS

QUALIFIED LIFE =
219114.00 HOURS
25.0 YEARS

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
ACCELERATED AGING 10/18/88

GENERIC NAME: 40-YEAR ANACONDA SPECIMENS

ACTIVATION ENERGY 1.63

AGING TEMPERATURE (C) 120

TEMPERATURE [C]	TIME [H]
60	131400

TOTAL TIME= 131400.00 HOURS

ACCELERATED AGING TIME AT 120 C=
22.498 HOURS
0.93 DAYS

The 40-year Anaconda specimens shall be thermally aged with the 40-year Rockbestos specimens at 112°C for 102 hours which is equivalent to 25-year qualified life based on the activation energy of 1.63 eV. Therefore, upon removal of the 40-year Rockbestos specimens from the chamber, the 40-year Anaconda specimens shall be subjected to an additional thermal aging at 120°C for 23 hours to simulate an additional 15-year qualified life.

"POST-DBE ACCELERATED AGING CALC"

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
LINEAR SLOPE EQUIVALENT 10/20/88

REF TEMP & SCALE 128.00 F — ACTIVATION ENERGY 1.63 eV
NUMBER OF SLOPES 2 — TEMPERATURE SCALE F

INITIAL TEMP	FINAL TEMP	HOURS	EQUIVALENT HOURS
168.00	128.00	709.8200	7938.90
128.00	128.00	1640.0000	1640.00
	TOTALS:	2349.8200	9578.90

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
ACCELERATED AGING 10/20/88

GENERIC NAME: SR INSULATED CABLES (ANACONDA)

ACTIVATION ENERGY 1.63 — AGING TEMPERATURE (C) 75

TEMPERATURE [F]	TIME [H]
128	9578.90

TOTAL TIME= 9578.90 HOURS

ACCELERATED AGING TIME AT 75 C=
259.394 HOURS
10.80 DAYS

APPENDIX II
References

TABLE II-REFERENCE LIST 10/19/88

CODE	TITLE
027180	"A STUDY OF STRONG SYNERGISM IN POLYMER DEGRADATION," R.L. CLOUGH, K.T. GILLEN, AND E.A. SALAZAR, SANDIA LABORATORIES, NO. SAND-79-092-CK, AUGUST 8, 1979.
047481A	"RADIATION-THERMAL DEGRADATION OF PE AND PVC: MECHANISM OF SYNERGISM AND DOSE RATE EFFECTS," R.L. CLOUGH AND K.T. GILLEN, SANDIA NATIONAL LABORATORIES, SAND 80-2149C.

APPENDIX III
Procedure for Handling Asbestos Material

Procedure for Handling Asbestos Material During Specimen Preparation

1.0 Coveralls, gloves, and footwear shall be worn that afford full protection to the individual performing the material handling. The coveralls and gloves recommended are those that may be disposed of upon completion of the material handling. A full face respirator which utilizes filter cartridges shall be used by the individual performing the material handling. All clothing and other safety equipment shall be approved by the responsible Test Engineer prior to initiation of specimen preparation. The area around where the specimens are to be unpacked and prepared for testing shall be barricaded and signs placed around the area that state: Danger; Asbestos; Cancer and Lung Disease Hazard; Authorized Personnel Only; Respirators and Protective Clothing are Required in This Area.

2.0 The specimen enclosure shall be opened by carefully removing the outer wrapping, warning indications, and enclosure cover. Prior to removal of the test specimens, the enclosure shall be vacuumed clean using a machine equipped with a HEPA filter or equivalent.

3.0 The test specimens shall be removed from the enclosure on an individual basis and after identification and tagging by the Test Engineer, the specimens shall be mounted to the cable trays as specified in Paragraph 3.2 of this qualification plan.

4.0 Both ends of each test specimen shall be cut to remove the silicone insulation and asbestos jacket, as directed by the Test Engineer. Prior to cutting the specimen material, the asbestos jacket shall be sprayed with water to keep release of asbestos material to a minimum.

5.0 All asbestos and silicone materials that remain as a result of preparation of the test specimen lead ends shall be placed in a sealable plastic container for disposal according to health and safety requirements. All containers containing asbestos materials shall be labeled and shall include the following information: Danger; Contains Asbestos Fibers; Avoid Creating Dust; Cancer and Lung Disease Hazard. The Test Engineer shall be responsible for enforcing all safety precautions and measures during preparation of the test specimens.

