REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR: 8610270077 DOC. DATE: 86/10/20 NOTARIZED: NO DOCKET #
FACIL: 50-269 Oconee Nuclear Station, Unit 1, Duke Power Co. 05000269
50-270 Oconee Nuclear Station, Unit 2, Duke Power Co. 05000270
50-287 Oconee Nuclear Station, Unit 3, Duke Power Co. 05000287
AUTH. NAME AUTHOR AFFILIATION
TUCKER, H. B. Duke Power Co.
RECIP. NAME RECIPIENT AFFILIATION
DENTON, H. R. Office of Nuclear Reactor Regulation, Director (post 851125
STOLZ, J. F. PWR Project Directorate 6

SUBJECT: Forwards response to NRC 860829 request for addl info re Tech Spec amend concerning hydrogen control sys. Related info also encl. W/one oversize drawing.

DISTRIBUTION CODE: A001D COPIES RECEIVED: LTR 1 ENCL 1 SIZE: 21+15
TITLE: OR Submittal: General Distribution

NOTES: AEOD/Ornstein: 1cy. S. West, NRR: 1cy. 05000269
AEOD/Ornstein: 1cy. S. West, NRR: 1cy. 05000270
AEOD/Ornstein: 1cy. S. West, NRR: 1cy. 05000287

See Drawings For oversize Drawing

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PWR-B EB	1	1	PWR-B PEICSB	2	2
	PWR-B FOB	1	1	PWR-B PD6 LA	1	0
	PWR-B PD6 PD 01	5	5	NICOLARAS, H	1	1
	PWR-B PEICSB	1	1	PWR-B RSB	1	1
INTERNAL:	ADM/LFMB	1	0	ELD/HDS4	1	0
	NRR/DHFT/TSCB	1	1	NRR/ORAS	1	0
	REG FILE 04	1	1	RGN2	1	1
EXTERNAL:	EG&G BRUSKE, S	1	1	LPDR 03	1	1
	NRC PDR 02	1	1	NSIC 05	1	1
NOTES:		2	2			

TOTAL NUMBER OF COPIES REQUIRED: LTTR 25 ENCL 21

DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

October 20, 1986

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. John F. Stolz, Project Director
PWR Project Directorate No. 6

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

By letter dated February 12, 1986 Duke Power Company (Duke) proposed an amendment to the Oconee Nuclear Station Technical Specifications concerning the operation and maintenance of the containment hydrogen recombiner system.

By letter dated August 29, 1986 the NRC staff requested additional information to complete their review of the subject proposed amendment. Please find enclosed Duke's response to your request for additional information.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

MAH/12/slb

Enclosure

xc: Dr. J. Nelson Grace, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Mr. J. C. Bryant
NRC Resident Inspector
Oconee Nuclear Station

Mr. Heyward Shealy, Chief
Bureau of Radiological Health
South Carolina Department of Health &
Environmental Control
2600 Bull Street
Columbia, South Carolina 29201

Mrs. Helen Pastis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

A001
1/1

ENCLOSURE

Duke Power Company
Oconee Nuclear Station

Response to the NRC Request for Additional Information
Dated August 29, 1986
Hydrogen Control System

Request 1

"Provide the following information on the external hydrogen recombiner used at the Oconee plant:

(a) Identify the type of recombiner. Reference to the manufacturer's literature could be made if the recombiner is of a standard design. If, however, it is a custom made unit, detailed design information, including design drawings, should be provided.

(b) Describe the installation of the recombiner in the Oconee plant. The description given in the Final Safety Analysis Report (FSAR) does not give sufficient information to enable us to review the operation of the system. Provide a detailed installation drawing which clearly shows how the recombiner interfaces with existing plant systems."

Response 1

(a) The hydrogen recombiner is a thermal recombiner of standard design manufactured by Rockwell International Rocketdyne Division. Attachments 1 and 2 to this enclosure are sections from Rockwell International Qualification Report No(s) 280QR000012 and 290QR000021, respectively, providing additional information concerning the Oconee hydrogen recombiner.

Rockwell International has previously submitted to the NRC Rockwell International Report AI-75-2, Rev. 3 "Thermal Hydrogen Recombiner System for Water Cooled Reactors", dated July 1977 describing in detail the hydrogen recombiner. This report was submitted by Atomic International letter 77AT-8210 dated September 16, 1977 from P. E. McCourt (AI) to Mr. Karl Kneil (NRC). Except for some upgrades to qualify the Oconee hydrogen recombiner in accordance with the requirements of IEEE 323-1974, the referenced report contains the pertinent technical information.

(b) The FSAR Sections 15.16.7, 15.16.8 and 15.16-9 describe the hydrogen recombiner. Detailed system design information are provided in Attachment 3 and drawing OFD-116C-2.1, also attached.

Request 2

"Identify the alternate power sources to be used for operating the recombiner system during a loss of offsite power."

Response 2

Redundant offiste and onsite power sources are provided for each Oconee unit to supply the unit auxiliaries during normal operation and abnormal and accident conditions. In the event of a loss of coolant accident and simultaneous loss of offsite power, emergency power is provided from two Keowee hydro units through two separate and independent routes. Each of Keowee hydro units is rated at 87,500 kVA and generate at 13.8 kV.

On emergency automatic startup both Keowee units can provided emergency power to any of the Oconee units through the respective startup transformer or the underground feeder and Transformer CT4 at Oconee.

