RESPONSE TO NOVEMBER 18, 1977, LETTER
FROM EDSON G. CASE TO GODWIN WILLIAMS, JR.
"ELECTRICAL CONNECTOR ASSEMBLIES"

This response provides the environmental qualification information for the electrical connectors used in the Browns Ferry Nuclear Plant, as requested by the November 18, 1977, letter from Edson G. Case to Godwin Williams, Jr., which references IE Bulletins 77-05 and 77-05A, dated November 8 and November 15, 1977, respectively. Also, this response includes TVA's justification for continued operation of the facilities without creating undue risk to the health and safety of the public. This response is divided into the following:

Part I - Identification of Systems, Components, and Associated Electrical Connectors Required to Function to Mitigate Design Basis Events.

Part II - Environmental Qualification of Electrical Connectors

Part III - Justification for Continued Operation

Part I

Identification of Systems, Components, and Associated Electrical Connectors Required to Function to Mitigate Design Basis Events

Table 1 lists the safety systems and components required to function to mitigate a postulated design basis event or accident outside containment. Those systems containing electrical connectors are so designated in this table. These systems or portions of systems and components have been categorized as being either inside primary containment or outside primary containment. Table 2 lists those electrical connectors for each Browns Ferry unit that are inside the primary containment and are a part of a safety system as listed in Table 1. Table 2 identifies the electrical penetration through the primary containment that each electrical connector is located on, the type of connector, the number of wires to the connector, the system whose circuits pass through the connector, the system component associated with the circuits, and the function of the circuits. Table 3 lists those electrical connectors for all three Browns Ferry units that are outside the primary containment and are a part of a safety system circuit. Only those safety systems which are required to function to mitigate a postulated design basis event or accident outside containment where the event itself could adversely affect the ability of the system to perform its safety function have been considered and listed in Tables 2 and 3.

For units 1 and 2, only one type of connector is used inside the primary containment in the identified safety circuits. This connector was supplied by Physical Sciences Corporation and is an integral part of the penetration. It has 48 pins, has gold-plated surfaces on both the pins and the female receptacles, utilizes a Neoprene 'O' ring as a sealing surface where the plug shell and receptacle shell interface, and has the insulated conductors potted in the shell. Both the plug shell and the receptacle shell are metallic.

For unit 3, two types of connectors are used inside the primary containment in identified safety circuits. These were supplied by Bendix and are similar to each other in design:

Part No. 10-214636-78S or P, 14 contacts (2Nos.16, 12Nos.8);

and Part No. 10-214628-51S or P, 12 contacts (Nos.12).

The types of connectors used outside of the primary containment in identified safety circuits are of various types as shown in Table 3.

TABLE 1

SYSTEMS AND COMPONENTS REQUIRED TO FUNCTION TO MITIGATE DESIGN BASIS EVENTS

I. INSIDE PRIMARY CONTAINMENT (* Denotes Systems with Connectors)

*Inboard Main Steam Isolation Valve Circuits

*Automatic Depressurization Relief Valve Circuits

*Inboard Containment Isolation Valve Circuits (See note 1)

*Oxygen and Hydrogen Monitoring Systems

*Suppression Pool to Drywell Vacuum Breakers

*Recirculation System Suction and Discharge Valves (See Note 1)

*Residual Heat Removal System Head Spray Flow Control Valves (See Note 1)

*High Pressure Coolant Injection System Steam Supply Valve (See Note 1)

*Reactor Core Isolation Cooling System Steam Supply Valve (See Note 1)

II. OUTSIDE PRIMARY CONTAINMENT

A. Inside Secondary Containment (* Denotes Systems with Connectors)

*Main Steam Isolation Valve Circuits (See Note 2)

*Automatic Depressurization Relief Valve Circuits (See Note 2)

*Containment Isolation Valve Circuits (See Note 2)

*Oxygen and Hydrogen Monitoring Systems (See Note 2)

4 KV and 480 V Boards (See Note 3)

Diesel Generations and Process Auxiliaries (See Note 3)

4 KV and 480 V System Circuits

250 VDC System Circuits

Control Bay Ventilation System Circuits (See Note 4)

Corner Room (Elev 519) Level Switch Circuits (See Note 5)

*Radiation Monitoring Systems

*- Main Steam Vault

*- RHR SW Effluent

*- RBCCW

*- RSW Effluent

TABLE 1 (CONT.)

Diesel-Generator Shutdown Board Room Ventilation System Circuits (See Note 4)

*RCIC Circuits (See Note 6)

Circuits for Other Essential Systems (See Note 7)

*- Automatic Depressurization System
*- Primary Containment Isolation
- Containment Inerting
- Reactor Building Isolation
- Reactor Building Vacuum Relief
- Standby Gas Treatment
- RHR
- RHRSW
- RHR Room Coolers
- EECW
- CS
- CS Room Coolers
- HPCI
- Reactor Protection System (Excluding Neutron Monitoring System, Control Rod Drive and Position Indicating Systems)
- Reactor Building Closed Cooling Water
- Fuel Pool Cooling
*- Reactor Water Cleanup (Isolation Function Only)
- Torus Water Level and Temperature

B. Control Bay

The control bay environment is controlled by the control bay ventilation system. The environment for equipment within the control bay is no more severe during design basis events than that to which it is exposed during normal unit operations.

C. Unit 1, 2, and 3 Diesel-Generator Shutdown Board Rooms

The diesel-generator shutdown board room environments are controlled by the board room ventilation systems. The environment for equipment within these board rooms is no more severe during design basis events than that to which they are exposed during normal unit operation.

TABLE 1 (CONT.)

Notes:

1. Connections at motor operated valves were excluded since these connections were qualified in conjunction with qualification of the valves and associated motor operators.
2. Circuits for any safety-related components outside containment were investigated. In addition, circuits outside containment serving safety-related components which are located inside containment were investigated.
3. Failure of these components that are required for onsite power distribution was analyzed previously. See "Concluding Report on the Effects of Postulated Pipe Failure Outside of Containment for Unit 1 of the Browns Ferry Nuclear Plant" DED-TM-PF1 (October 15, 1973) and "Concluding Report on the Effects of Postulated Pipe Failure Outside of Containment for the Browns Ferry Nuclear Plant Units 2 and 3" DED-TM-PF2 (March 1, 1974).
4. These circuits were investigated for any extensions outside of the control bay or shutdown board rooms into the boundaries of secondary containment.
5. These rooms contain vital HPCI, RCIC, CS, and RHR equipment. The level switch circuits investigated are those which warn of flooding internal to these rooms.
6. In terms of function and objective, the RCIC system is not actually a safety system. However, with regard to engineering analyses, fabrication, and erection processes, and quality assurance control and documentation, this system received the same attention as the safety-related systems. For this reason, RCIC was evaluated using the same criteria as for the safety-related systems.
7. The investigation includes any wall sockets or wall power outlets associated with these circuits.