Note: Based on test results of the asbestos monitoring and analysis documented in Environmental Test Report No. 108075 by Technical Micronics Control, Inc., the asbestos levels described below in the work area were well below the threshold limit value of 0.2 fibers/cc. Therefore, it is concluded that personnel protection from asbestos fibers is not required in handling the test specimens after the initial Specimen Identification and Preparation of Paragraphs 3.1 and 3.2, respectively. A

Specimen Handling Related to Asbestos Exposure	Fibers of Asbestos (fibers/cc)
Before	0.027
During	0.055
After	0.014

THIS PAGE INTENTIONALLY LEFT BLANK

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

Reference No. 18056K-007

3 March 1989

Tennessee Valley Authority
J. D. Hutson (Chief Electrical Engineer)
400 West Summit Hill Drive
WT11C 126
Knoxville, TN 37902

Attention: Mr. Kent Brown

Subject: Nuclear Qualification of Cables

Reference: Contract TV-73743A
Task 0011-391159

Enclosed is Technical Inquiry Response Document No. TR18056-1 dated March 3, 1989 regarding test envelope requirements. If you have any further questions regarding this subject please call Fred Sittason (205) 837-4411.

Sincerely,

WYLE LABORATORIES
Eastern Operations

Joanne F. Kelly

Joanne F. Kelly
Senior Contracts Administrator

JFK/drl

TECHNICAL INQUIRY RESPONSE

TO: Tennessee Valley Authority
400 Summitt Hill Drive
Knoxville, TN

DOCUMENT NO. TR18056-1

WYLE JOB NO. 18056-1

DATE OF INQUIRY March 3, 1989

PAGE 1 of 1 PAGES

DATE

1.0 ATTENTION Kent Brown

2.0 FROM Fred Sittason

3.0 SUBJECT Wyle TR18056-1, Post-Accident Aging

4.0 REFERENCES

In response to your inquiry, a calculation was performed assuming post accident temperature decreasing from 165^{O} at the 24 hour point, stabilizes at 115^{O} at 30 days and continues at 115^{O} through 110 days. These requirements were compared to actual test temperatures achieved in WLTR 18056-1. The attached Linear Slope Comparison demonstrates that the test profile envelops the requirement with a 34% margin.

Should you have further questions or comments, contact me at (205) 837-4411.

WYLE LABORATORIES
SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

PREPARED BY [signature] 3-3-89
M. Brandt Howard

APPROVED BY [signature] 3-3-89
F. Sittason

WYLE Q.A. G.W. Hight 3-3-89
G. W. Hight

WH 1202A, Dec. 1980

WYLE LABORATORIES

NUCLEAR ENGINEERING SERVICES

LINEAR SLOPE COMPARISON 03/03/89

REF TEMP & SCALE: 133.00 f ACTIVATION ENERGY 1.63 eV

* * PLANT REQUIREMENT * *				* * TEST PROFILE * *			
TEMP SCALE (F/C) f	NO. SLOPES: 4			TEMP SCALE (F/C) F	NO. SLOPES: 7		
INITIAL TEMP	FINAL TEMP	SLOPE HOURS	EQUIVALENT HOURS (2 PL)	INITIAL TEMP	FINAL TEMP	SLOPE HOURS	EQUIVALENT HOURS (2 PL)
183.00	168.00	31.5600	1586.11	166.00	166.00	18.0000	373.60
168.00	143.00	222.2200	2235.33	170.00	170.00	47.0000	1378.79
143.00	133.00	442.2200	745.38	168.00	168.00	74.0000	1826.99
133.00	133.00	1920.0000	1920.00	164.00	164.00	120.0000	2091.49
TOTALS:		2616.0000	6486.83	161.00	161.00	171.0000	2288.60
				158.00	158.00	20.0000	205.02
				154.00	154.00	81.0000	579.51
				TOTALS:		531.0000	8743.99

RATIO TEST PROFILE/PLANT REQUIREMENT = 1.3480

TEST ENVELOPS REQUIREMENTS - PRESS ANY KEY TO CONTINUE