On loss of their normal source of power the 4160 volt main feeder buses are transferred to alternate sources of power supplied from one of the two Keowee hydro units via the 230 kV switchyard, and the standby power from one Keowee unit via the 13.8 kV underground feeder or from the 100 kV transmission line from Lee steam station.

For each unit the recombiner power is fed from a 600V AC, 60HZ, three phase motor control center (MCC). The motor control centers are fed by either of two breakres that are key interlocked and are suppled by 4160V switchgears via 600V load centers. Alternate 4160V switchgears for:

Units 1 or 2 provide power for recombiner on Unit 1
Units 2 or 3 provide power for recombiner for Unit 2
Units 1 or 3 provide power for recombiner on Unit 3

In the event of a LOCA and simultaneous loss of offsite power, the non-essential load breakers are tripped. The 4160V breakers will also trip by Emergency Power Switching Logic System on load shed. The emergency load shed is only required initially when breakers supplying the engineered safeguard loads are closed during a LOCA. As a result, motor control centers supplying power to hydrogen recombiner will also be load shedded. However, because of abundant emergency power from Keowee Units power to the shedded loads, including the MCCs, can be restored shortly.

It should be noted that a source of power for hydrogen recombiner is not needed immediately following the accident because of the time needed to transfer and connect a hydrogen recombiner to the affected unit. Furthermore, analyses have indicated that post-LOCA containment hydrogen concentration will not reach the flamability limit until several weeks after the accident. During the post-LCOA conditions sufficient emergency power is available to supply the hydrogen recombiner even with a simultaneous loss of offsite power long before the containment hydrogen concentration reaches the Technical Specification limit.

3.0 EQUIPMENT SPECIFICATION

3.1 DESCRIPTION OF EQUIPMENT TO BE QUALIFIED

The equipment being qualified is the Oconee power and control cabinet that contains the electrical devices required to supply power to and control the operation of the recombiner skid. The Class 1E electrical components for use on the Oconee hydrogen recombiner power and control cabinet are shown in Table 3.

Figure 7 presents the power and control cabinet single-line electrical schematic, and Figure 8 depicts a cutaway isometric drawing of the cabinet indicating the location of the major components. A lead box is used to shield the sensitive electronic assemblies from high integrated dosages of gamma radiation.

3.2 ELECTRICAL CHARACTERISTICS/REQUIREMENTS

The power and control cabinet shall be capable of delivering 480-Vac, 3-phase, 60-Hz and 120-Vac power to the skid. The Oconee power and control cabinet was designed and fabricated to the requirements of assembly Drawing 280000022-01. The Rockwell design specifications encompass all performance requirements for the Oconee application. The power and control cabinet electrical interfaces are shown in Table 4.

3.3 MOUNTING METHOD, CONFIGURATION, AND INTERFACE

The Oconee power and control cabinet base is provided with mounting holes at the cabinet corners for 1-8UNC studs for plant installation. Torque requirements for the holddown nuts are 183 ft-lb $\pm$ 10%. The cabinet installation is specified on Rockwell Drawing 280000069. The cabinet is designed to be seismically rigid, with all component mounting interfaces having resonance frequencies greater than 35 Hz. For routing interconnecting cabling to and from the cabinet, cable access is permissible from the lower rear compartment of the cabinet.

TABLE 3

OCONEE PWR POWER AND CONTROL CABINET CLASS 1E ELECTRICAL COMPONENTS
(Sheet 1 of 4)

Description	Manufacturer	Part Number	Function	Qualification Method	Qualification Report No.	Reference
1. SCR Power Controller (JC1)	Halmar	RI-480150 (N30537)	Proportions power to the electrical heater elements positioned around the reaction chamber coil.	Type testing	280QR000002 (Rockwell)	5
1.1 Trigger Board Assy.	Halmar	RI-TBPWR				
1.2 SCR Adj. Pot. Assy.	Halmar	RI-BG1				
2. Contactors	Telemecanique (Gould Nuclear)					
2.1 NEMA 5 Contactor (JS1)		A103G12X3X3	Controls 3-phase facility power to the recombiner electrical heaters, to the inlet gas centrifugal blower, and to the cooling fan motor.	Type testing and analysis	CC-74-358 and SC-648 (Telemecanique)	7 and 8
2.2 NEMA 1 Contactors (JS2)		A103C12	Provides instrumentation power.	Type testing and analysis	CC-74-358 and SC-648 (Telemecanique)	7 and 8
3. Fuses	Telemecanique (Gould Nuclear)		Provides circuit protection for:	Type testing and analysis	CC-74-358 and SC-648 (Telemecanique)	7 and 8
3.1 Main Power (250A)		280000033-11 (A4J250)	. Facility power circuit			
3.2 Heater (125A)		280000033-06 (A4J125)	. Heater circuit			
3.3 Blower Motor (20A)		AJT20	. Blower-motor circuit			
3.4 Heat Exchanger Motor (10A)		AJT10	. Heat exchanger motor circuit			
3.5 Transformer (6A)		AJT6	. 120-Vac circuit.			
4. Fuse Block		60358J	Provides electrical continuity and mounting block for fuses.	Type testing and analysis	CC-74-358 and SC-648 (Telemecanique)	7 and 8

TABLE 3

OCONEE PWR POWER AND CONTROL CABINET CLASS 1E ELECTRICAL COMPONENTS
(Sheet 2 of 4)