TABLE 2

UNIT 1 - PENETRATION CONNECTORS INSIDE PRIMARY CONTAINMENT
MANUFACTURER - PHYSICAL SCIENCES, 48 PIN, NO. 12
PLUG NO. 6448-2
RECEPTACLE NO. 6445-2

Penetration No.	Connector No.*	System	Component	Function	No. of Wires
EB	G2-2G	Recirculation Discharge	FCV-68-79	Logic	7
		Recirculation Suction	FCV-68-77	Logic	7
		Recirculation Discharge	FCV-68-79	Logic	2
	G3-3G	Relief Valve	PSV-1-30	Power	2
		Recirculation Discharge	FCV-68-79	Logic	2
		HPCI Steam Supply	FCV-73-2	Logic	7
	G4-4G	RHR Head Spray	FCV-74-78	Logic	7
		Recirculation Sampling	FCV-43-13	Power & Logic	5
		MS Drain	FCV-1-55	Logic	7
		RWCU Letdown	FCV-69-1	Logic	7
	G5-5G	Relief Valve	PSV-1-5	Sol Valve Power	2
	G7-7G	Main Steam Isolation	FCV-1-14	Logic	2
		Main Steam Isolation	FCV-1-37	Logic	2
	G8-8G	Main Steam Isolation	FCV-1-14	Power & Logic	9
		Main Steam Isolation	FCV-1-26	Power & Logic	9
		Main Steam Isolation	FCV-1-37	Power & Logic	9
		Main Steam Isolation	FCV-1-51	Power & Logic	9
		RHR Letdown Supply	FCV-74-48	Power & Logic	11
	G9-9G	RWCU Letdown	ZS-69-1	Logic	4
EC	G4-4G	Relief Valve	PSV-1-19	Power	2
		Relief Valve	PSV-1-31	Power	2
	G9-9G	Main Steam Isolation	FCV-1-14	Logic	2
		Main Steam Isolation	FCV-1-26	Logic	2
		Relief Valve	PSV-1-22	Power	2
		Relief Valve	PSV-1-34	Power	2
ED	J3-3J	H_2E	HE 76-39	Instrumentation	4
		O_2E	OE 76-43	Instrumentation	4
EE	G4-4G	RHR Letdown Supply	FCV-74-48	Logic	4
		RCIC Steam Supply	FCV-71-2	Logic	7
	G6-6G	Drywell Equipment Sump	FCV-77-14B	Power & Logic	9
	G7-7G	Main Steam Isolation	FCV-1-26	Logic	2
		Main Steam Isolation	FCV-1-51	Logic	2

TABLE 2 (CONT.)

UNIT 1 - CONNECTORS INSIDE CONTAINMENT

Penetration No.	Connector No.*	System	Component	Function	No. of Wires
	G8-8G	Main Steam Isolation	FCV-1-37	Logic	2
		Main Steam Isolation	FCV-1-51	Logic	2
	G9-9G	Recirculation Suction	FCV-68-1	Logic	7
		Recirculation Discharge	FCV-68-3	Logic	11

*The penetrations have connectors on both ends, only the inboard connectors are listed since they experience the worst environment.

TABLE 2 (CONT.)

UNIT 2 - PENETRATION CONNECTORS INSIDE PRIMARY CONTAINMENT
MANUFACTURER - PHYSICAL SCIENCES, 48 PIN, NO. 12
PLUG NO. 6448-2
RECEPTACLE NO. 6445-2

Penetration No.	Connector No.*	System	Component	Function	No. of Wires
EB	G2-2G	Recirculation Discharge	FCV-68-79	Logic	7
		Recirculation Suction	FCV-68-77	Logic	7
		Recirculation Discharge	FCV-68-79	Logic	2
	G3-3G	Relief Valve	PSV-1-30	Power	2
		HPCI Steam Supply	FCV-73-2	Logic	7
	G4-4G	RHR Head Spray	FCV-74-78	Logic	7
		Recirculation Sampling	FCV-43-13	Power & Logic	5
		Main Steam Drain	FCV-1-55	Logic	7
		RWCU Letdown	FCV-69-1	Logic	7
	G6-6G	Relief Valve	PSV-1-5	Power	2
	G7-7G	Main Steam Isolation	FCV-1-14	Logic	2
		Main Steam Isolation	FCV-1-37	Logic	2
	G8-8G	Main Steam Isolation	FCV-1-14	Logic	9
		Main Steam Isolation	FCV-1-26	Logic	9
		Main Steam Isolation	FCV-1-37	Logic	9
		Main Steam Isolation	FCV-1-51	Logic	9
		RHR Letdown Supply	FCV-74-48	Logic	11
	G9-9G	RWCU Letdown	ZS-69-1	Logic	4
EC	G4-4G	Relief Valve	PSV-1-19	Power	2
		Relief Valve	PSV-1-31	Power	2
	G9-9G	Main Steam Isolation	FCV-1-14	Logic	2
		Main Steam Isolation	FCV-1-26	Logic	2
		Relief Valve	PSV-1-22	Power	2
		Relief Valve	PSV-1-34	Power	2
ED	J3-3J	H_2E	H_2E-76-39	Instrumentation	4
		O_2E	O_2E-76-43	Instrumentation	4
EE	G4-4G	RHR Letdown Supply	FCV-74-48	Logic	4
		RCIC Steam Supply	FCV-71-2	Logic	7
	G5-5G	Recirculation Discharge	FCV-68-3	Logic	2
	G6-6G	Drywell Equipment Sump	FCV-77-14B	Power & Logic	9

TABLE 2 (CONT.)

UNIT 2 - PENETRATION CONNECTORS INSIDE PRIMARY CONTAINMENT

Penetration No.	Connector No.*	System	Component	Function	No. of Wires
	G7-7G	Main Steam Isolation	FCV-1-26	Logic	2
		Main Steam Isolation	FCV-1-51	Logic	2
	G8-8G	Main Steam Isolation	FCV-1-37	Logic	2
		Main Steam Isolation	FCV-1-51	Logic	2
	G9-9G	Recirculation Suction	FCV-68-1	Logic	7
		Recirculation Discharge	FCV-68-3	Logic	9

*The penetrations have connectors on both ends, only the inboard connectors are listed since they experience the worst environment.

TABLE 2 (CONT.)