	Description	Manufacturer	Part Number	Function	Qualification Method	Qualification Report No.	Reference
5.	Transient Suppressor	Telemecanique (Gould Nuclear)	F20C12	Provides voltage spike protection for instrumentation and contactor coils.	Type testing and analysis	CC-74-358 and SC-648 (Telemecanique)	7 and 8
6.	Lamp Assembly*	Telemecanique (Gould Nuclear)	H35P7R H35P7G	Provides "system ready" status indicator, "recombiner status," and recombination temperatures.	Type testing and analysis	CC-74-358 and SC-648 (Telemecanique)	7 and 8
7.	Pushbutton Switch and Contact Blocks	Telemecanique (Gould Nuclear)	H35RI H33A H33B	Provides recombiner "start" and "stop" controls.	Type testing and analysis	CC-74-358 and SC-648 (Telemecanique)	7 and 8
8.	Insulated Feedthroughs	Conax	7J68-11000-01	Provide electrical continuity and isolation for 3-phase main power and heater power wall penetrations. Provides main power connect point and heater power distribution point.	Type testing	280QR000002 (Rockwell)	5
9.	Transformer	Hevi-Duty Electric	1233063T00	Provides 120 Vac, 1 phase, power and instrumentation power.	Type testing	280QR000002 (Rockwell)	5
10.	Power and Instrument Cables	Anaconda	AP63040 Flame-Guard FR-EP cable, AP39150 Switchboard NSIS wire AP69280 Thermocouple Wire	Provide electrical power and instrument signal continuity.	Type testing and analysis	290QR000001 (Anaconda/ Rockwell)	9
10a.	Hookup Wire	Raychem	M81044/9-16-8		Type testing	280QR000002 (Rockwell)	5
10b.	Power Cable	Kerite	1/0 AWG, 1/C 1 AWG, 1/C		Type testing and analysis	HTK FR (Kerite)	10

TABLE 3

OCONEE PWR POWER AND CONTROL CABINET CLASS 1E ELECTRICAL COMPONENTS
(Sheet 3 of 4)

	Description	Manufacturer	Part Number	Function	Qualification Method	Qualification Report No.	Reference
11.	Terminals and Lugs	AMP, Inc. Burndy	30927, 31393 31159, 32190, 31397, 325350, 33460, 30928, 325303, 31398, 33462, 320678, 33463, 325307 QA26-B	Provide wire termination	Type testing and analysis	290QR000005 280QR000002 (Rockwell)	11 5
12.	Terminal Blocks	Marathon	1512 NUC 1506 NUC	Provide wire interface points.	Type testing	280QR000002 (Rockwell)	5
13.	Cooling Fans	Rotron	034495	Provides component cooling within cabinet.	Type testing	280QR000002 (Rockwell)	5
14.	Fan Capacitor Assy.	Rockwell	280000028-01	Aids the startup and running of the cooling fans.	Type testing	280QR000002 (Rockwell)	5
15.	Insulated Standoffs	Glastic	2165-1B	Electrically insulate from ground and structurally support the fuses and the bus bars.	Type testing	280QR000002 (Rockwell)	5
16.	Shield Connector Rings	Thomas & Betts Co.	GSC1130 GSB920	Tie shields of conductors together to one common shield for grounding.	Type testing	280QR000002 (Rockwell)	5
17.	Connectors						
17a.	Power Connector, Receptacles	Crouse-Hinds Co.	AR61048 AR6348 AR6348-S4 RPC641-014- P05NT	Provide connectors for interfacing with recombiner skid (blower motor, heat exchanger motor, heater, flow transmitter, and thermocouples) and customer annunciator and remote control switches.	Type testing	280QR000002 (Rockwell)	5
17b.	Instrumentation Connectors/Backshells	ITT Cannon	MS3476L24-31PN MS3472L24-31SN 057-0713-002 M83723-35S-20R M83723-19R-2015N		Type testing	280QR000002 (Rockwell)	5

TABLE 3

OCONEE PWR POWER AND CONTROL CABINET CLASS 1E ELECTRICAL COMPONENTS

(Sheet 4 of 4)

Description	Manufacturer	Part Number	Function	Qualification Method	Qualification Report No.	Reference
17b. Instrumentation Connectors/Backshells (continued)		M83723-19R-2015W M83723-35S-15R M83723-19R-1502N MB3723-35S-28R MB3723-20R-2812N MB3723-23R-2812W MB3723-20R-2812W MB3723-19R-2812X				
18. Spacers	Accurate Screw Machine Co.	4030-R-N-250-01	Provide electrical and physical isolation between lead box housing and the SCR trigger board foil (circuitry).	Type testing	280QR000002 (Rockwell)	5
19. Lexan Baffle	Keelco	280000070-01	To assure (channel) proper air circulation within the lead box.	Type testing	280QR000002 (Rockwell)	5
20. Temperature Controller Indicator	Barber-Colman	524D-43406-050-3-G9	Provides proportional input to SCR power controller for heater control. Auxiliary alarm powers reaction status lamps.	Type testing	280QR000002 (Rockwell)	5
21. Alarm Switches	Moore Industries					
21a. Flow Switch (FSL1)	Moore Industries	DCA/4-20 mA/ S-X2/117 Vac/ IO-TX-HS (AB)	Provides low process gas flow interlock.	Type testing	280QR000002 (Rockwell)	5
21b. Temperature Switch (TSH 2, 3, 5)	Moore Industries	TCA/K-50 mV/ S-X1/117 Vac/ -HS (AB)	Provides overtemperature alarms interlock for: 1) Heater wall temperature 2) Heater gas temperature 3) Reaction chamber wall temperature	Type testing	280QR000002 (Rockwell)	5
21c. Temperature Switch (TSH 6)	Moore Industries	TCA/K-10 mV/ S-X1/117 Vac/ -HS (AB)	Provides overtemperature interlock for return gas wall temperature.	Type testing	280QR000002 (Rockwell)	5

*Associate 1E component

6254F/emh

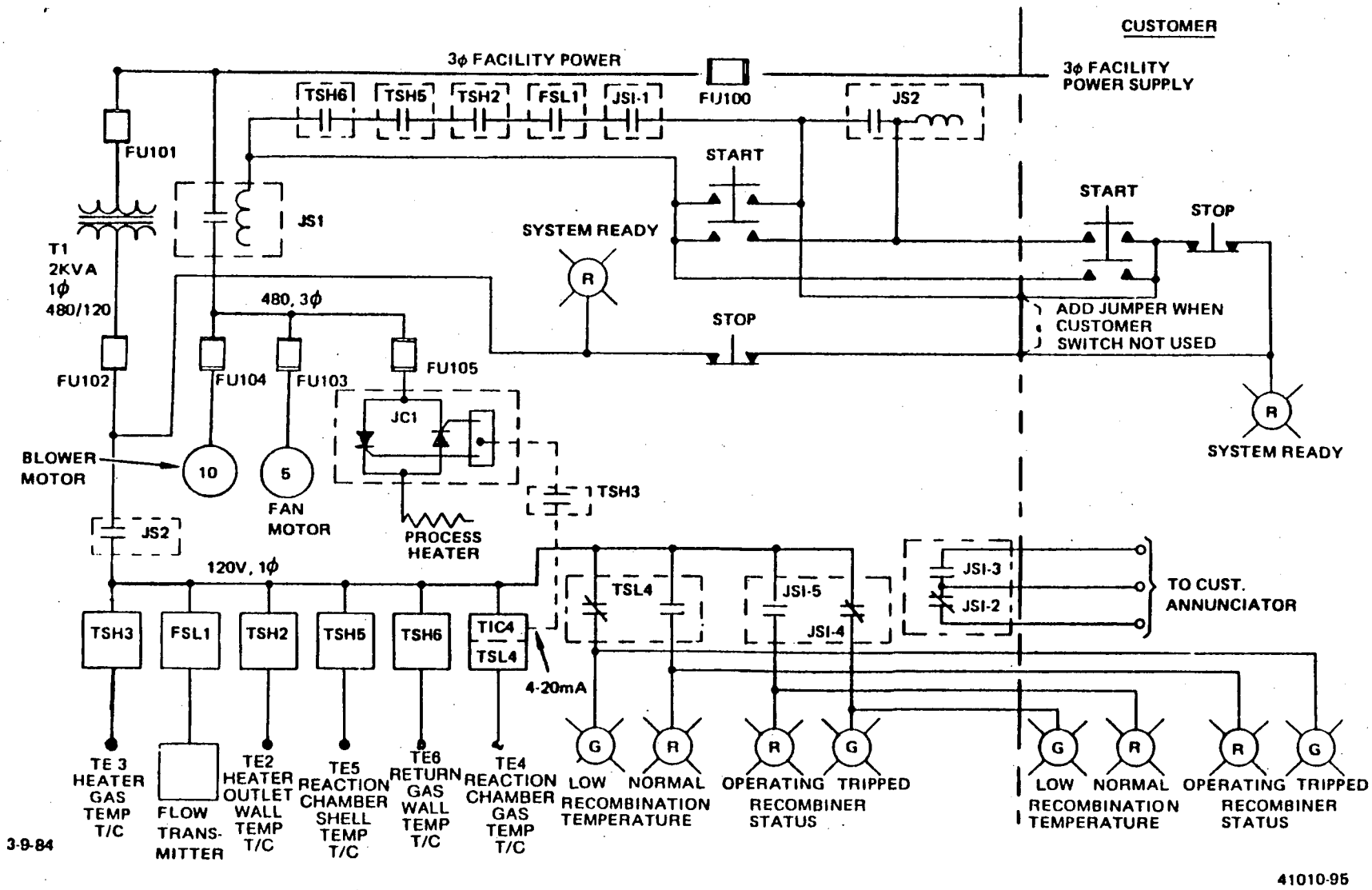

Figure 7. Oconee PWR Power and Control Cabinet Electrical Schematic

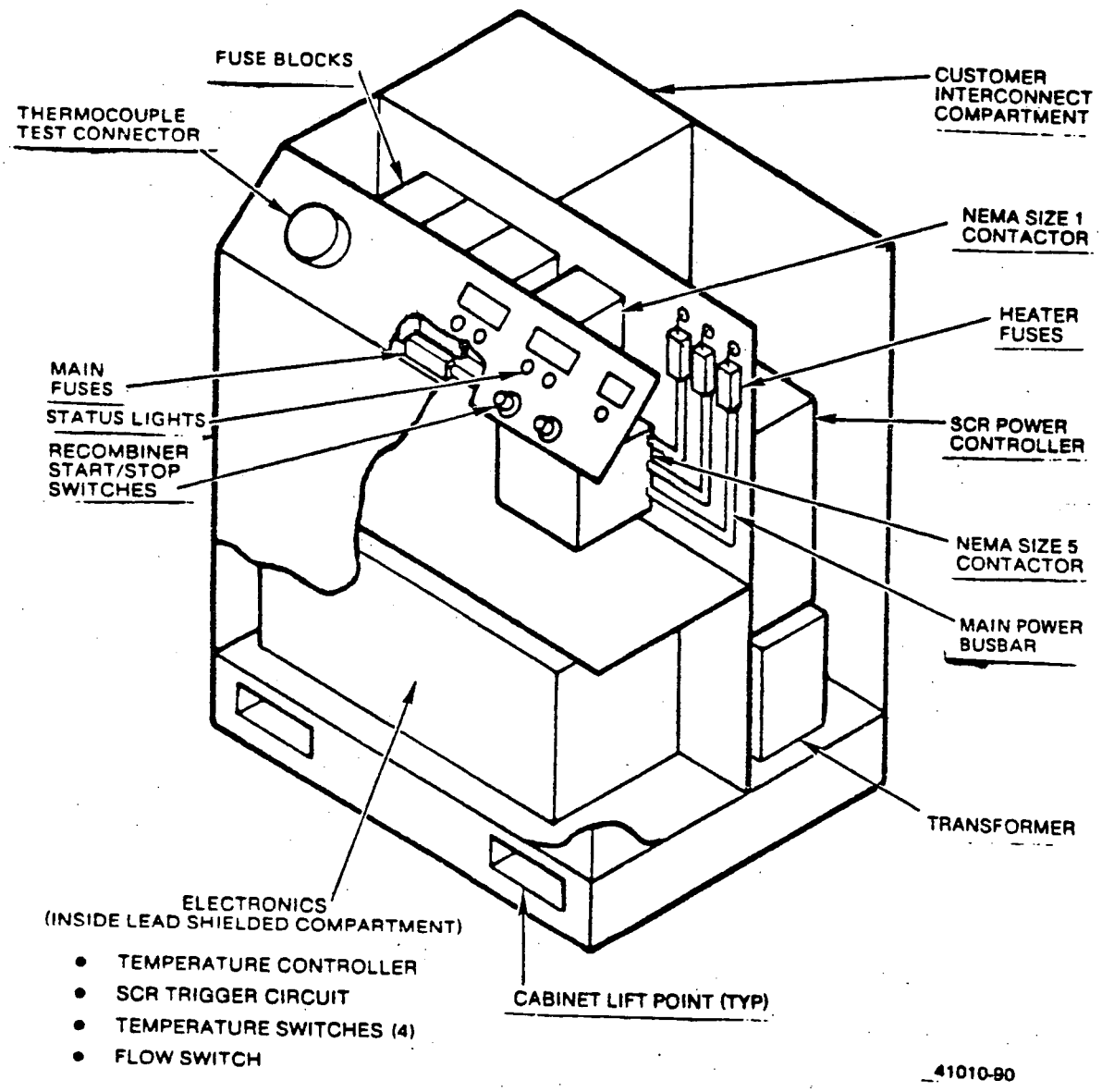

Figure 8. Oconee Power and Control Cabinet, Location of Major Components

TABLE 4

OCONEE PWR POWER AND CONTROL CABINET
ELECTRICAL INTERFACES

Item	Origin/Destination	Power
Facility power	Customer disconnect	480 Vac, 250 A, 3 phase
Remote "start/stop" switches	Customer control panel	120 Vac, 1 phase
Heater power	Skid	480 Vac, 3 phase, 67.2 Kva
Blower motor	Skid	480 Vac, 3 phase, 10 hp
Heat exchanger motor	Skid	480 Vac, 3 phase, 5 hp

Interface practices other than those specified by Rockwell will require analysis by the customer to ensure that qualification of the cabinet is maintained.

3.4 EQUIPMENT SAFETY FUNCTION

Regulatory Guide 1.7 (Reference 12), prepared for meeting the intent of Criterion 41 "Containment Atmosphere Cleanup" of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," advises for all containments the following:

> ". . . it is advisable to provide means by which combustible gases resulting from the postulated metal-water reaction, radiolysis, and corrosion following a LOCA can be mixed, sampled, and controlled without releasing radioactive materials to the environment.
>
> "Since any system for combustible gas control is designated for the protection of the public in the event of an accident, the system should meet the design, quality assurance, redundancy, energy source, and instrumentation requirements for an engineered safety feature. . . .the system itself should not introduce safety problems that may affect containment integrity. The combustible gas control system should be designated Seismic Category I (see Regulatory

Guide 1.29). Guide 1.26, 'Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,' should be applied."

The hydrogen recombiner is a combustible gas control system. It performs a safety-related function and, therefore, is classified as 1E equipment.

The Oconee hydrogen recombiner system consists of two subsystems: (1) the skid assembly, and (2) the power and control cabinet assembly, which is the subject of this report. The skid assembly contains all the equipment necessary to perform the H_2-O_2 recombination process. The power and control cabinet supplies power to the recombiner skid during periodic testing and post-LOCA conditions and contains the electronics necessary to monitor and control the recombiner operation.

All electrical components within the power and control cabinet are 1E safety-related items, except for the system status lamps, (annunciation function only), which are associated 1E components.