UNIT 3 - CONNECTORS INSIDE PRIMARY CONTAINMENT
MANUFACTURER - BENDIX

Penetration No.	Connector[1,2] No.	Type	System	Component	Function	No. of Wires
EA	J1	1	HPCI Steam Supply	FCV-73-2	Power	3
	J6	1	Recirculation Discharge	FCV-68-79	Logic	5
	J7	1	Recirculation Discharge	FCV-68-79	Power	3
			Recirculation Suction	FCV-68-77	Power	3
			Main Steam Drain	FCV-1-55	Power	3
	J8	1	RWCU Letdown	FCV-69-1	Power	3
	J9	1	RHR Head Spray	FCV-74-78	Power	3
			RHR Letdown Supply	FCV-74-48	Power	3
EB	J1	2	Relief Valve	PSV-1-18	Power	2
	J2	2	Relief Valve	PSV-1-41	Power	2
	J3	2	Relief Valve	PSV-1-5	Power	2
	J7	2	Recirculation Discharge	FCV-68-79	Logic	7
	J8	2	Recirculation Discharge	FCV-68-79	Logic	2
			" Suction	FCV-68-77	"	7
	J11	2	RWCU Letdown	FCV-69-1	Logic	7
			RWCU Letdown	ZS-69-1	Logic	4
	J12	2	HPCI Steam Supply	FCV-73-2	Logic	7
	J17	2	RHR Head Spray	FCV-74-78	Logic	7
			Recirculation Sampling	FCV-43-13	Power & Logic	5
	J19	2	RHR Letdown Supply	FCV-74-48	Logic	11
	J20	2	Main Steam Isolation	FCV-1-14	Power & Logic	9
	J21	2	Main Steam Isolation	FCV-1-26	Power & Logic	9
	J22	2	Main Steam Isolation	FCV-1-37	Power & Logic	9
	J23	2	Main Steam Isolation	FCV-1-51	Power & Logic	9
	J29	2	Main Steam Drain	FCV-1-55	Logic	7
	25	2	Main Steam Isolation	FCV-1-14	Logic	2
			Main Steam Isolation	FCV-1-37	Logic	2

TABLE 2 (CONT.)

UNIT 3 - CONNECTORS INSIDE PRIMARY CONTAINMENT

Penetration No.	Connector No.	Type	System	Component	Function	No. of Wires
EC	J16	2	Relief Valve	PSV-1-19	Power	2
	J18	2	Relief Valve	PSV-1-22	Power	2
			Relief Valve	PSV-1-34	Power	2
	25	2	Main Steam Isolation	FCV-1-14	Logic	2
			Main Steam Isolation	FCV-1-26	Logic	2
ED	J13	2	H_2E	H_2E-76-39	Instrumentation	4
			O_2E	O_2E-76-43	Instrumentation	3
	16	2	Main Steam Isolation	FCV-1-26	Logic	2
			Main Steam Isolation	FCV-1-51	Logic	2
EE	J1	2	Recirculation Discharge	FCV-68-1	Logic	7
	J2	2	Recirculation Discharge	FCV-68-3	Logic	9
	J9	2	RHR Letdown Supply	FCV-74-48	Logic	4
	J10	2	RCIC Steam Supply	FCV-71-2	Logic	7
	J11	2	Recirculation Discharge	FCV-68-3	Power & Logic	2
	J12	2	Drywell Equipment Sump	FCV-77-14B	Power & Logic	9
	25	2	Main Steam Isolation	FCV-1-37	Logic	2
			Main Steam Isolation	FCV-1-51	Logic	2
EF	J4	1	Recirculation Discharge	FCV-68-1	Power	3
			Recirculation Discharge	FCV-68-3	Power	3
	J6	1	RCIC Steam Supply	FCV-71-2	Power	3
	J7	1	Recirculation Discharge	FCV-68-3	Logic	5

1. NOTE: Type 1 - Bendix Part No. 10-214636-78S or P, 14 Contacts (2Nos.16, 12Nos.8)
Type 2 - Bendix Part No. 10-214628-51S or P, 12 Contacts (Nos.12)

2. NOTE: The penetrations have connectors on both ends that are not part of the pressure boundary, only the inboard connectors are listed since they experience the worst environment.

TABLE 3

CONNECTORS OUTSIDE OF CONTAINMENT

System	Function	Unit	No. of Devices/ Unit	Manufacturer	Type	Temperature °F Design	Temperature °F Environment
Main Steam Line Rad Mon	Instrumentation	1,2,3	4	Amphenol	B2-816	350	300
Reactor Water Cleanup and Primary Containment	Isolation	1,2,3	2	Amphenol	MS3106-A-20-4P MS3102-A-20-4S	257	170
Main Steam Line Leak Detectors & Pri Containment	Isolation	1,2,3	16 16	Amphenol Amphenol	MS3102-A-20-4F MS3102-A-20-4S	257*	550
RHR Heat Exch Disch Rad Mon	Instrumentation	1,2,3	6 2 2	Amphenol Amphenol Amphenol	UG1213/U UG932/U UG260/U	185 350 185	150 150 150
Raw Water Effluent Rad Mon	Instrumentation	1,2,3	3 1 1	Amphenol Amphenol Amphenol	UG1213/U UG260/U UG932/U	185 185 350	150 150 150
Reac Bldg Closed Cool Water Effluent	Instrumentation	1,2,3	3 1 1	Amphenol Amphenol Amphenol	UG1213/U UG932/U UG260/U	185 350 185	115 115 115
HPCI Steam Leak Detectors	Instrumentation	1,2,3	16 16	Amphenol Amphenol	3106A-20-4P 3102A-20-4S	257	550
RCIC Leak Detectors	Instrumentation	1,2,3	16 16	Amphenol Amphenol	3106A-20-4P 3102A-20-4S	257*	550
RCIC Backup Control Center	Test	1,2,3	1	Amphenol	69-OB-18-15	257*	115
Fuel Pool Cooling	Instrumentation	1,2,3	1	Amphenol	Rept 69-OR16-105-C100 Plug 69-6R-16-10P	257	115

*See Part II, Section C

Part II

Environmental Qualification of Electrical Connectors

A. Original Testing

The original qualification tests (i.e., pressure, temperature) conducted on the Browns Ferry penetrations and associated connectors were described during a meeting with NRC representatives on November 16, 1977. These tests did not include qualification for the electrical connectors for the environment resulting from a postulated design basis event or accident outside containment.

B. Steam Environment Test

Based on the discussions held during the November 16, 1977, meeting and on the November 18, 1977, letter, TVA decided to conduct a preliminary environmental test on selected samples of the electrical connector types used in containment in identified safety systems to determine if they could continue to function in a steam environment of a design basis event. These samples were taken from the plant stock of spares and were not thermally or radiation preaged. Attachment 1 describes the test procedures used, the connector samples tested, the test facility, the environmental conditions used in the test, the electrical loadings used, and the test results. The actual test conditions exceeded those that would be expected in the case of an actual design basis event for Browns Ferry Nuclear Plant. The electrical connectors satisfactorily passed the steam environment test.

The purpose of this test was to provide a rapid assessment of the performance in a steam environment of the electrical connectors within primary containment.

C. Evaluation of Connectors Outside Primary Containment

The critical electrical connectors outside containment are those that are associated with the main steam, HPCI, and RCIC leak detectors. The postulated accident environment temperature can exceed the design temperature of these connectors. These are identified in Table 3 with an asterisk (*). These circuits are provided to detect and initiate isolation signals in the event of a pipe break. Since the signal to initiate isolation is set at 200° F and is well below the design temperature of 257° F for the electrical connectors, these connectors will have performed their safety function before any potential environmental degradation. These sensors and associated electrical connectors are not required to function following the initiation of the isolation signal.