3.5 OCONEE POWER AND CONTROL CABINET ENVIRONMENTAL QUALIFICATION CONDITIONS

The environmental and seismic requirements for the Oconee power and control cabinet are presented in Table 1 and Figures 1 and 2.

ATTACHMENT 2

4.0 PWR HYDROGEN RECOMBINER

4.1 OPERATION

The PWR hydrogen recombiner system consists of two distinct subsystems, the skid assembly and the power and control cabinet assembly.

This qualification report addresses only the skid assembly.

During a loss of coolant accident (LOCA) in light water reactors, hydrogen may be generated as a result of metal/water reaction and radiolytic decomposition of water. The thermal hydrogen recombiner performs the safety function of recombining hydrogen with oxygen to produce water vapor (Ref. 5). To provide redundancy, two recombiner systems are installed in parallel, with only one system required to operate. Periodic functional testing and maintenance ensures the system's operability.

The Project 81 PWR hydrogen recombiner is designed to process 90 scfm of containment gas containing from 0.5% to 5% hydrogen, with the balance consisting of varying amounts of oxygen, nitrogen, or water vapor. Standard conditions for gas flow rate (scfm) are referenced to 14.7 psia pressure and 68°F temperature. A gas blower on the recombiner draws the containment atmosphere (a combination of gases, entrained fission products, droplets of borated water, and other particulates) through a separator into the recombiner where entrained solids and liquids are removed, and where they are heated to a temperature at which free hydrogen will recombine with oxygen to form water vapor ($2\ H_2 + O_2 = 2\ H_2O$). The water vapor, gases, and entrained particles pass through an air blast heat exchanger where they are cooled and returned to containment. The PWR hydrogen recombiner is shown in Figures 13 and 14.

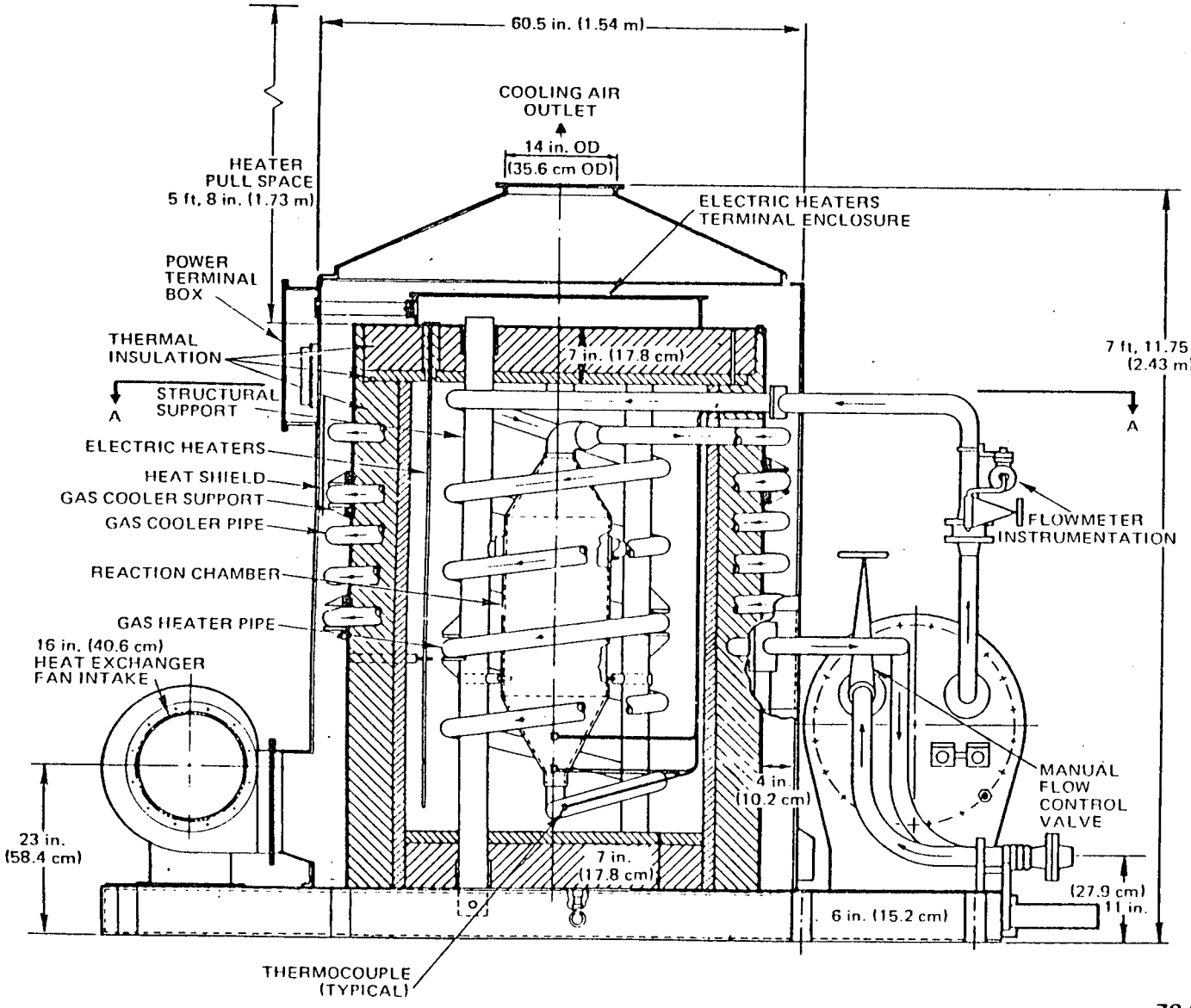

Figure 14. Thermal Hydrogen Recombiner

4.2 SAFETY FUNCTION

Regulatory Guide 1.7 (Ref. 5), prepared for meeting the intent of Criterion 41, "Containment Atmosphere Cleanup" of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," advises for all containments, the following:

> ". . . it is advisable to provide means by which combustible gases resulting from the postulated metal-water reaction, radiolysis, and corrosion following a LOCA can be mixed, sampled, and controlled without releasing radioactive materials to the environment."
>
> "Since any system for combustible gas control is designated for the protection of the public in the event of an accident, the system should meet the design, quality assurance, redundancy, energy source, and instrumentation requirements for an engineered safety feature. . . .the system itself should not introduce safety problems that may affect containment integrity. The combustible gas control system should be designated Seismic Category I (see Regulatory Guide 1.29). Guide 1.26, 'Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,' should be applied."

The hydrogen recombiner is a combustible gas control system. It performs a safety-related function, and therefore is classified as 1E equipment.

4.3 EQUIPMENT DESCRIPTION

4.3.1 Recombiner Skid Assembly

The skid assembly of the recombiner is installed exterior to primary containment and connected to the in-containment space by piping (see Figure 15). The recombiner piping system is designed and fabricated to the requirements of the ASME Boiler and Pressure Vessel Code Section III, Class 2. The skid

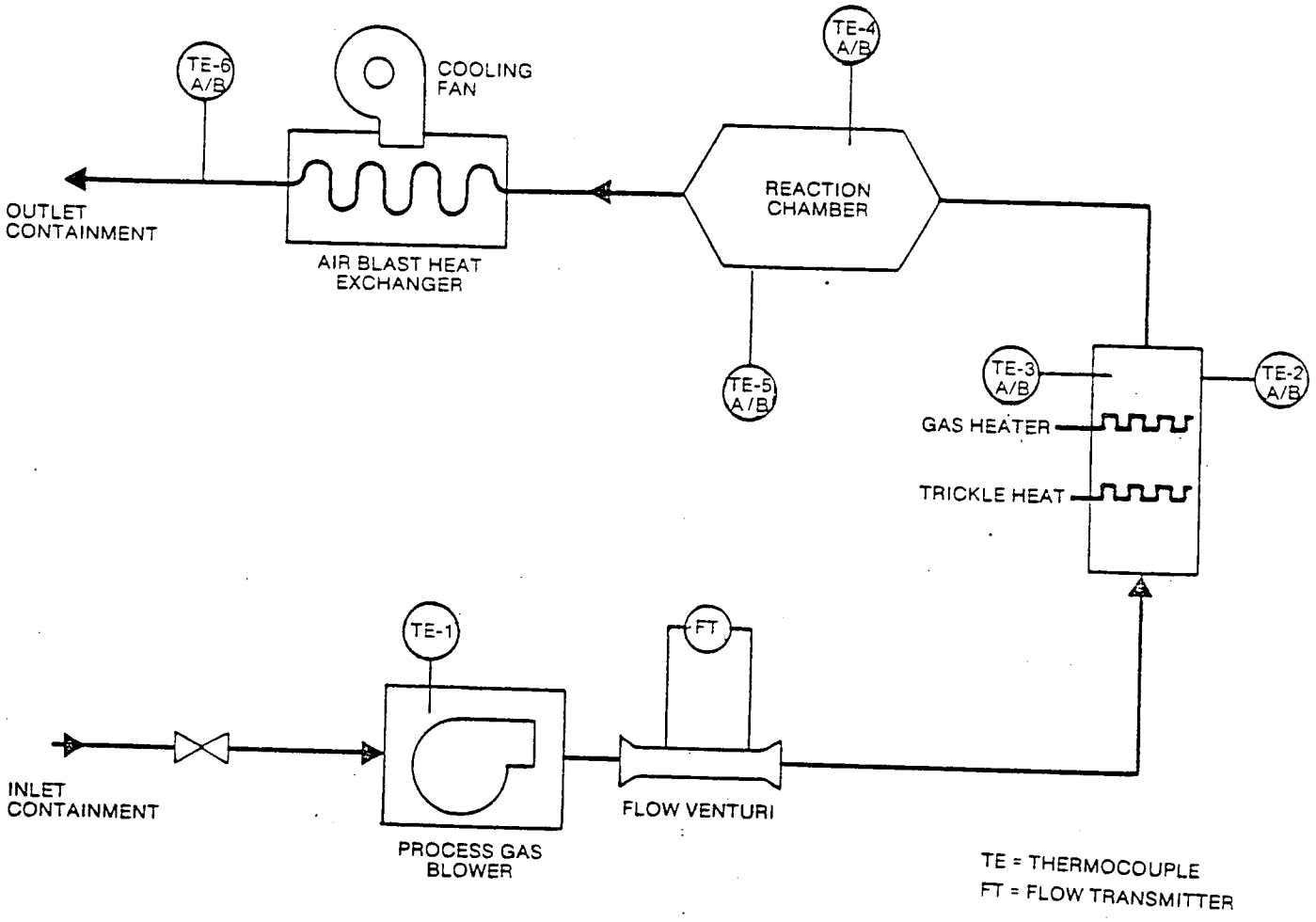

Figure 15. PWR Hydrogen Recombiner Skid Configuration

assembly includes venturi-type flowmeters, manual valves, welded supports, flanges, instrument lines, and the piping. The skid assembly is mounted to the foundation with eight anchor bolts and consists of the following major components:

4.3.1.1 Gas Heater

The gas heater has 21 U-shaped electric heater elements, each with a rating of 3.2 kW. The heaters are individually replaceable and are positioned at least 2 in. away from the heater coil and insulation. The heater radiates either directly to the heater coil and reaction chamber or to the insulation, with subsequent reradiation to the pipe.