D. Evaluation of Radiation Effects

The Physical Science and Bendix connectors were specified to withstand a nuclear radiation of 10^8 R. In actuality, the threshold for damage of organic materials generally is greater than 10^8 R, with embrittlement beginning above approximately five times this value. The integrated dose to affected connectors would not be expected to exceed 10^8 R during the time interval in which they are needed following an LOCA, and the exposure from operation to the present time is extremely small by comparison. Therefore, radiation damage to these connectors is not a concern related to operation during the next few months. (See Item E).

E. Tests to Determine Qualified Life (Future Additional Tests)

TVA intends to establish the qualified life of all electrical connectors both inside and outside primary containment used in safety-related

circuits at Browns Ferry using the requirements of IEEE Standard 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations." Type testing will be used to establish qualified life with the effects of thermal and radiation aging included. It is anticipated that this portion of the program will be completed within 90 days.

Attachment 1

Date November 22, 1977 Unit 0 BFSTER No. 22

System N/A Originator J. E. Gibbs

Title: TEST PROCEDURE FOR BROWNS FERRY CONNECTORS Cognizant Section Outage

Reason for Test or Experiment:

To test Bendix Corporation type and Physical Science type connectors used in electrical penetrations at Browns Ferry Nuclear Plant.

Safety Related [ ]	Non-Safety-Related [X]

• Transmitted to NGB: Date _____

• Required safety review and safety analyses (10 CFR 50.59) have been completed for

A. Unreviewed safety question

B. Technical specification limits

DED signoff _____ Date _____

OPP signoff _____ Date _____

• PORC Review: • Approved:

_____ _____
Date Plant Superintendent

• Authorization to Perform:

_____ _____
Plant Superintendent Date

• PORC Review:

November 22, 1977
Date

• Approved:

J. S. Lawrence
Plant Superintendent

• Authorization to Perform:

J. S. Lawrence
Plant Superintendent

November 22, 1977
Date

Plant Superintendent J. S. Lawrence
General Revision

Date 11/25/77

BFSTER Complete J. S. Lawrence 11/27/77
Plant Superintendent Date

Attachment 2
(Sheet 1 of 2)

Unreviewed Safety Question Determination

Originator J. E. Gibbs STER No. 22

References: NONE

*Test or Experiment Summary

To test electrical connectors to verify response to LOCA conditions and main steam line break.

Unreviewed Safety Question

Is the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the Final Safety Analysis Report increased?

Yes [ ] No [X]

Justification

This is a test that is performed in a test laboratory.

*Revision A/V

Attachment 2
(Sheet 2 of 2)

Unreviewed Safety Question Determination

Unreviewed safety question (Continued)

Is the possibility for an accident or malfunction of a different type than any evaluated previously in the Final Safety Analysis Report created?

Yes [ ] No [X]

Justification

This is a test conducted at a laboratory for purposes of collecting data.

Is the margin of safety as defined in the basis for any technical specification reduced?

Yes [ ] No [X]

Justification

This test is not performed at Browns Ferry Nuclear Plant.

*Unreviewed safety question involved (PORC).

Yes [ ] No [X]

November 22, 1977
Date

*Revised 11/72

TEST PROCEDURE FOR BROWNS FERRY CONNECTORS

1. Scope

To test connectors used in electrical penetrations for units 1 and 2 at Browns Ferry and to test typical connectors used for unit 3 at Browns Ferry for ability to withstand the steam temperature pressure profile resulting from a LOCA or a pipe break.

2. Material to be tested shall be:

1 - 48-pin connector Physical Science type contained in electrical penetration type used for Browns Ferry units 1 and 2

1 - 12-pin connector Bendix Corporation type 10-214-628-515 used on pigtails out of Browns Ferry unit 3 penetration

3. Test Setup

Provide an environmental test chamber with dimensions capable of containing the test specimens (see figure 1). The chamber shall be provided with a pressure gauge and temperature sensors for measuring the temperature inside the test chamber.

3.1 Connect the pins of the connectors with wires so as to form a series parallel circuit which will give a voltage gradient within the connector as well as simulate a load (see figure 2)

The circuit shall be loaded to approximately 5 amperes and a voltmeter and ammeter shall be connected to the load.

4. Test Procedure

4.1 Verify the initial status of the penetration connector and the separate connector for voltage integrity. Megger pin to all other pins and shell combined. Check for current continuity through the connector.

4.2 Energize the connectors from a 250 V dc source. Bring the environmental chamber to the initial condition of 150 F.

4.3 Admit steam into the environmental chamber at flow condition so as to achieve a stabilized temperature of 322°F. Hold this condition for 5 minutes. Record all voltmeter, ammeter, pressure and temperature readings at each major change in profile and each hour.

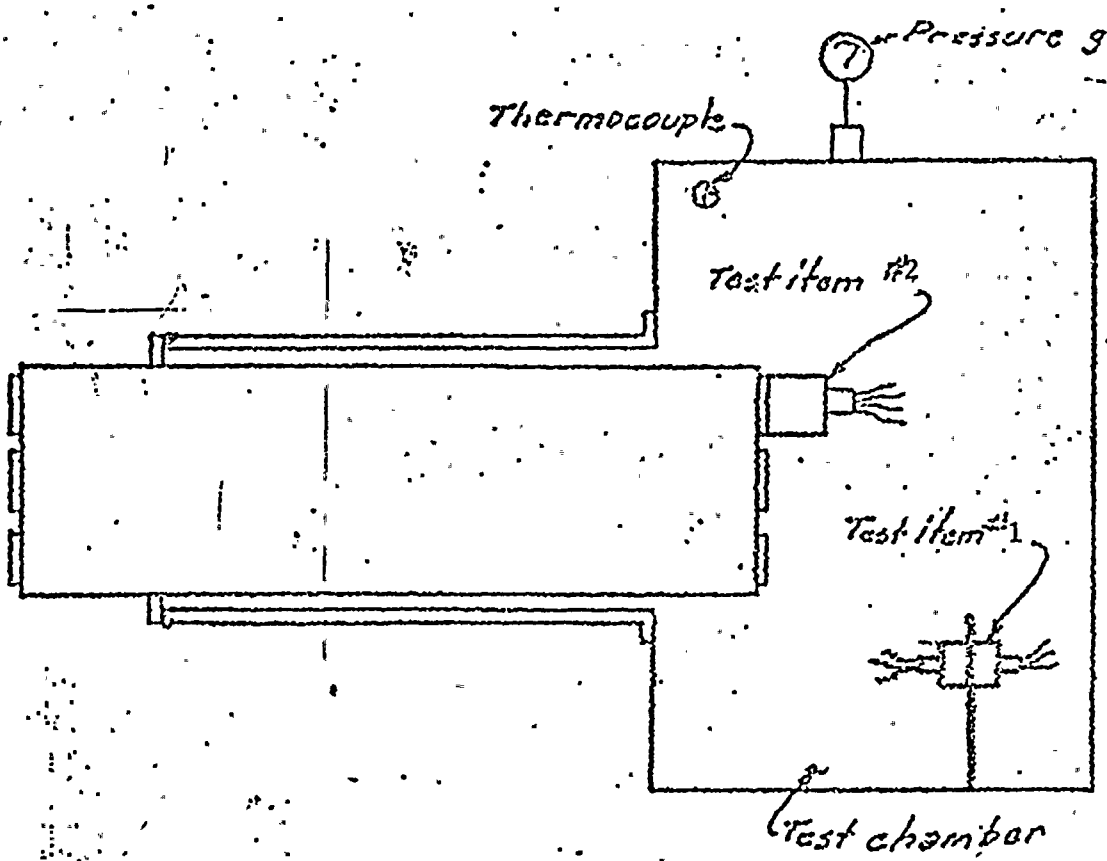
TEST PROCEDURE FOR BROWNS FERRY CONNECTORS

4.4 Reduce pressure at 0.7 lb/minute to reach 36 psig and 282F in 60 minutes. Then drop the pressure immediately to 15 psig (apprximately 250F). Thereafter reduce the pressure at 1.0 lb/hour until atmospheric pressure is reached at 16 hours into the test (212F).

4.5 Thereafter drop the temperature at 7½°F/hr at atmospheric pressure until 150°F is reached after 24 hoursinto the test. The profile curve is figure 3.

5. Criteria

5.1 The connector shall carry the required load at not more than 10% reduction in voltage after the full duration of the test.

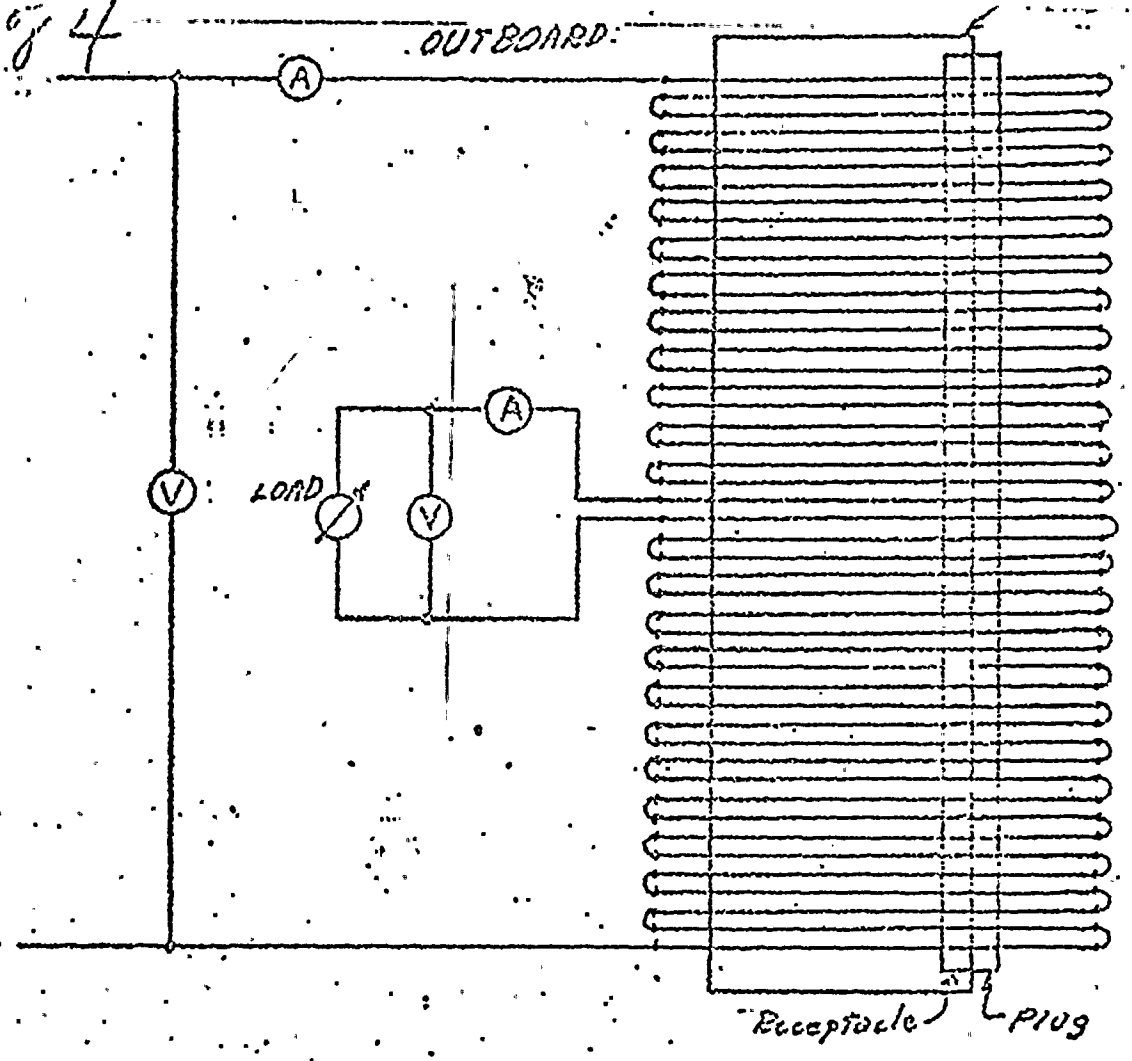


Test item #2 { Physical Science 6445-1 Receptacle
Physical Science 6448-1 Plug

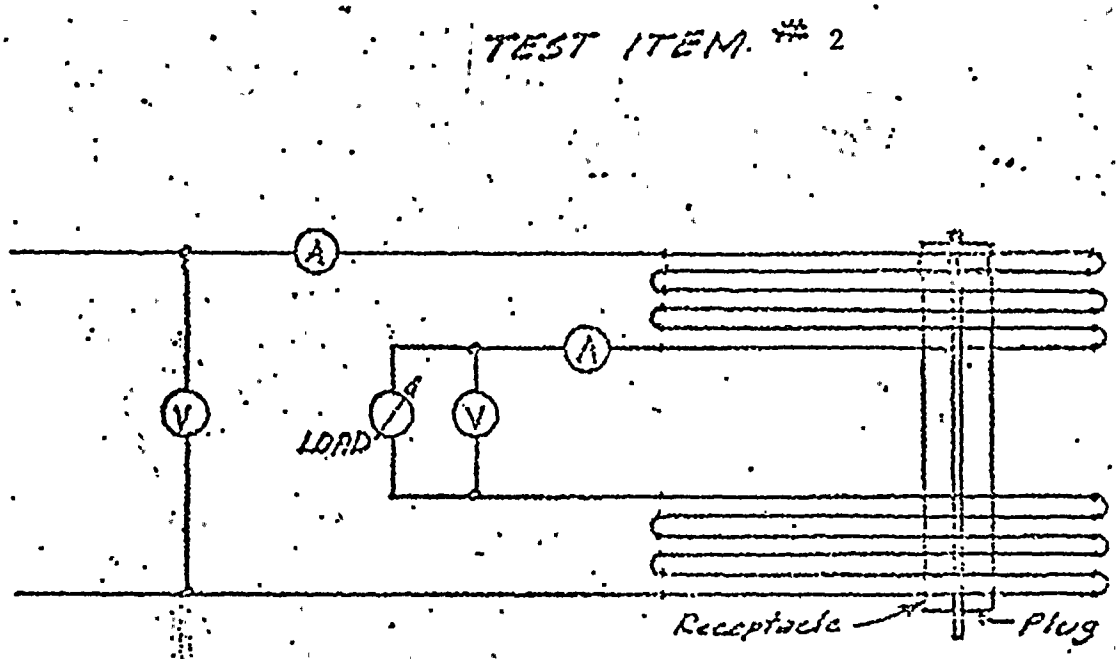
Test item #1 { Bendix 10-214028-51 Receptacle
Bendix 10-214628-51 Plug