The heater power requirements are 480 Vac, 3 phase, 60 Hz (277 Vac across each element, ungrounded "Y" connected), with a maximum sheath (made of Incoloy 800) temperature of less than 1600°F (871°C) and a maximum heat flux of 20 $W/in.^2$. The heater system allows system startup in about 1-1/2 hr. The system will continue to operate after startup even if up to 30% of the heater elements become inoperative. Electrical power to the heaters is controlled by silicon-controlled rectifier power controllers (SCRs). Proportional heater control is provided by the temperature controller using input signals from the thermocouples. Temperature switches automatically cut off electric heater power when the gas heater wall temperature reaches a preset level.

4.3.1.2 Reaction Chamber

A Type 304 stainless steel reaction chamber is located downstream of the gas heater. The reaction chamber is covered with 1/2 in. of insulation to provide uniform heat distribution. Process gas flows through the coiled gas heater pipes into the reaction chamber. The geometric configuration and volume of the reaction chamber provide gas flow movement that assures, at the process temperature, virtually 100% of the hydrogen mixture will be recombined with oxygen.

When the temperature of the reaction chamber gas approaches 1350°F, the recombiner is in the operate mode. In the operate mode, the recombiner runs with minimum attention. The electric power to the heater is automatically reduced to compensate for the exothermic heat of recombination of the hydrogen and oxygen. During startup and periodically during its operation, it is necessary to evaluate the properties of the containment gases to determine whether sufficient hydrogen has been removed to warrant termination of operation. For instance, with 4% hydrogen in the process gas, the heater power will be reduced to less than half its rated power. The reacted gas flows through a 4-in. pipe into the air blast heat exchanger.

4.1.1.3 Air Blast Heat Exchanger (Fan Motor)

The air blast heat exchanger consists of a coil of 2-in., Type 304 stainless steel pipe, 75 ft long, and a centrifugal, squirrel-cage fan driven by a 5-hp motor. The centrifugal fan forces ambient air past the coil and out the exhaust air stack. The flow of air cools the process gas in the coil to below 190°F (88°C) for dry air, or to the saturation temperature of the exhaust for conditions with sufficient water vapor to cause saturation above 150°F (66°C). The cooled reacted flow returns to the containment building. The air blast heat exchanger has been qualified under a separate qualification program (References 17 and 18).

4.3.1.4 Motor/Blower Assembly

A totally enclosed motor/blower assembly generates the pressure differential necessary to cause gas flow from the reactor containment through the recombiner to the reactor containment. The 10-hp motor operates the centrifugal blower at its maximum load condition. This assembly contains an aspirator to process condensate through the recombiner and prevent buildup in the blower can. The motor/blower assembly has been qualified under a separate qualification program (References 17 and 18).

4.3.1.5 Flow Transmitter

A venturi-type flowmeter is used to measure the inlet flow rate. The flowmeter is installed between the blower outlet and the reaction chamber inlet. A differential pressure transmitter, connected to the flowmeter through Type 304 stainless steel tubes, converts the differential pressure of the flowmeter to an electrical signal and transmits it to the power and control panel. A flow value of 50% of rated flow will cause the system to trip.

4.3.1.6 Hand-Operated Valves

There are three 1/2-in., hand-operated shutoff valves on each recombiner that are used as instrument isolation valves for the calibration of the flow transmitter.

4.3.1.7 Thermocouples

The recombination process is dependent upon accurate, temperature monitoring and control. Lack of temperature control may cause the piping to exceed the design temperature. Low temperatures existing in the reaction chamber will result in partial or no recombination of hydrogen, thus violating the allowable hydrogen content specified at the outlet (0.1% in a noninerted atmosphere).

Type K, ungrounded, sheathed, MgO-packed thermocouples are used to measure temperatures. Wall temperatures are measured by thermocouples on the outer pipe surfaces. Gas temperatures are measured by thermocouples extending through the component wall into the gas stream. All thermocouples are duplicated except for TE-1. All thermocouples including spares are wired to the control console. The spare thermocouple can be easily connected if the primary unit ceases to function.

4.3.1.8 Wire/Terminals/Terminal Blocks/Connectors

Insulated wire is used on the recombiner skid for interconnection of components and for grounding. Terminals/lugs are used for termination of wires. Terminal strips/blocks and connectors provide the interface between components, equipment, and the customer wiring.

4.3.2 Power and Control Cabinet

Each PWR recombiner system is supplied with a power and control cabinet. It contains the equipment related to the power supply for the various components of the recombiner skid and the necessary instrumentation for control and operation of the recombiner system. The qualification of the power and control cabinet is documented in a separate report. The power and control cabinet is qualified by type testing and analysis in accordance with the requirements of the PWR power and control cabinet Qualification Plan 280QP000002. The qualification of the power and control cabinet, therefore, is not within the scope of this report.