FIGURE 1
ENVIRONMENTAL
TEST CHAMBER

BROWNS FERRY NUCLEAR PL
CONNECTOR TEST



TEST ITEM # 2



TEST ITEM # 1

FIGURE 2
2AM15

BROWNS FERRY NUCLEAR P
CONNECTOR TEST

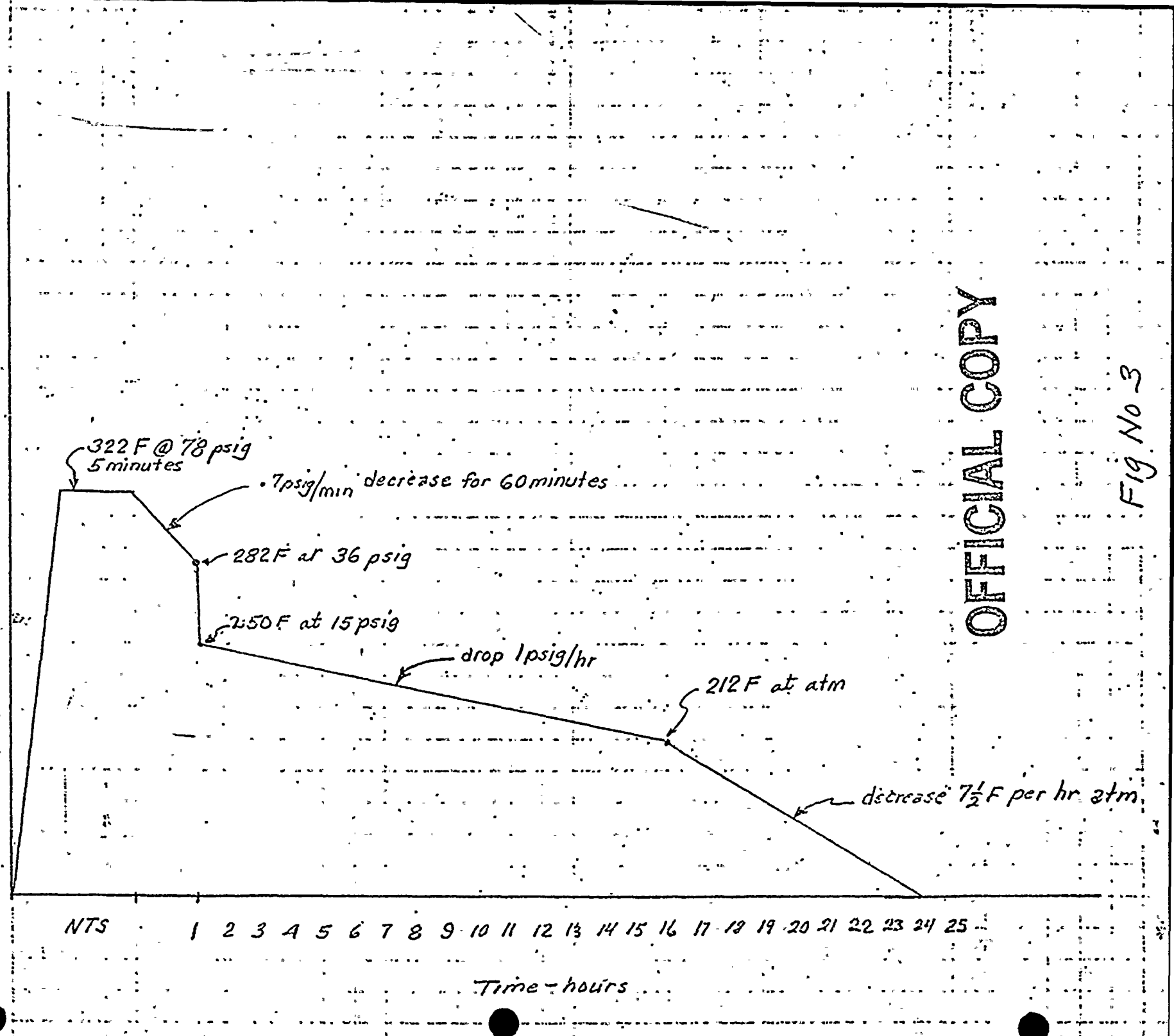


Fig No 3

THIS PAGE DELETED

DATA COVER SHEET

#1 BENDIX

This data package includes test data sheets.

Instrument Calibrated — J. Edward Gibbs / 11/25/77
Verified By / Date

Acceptance Criteria Met — Yes (Yes) ____ (No)

Data Takers/Organization
J. Edward Gibbs DPP (Outage)
David Dayton, DED
Dennis McCloud, DPRP
Mike Montsinger, DPP (QA)
Tom Kalaga, DPP (Outage)
Mike McInerney, DPP (QA)
Joe Bradley, DED

Dates Test Performed — 11/26/77 — 11/27/77

Reviewed by Cognizant Engineer — J Edward Gibbs
Reviewed by Results Section Supervisor — Wm C Thomison 11/27/77
Reviewed by Quality Assurance Supervisor — John T. Harmon 11/27/77

STER 22

TEST DATA/BROWNS FERRY CONNECTORS

#1 Pin Connector | BENDIX Model Number

STEP	ITEM	RESULTS	BY/DATE
4.1.a	Verify proper hook up for connector (test item #2, figure 2, for 48-pin connector; test item #1, figure 2, for 12-pin connector)	✓ OK	Verified 11/24
4.1.b	Megger: pin to all pins and shell combined	7 45 X 10^9 Ohms	
	pin to shell	14 X 10^9 Ohms	
4.1.c	Verify current continuity	✓ OK	
4.2.a	Energize connector from nominal 250 VDC source (verify)	✓ OK	Verified 11/28
4.2.b	Load voltage	247.0 Volts	11/26
4.2.c	Set load for connector so as to give load current of 5.0 ± 0.5 amps (initial values)	4.95 Amps	QC 11/26
4.2.d	Initial test chamber pressure and temperature	0 psig 150 °F.	Verified 11/26
4.3.a	Admit steam, bringing temperature to 322 ± 5° F. Also note start time of the test (t_0).	78 psig 322 °F. 10:45:14 Start time	Verified 11/26
4.3.b	Stabilize temperature and pressure at 322 ± 5° F.	10:50:09 time	Verified 11/26
4.3.c	When stabilized, record load current and voltage.	4.96 amps Load 248 volts Input 251 volts	QC 11/26

Connector #1, Bendix

STEP	ITEM	RESULTS	BY/DATE
4.3	(Continued)		
4.3.d	Maintain in stabilized condition for 5 minutes; record load current and voltage at end.	4.97 Amps Load 24.7 Volts Input 250 Volts	QC 11/26/77

Connector #1, Bendix

STEP	ITEM	RESULTS	BY/DATE
4.4			
4.4.a	Reduce pressure at o.7 psig/ minute to 282°F at 36 psig in one hour; record initial load current and voltage.	10:55:04 time 4.98 amps load 247.2 volts input 250 volts	MJM 11/26/77 verified
	Repeat at three 5 minute intervals	11:02:35 time 4.91 amps load 248.18 volts input 251 volts	MJM 11/26/77 verified
		11:07:35 time 4.94 amps load 248.7 volts input 250 volts	MJM 11/26/77 verified
		11:12:35 time 4.93 amps load 248.3 volts input 250 volts	MJM 11/26/77 verified
4.4.b	Drop pressure immediately to 150 psig. Record load current and voltage.	12:01 time 4.98 amps load 248.5 volts input 251 volts	MJM 11/26/77 verified
4.4.c	At hourly intervals; reduce the pressure by 1.0 ± 0.5psig Record time of pressure reduction, new pressure (psig), load current and voltage. Repeat for 15 hours until 212°F at atmospheric pressure is obtained.		

should be 250°F, 15 psig
JSL 11/27/77

Connector #1, Bendix

STEP	ITEM	RESULTS	BY/DATE
4.4.c (Continued)		26:13:01:13 T	JSB 1 11/26
		14 P	
		4.88 A	
	Load	248.56 V	
	Input	250 V	
		14:02:19 T	JSB 1 11/26
		13 P	
		4.89 A	
	Load	249.57 V	
	Input	250 V	
		15:03:19 T	JSB 1 11/26
		12 P	
		9.86 A	
	Load	248.23 V	
	Input	250 V	
		16:05:24 T	JSB 1 11/26
		10.8 P	
		4.86 A	
	Load	248.14 V	
	Input	250 V	
		17:05:24 T	dem 1 11/26
		10.0 P	
		4.85 A	
	Load	247.8 V dem 11/26/77	
	Input	249 V	
		18:05:24 T	dem 11/26
		9 P	
		4.87 A	
	Load	248.66 V	
	Input	250 V	

Connector #1, Bendix

STEP	ITEM	RESULTS	BY/DATE
4.4.c (Continued)		19:05:24 T	dem 1 11/26
		8 P	
		4.85 A	
	Load	247.8 V	
	Input	248 V	
		20:05:24 T	TAK 11/26
		7 P	
		4.84 A	
	Load	246.8 V	
	Input	249 V	
		21:05:24 T	TAK 11/26
		6 ~~4.93~~ TAK 11/26/77 P	
		4.93 A	
	Load	248.4 V	
	Input	250 V	
		22:05:24 T	TAK 11/26
		5 P	
		4.87 A	
	Load	248.5 V	
	Input	250 V	
		23:05:24 T	TAK 11/2
		4 P	
		4.86 A	
	Load	248.4 V	
	Input	250 V	
		00:05:24 T	TAK 11/2
		3 P	
		4.86 A	
	Load	248.0 V	
	Input	250 V	

Connector #1, Bendix

STEP	ITEM	RESULTS	BY/DATE
4.4.c	(Continued)	01:05:24 T	TAK 11/27
		2 P	
		4.87 A	
		Load 248.8 V	
		Input 250 V	
		2:05:24 T	TAK 11/27
		1 P	
		4.86 A	
		Load 248.0 V	
		Input 250 V	
		3:05:24 T	TAK 11/27
		0 P	
		4.87 A	
		Load 248.7 V	
		Input 250 V	
	Not Required JSS 11/26/77	T	1
		P	
		A	
		Load V	
		Input V	

4.5	At hourly intervals, reduce temperature by 7½°F/hr. Record time of temperature reduction, new temperature, load current and voltage. Repeat until 150°F is reached after 24 hours into the test.

Connector #1, Bendix

STEP	ITEM	RESULTS	BY/DATE
4.5	(Continued)	4:05:24 T	TAK 11/2
		204°F temp	
		4.87 A	
		Load 248.6 V	
		Input 250 V	
		5:05:24 T	TAK 11/2
		196°F temp	
		4.86 A	
		Load 248.0 V	
		Input 250 V	
		06:05:24 T	JSL 11/27
		188°F temp	
		4.865 A	
		Load 248.4 V	
		Input 249.0 V	
		07:05:24 T	JSL 11/2
		182°F temp	
		4.87 A	
		Load 248.9 V	
		Input 250.0 V	
		08:05:24 T	JSL 11/2
		174°F temp	
		4.85 A	
		Load 247.8 V	
		Input 250.0 V	
		09:05:24 T	JSL 11/2
		166.5°F temp	
		4.85 A	
		Load 247.5 V	
		Input 247.0 V	

Connector #1, Bendix

STEP	ITEM	RESULTS	BY/DATE
4.5 (Continued)		27:10:05:24 T	MJM 11/27/77
		160 temp	
		4.86 A	
		Load 248.47 V	
		Input 250.0 V	
		27:11:04:57 T	dam 1 11/27/77
		159 temp	
		4.85 A	
		Load 247.8 V	
		Input 249 V	

Test Data Verification: M.J. McInerney 11/27/77 J. Edward Dibbs 11/27/77
QC Inspector/Date Test Engineer/Date

DATA COVER SHEET

#2 GULTON

This data package includes test data sheets.

Instrument Calibrated — J. Edward Gibbs / 11/25/77
Verified By / Date

Acceptance Criteria Met — Yes (Yes) — ____ (No)

Data Takers/Organization

Joe Bradley, DED
David Dayton, DED
Dennis McCloud, DPRP
J. Edward Gibbs, DPP (Outage)
Mike Montsinger, DPP (QA)
Tom Kulaga, DPP (Outage)
Mike McInerney, DPP (QA)

Dates Test Performed — 11/26/77 - 11/27/77

Reviewed by Cognizant Engineer — J. Edward Gibbs 11/27/77

Reviewed by Results Section Supervisor — Wm C Thomison 11/27/77

Reviewed by Quality Assurance Supervisor — John L. Harmon

STER 22

TEST DATA/BROWNS FERRY CONNECTORS

#2 Pin Connector GULTON Model Number

STEP	ITEM	RESULTS	BY/DATE
4.1.a	Verify proper hook up for connector (test item #2, figure 2, for 48-pin connector; test item #1, figure 2, for 12-pin connector)	✓ OK	DDD 1/24/78 Verified
4.1.b	Megger: pin to all pins and shell combined	≥ 1.3×10^9 Ohms	Eliminated pin "9" as it showed discoloration around base of pin. Eliminated pin "5" to restore test circuit. (inboard plug)
	pin to shell	320×10^6 Ohms	
4.1.c	Verify current continuity	✓ OK	
4.2.a	Energize connector from nominal 250 VDC source (verify)	✓ OK	JSR 1/24/78 Verified
4.2.b	Load voltage	242 Volts	JSR 1/24/78
4.2.c	Set load for connector so as to give load current of 5.0 ± 0.5 amps (initial values)	4.83 Amps	MGM 1/24/78 QC
4.2.d	Initial test chamber pressure	0 psig	MGM 1/24/78 Verified
	and temperature	150 °F.	
4.3.a	Admit steam, bringing temperature to 322 ± 5° F.	78 psig	JSR 1/24/78 Verified
	Also note start time of the test (t_0).	322 °F.	
		10:45:14 Start time	
4.3.b	Stabilize temperature and pressure at 322 ± 5° F.	10:50:01 time	JSR 1/24/78 Verified
4.3.c	When stabilized, record load current and voltage.	4.83 amps	MGM 1/24/78 QC
		Load 242 volts	
		Input 251 volts	

Connector #2, Gulton

STEP	ITEM		RESULTS	BY/DATE
4.3	(Continued)			
4.3.d	Maintain in stabilized condition for 5 minutes; record load current and voltage at end.		4.82 Amps	mgm 11/16 QC
		Load	242 Volts	
		Input	250 Volts	

Connector #2 (GOLDEN)

STEP	ITEM	RESULTS	BY/DATE
4.4			
4.4.a	Reduce pressure at 0.7 psig/minute to 282°F at 36 psig in one hour; record initial load current and voltage.	10:55:04 time 4.82 amps load 203.8 volts input 250 volts	M.J.M 11/26 verified
	Repeat at three 5 minute intervals	11:02:35 time 4.81 amps load 243.1 volts input 251 volts	M.J.M 11/26 verified
		11:07:35 time 4.80 amps load 243.2 volts input 250 volts	M.J.M 11/26 verified
		11:12:35 time 4.79 amps load 242.6 volts input 250 volts	M.J.M 11/26 verified
4.4.b	Drop pressure immediately to 150 psig. Record load current and voltage.	JCS 11/24/77 Should be 250°F 15 psig 12:01:00 time 4.82 amps load 243 volts input 251 volts	M.J.M 11/26 verified
4.4.c	At hourly intervals, reduce the pressure by 1.0 ± 0.5psig Record time of pressure reduction, new pressure (psig), load current and voltage. Repeat for 15 hours until 212°F at atmospheric pressure is obtained.		

Connector #2, GUILTON

STEP	ITEM	RESULTS	BY/DATE
4.4.c (Continued)		26:13:01:13 T	J.S.R. 11/26
		14 P	
		4.79 A	
	Load	242.4 V	
	Input	250 V	
		14:02:19 T	J.S.R. 11/26
		13 P	
		4.80 A	
	Load	243.34 V	
	Input	250 V	
		15:02:19 T	J.S.R. 11/26
		12 P	
		4.77 A	
	Load	241.86 V	
	Input	250 V	
		16:05:24 T	J.A.B. 11/26
		10.8 P	
		4.77 A	
	Load	241.79 V	
	Input	250 V	
		17:05:24 T	dam 11/26
		10.0 P	
		4.77 A	
	Load	241.5 V	11/26/77
	Input	249 V	
		18:05:24 T	dam 11/26
		.9 P	
		4.78 A	
	Load	2423 V	
	Input	250 V	

Connector HZ, Gulton

11/25/77

STEP	ITEM	RESULTS	BY/DATE
4.4.c (Continued)		19:05:24 T	dcm 11/26
		8 P	
		4.76 A	
	Load	241.4 V	
	Input	248 V	
		20:05:24 T	TAK 11/26
		7 P	
		4.74 A	
	Load	240.6 V	
	Input	249 V	
		21:05:24 T	TAK 11/26
		6 P	
		4.78 A	
	Load	242.0 V	
	Input	250 V	
		22:05:24 T	TAK 11/26
		5 P	
		4.78 A	
	Load	242.0 V	
	Input	250 V	
		23:05:24 T	TAK 11/2
		4 P	
		4.78 A	
	Load	241.9 V	
	Input	250 V	
		00:05:24 T	TAK 11/2
		3 P	
		4.77 A	
	Load	241.75 V	
	Input	250 V	

Connector #2, GULTON

STEP	ITEM	RESULTS	BY/DATE
4.4.c	(Continued)	1:05:24 T	TAK 11/27
		2 P	
		4.78 A	
		Load 242.4 V	
		Input 250. V	
		2:05:24 T	TAK 11/27
		1 P	
		4.77 A	
		Load 241.7 V	
		Input 250 V	
		3:05:24 T	TAK 11/27
		0 P	
		4.78 A	
		Load 242.4 V	
		Input 250 V	
	Not Required JSS 11/26/77	T	1
		P	
		A	
		Load V	
		Input V	

4.5 At hourly intervals, reduce temperature by 7½°F/hr. Record time of temperature reduction, new temperature, load current and voltage. Repeat until 150°F is reached after 24 hours into the test.

Connector #2, Guiton

STEP	ITEM	RESULTS	BY/DATE
4.5	(Continued)	4:05:24 T	TAK 11/2
		204°F temp	
		4.76 A	
		Load 242.6 V	
		Input 250 V	
		05:05:24 T	TAK 11/2
		196°F temp	
		4.77 A	
		Load 241.7 V	
		Input 250 V	
		06:05:24 T	JEB 11/27
		188°F temp	
		4.78 A	
		Load 242.2 V	
		Input 249.0 V	
		07:05:24 T	JSB 11/2
		182°F temp	
		4.78 A	
		Load 242.7 V	
		Input 250 V	
		08:05:24 T	JSB 11/2
		174°F temp	
		4.77 A	
		Load 241.6 V	
		Input 250.0 V	
		09:05:24 T	JSB 11/2
		166.5°F temp	
		4.77 A	
		Load 241.4 V	
		Input 249.0 V	

Connector #2, GULTON

STEP	ITEM	RESULTS	BY/DATE
4.5	(Continued)	27: 10:05:24 T	MJM 11/27/77
		160 temp	
		4.78 A	
		Load 242.30 V	
		Input 250. V	
		27:11:04:57 T	dem 11/27/77
		159 temp	
		4.78 A	
		Load 241.62 V	
		Input 249 V	

Test Data Verification: M J McInerney 11/27/77 J. Edward Dibb 11/27/77
QC Inspector/Date Test Engineer/Date

Part III

Justification for Continued Operation

TVA considers the tests and evaluations described in Part II sufficient to permit the continued operation of the facility without creating undue risk to the health and safety of the public for the period it will take to fully environmentally qualify the connectors. This position is based upon the low probability of the events that produce adverse environments, the supplemental testing that demonstrated that the connectors within containment can continue to function in a postulated steam environment, the short time required for critical connectors outside containment to function before exceeding their design temperature, and the connector resistance to a radiation environment.