PSE&G Public Service Electric and Gas Company

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Robert L. Mittl General Manager
Nuclear Assurance and Regulation

October 3, 1984

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, MD 20814

Attention: Mr. Albert Schwencer, Chief
Licensing Branch 2
Division of Licensing

Gentlemen:

HOPE CREEK GENERATING STATION
DOCKET NO. 50-354
DRAFT SAFETY EVALUATION REPORT
FSAR QUESTION 421.10

Pursuant to discussions with the Power Systems Branch, attached is a copy of revised FSAR Question 421.10 previously transmitted on September 7, 1984.

Should you have any questions or require any additional information on these items, please contact us.

Very truly yours,

R L Mittl

Attachment

C D. H. Wagner
USNRC Licensing Project Manager (w/attach.)

W. H. Bateman
USNRC Senior Resident Inspector (w/attach.)

B001 1/1

ATTACHMENT

QUESTION 421.10 (SECTION 7.1 & 7.2)

The staff believes that the physical separation provided in the design of the RPS cabinets may not satisfy the requirements of Regulatory Guid 1.75 or the plant separation criteria and is, therefore, unacceptable. As an example, it has been noted on similar plants that the cabinet lighting and power circuits (which are not treated as associated circuits) becomes associated with Class 1E circuits inside the RPS cabinets. Section 8.1.4.14 includes a brief discussion on the physical separation provided within panels, instrument racks and control boards for the instrumentation and control circuits of different divisions. Review the design of all Class 1E cabinets for separation between non-Class 1E and Class 1E circuits. Provide the staff with a listing of the cabinets which were reviewed and describe in detail how physical separation is maintained within the panels, racks and boards for those cases where a 6 inch air space cannot be maintained. Provide a summary of the analysis and testing performed to support this lesser separation. Include in the discussion the separation provided for associated circuits, internal wiring identification and the use of common terminations.

RESPONSE

The HCGS RPS cabinets (10C609, 10C611, 10C622 and 10C623) meet the requirements of IEEE Standard 384 as modified and endorsed by Regulatory Guide 1.75, as stated in Section 1.8.1.75. Cabinet lighting and receptacle power circuits are physically separated from RPS circuits by being routed in metallic conduit or by structural steel barriers.

Physical separation between non-Class 1E and Class 1E instrumentation and control circuits is provided in panels, instrument racks and control boards in accordance with IEEE Standard 384, as modified and endorsed by Regulatory Guide 1.75 as stated in Section 1.8.1.75. The following is a listing of Class 1E panels, instrument racks and control boards reviewed for the separation requirements of IEEE Standard 384:

Panels

1AC200	H_2/O_2 Analyzer A Panel
1BC200	H_2/O_2 Analyzer B Panel
1CC200	H_2/O_2 Analyzer Heat Trace Panel
1DC200	H_2/O_2 Analyzer Heat Trace Panel
1AC201	SACS Control Panel A
1BC201	SACS Control Panel B
1CC201	SACS Control Panel C
1DC201	SACS Control Panel D
1OC202	RACS Heat Exchanger and Pumps Control Panel

1AC213	Instrument Gas Compressor A Control Panel
1BC213	Instrument Gas Compressor B Control Panel
1AC215	H_2 Recombiner A Power Distribution Panel
1BC215	H_2 Recombiner B Power Distribution Panel
1AC281	Reactor Building Unit Cooler Control Panel
1BC281	Reactor Building Unit Cooler Control Panel
1CC281	Reactor Building Unit Cooler Control Panel
1DC281	Reactor Building Unit Cooler Control Panel
1AC285	Reactor Building FRVS Control Panel
1BC285	Reactor Building FRVS Control Panel
1CC285	Reactor Building FRVS Control Panel
1DC285	Reactor Building FRVS Control Panel
1OC286	Reactor Building Equipment Lock Ventilation
1OC399	Remote Shutdown Panel
1OC401	Diesel Generator Area Battery Room Panel
1OC402	Diesel Generator Area Battery Room Panel
1AC420	Diesel Generator A Exciter Panel
1BC420	Diesel Generator B Exciter Panel
1CC420	Diesel Generator C Exciter Panel
1DC420	Diesel Generator D Exciter Panel
1AC421	Diesel Generator A Local Engine Control Panel
1BC421	Diesel Generator B Local Engine Control Panel
1CC421	Diesel Generator C Local Engine Control Panel
1DC421	Diesel Generator D Local Engine Control Panel
1AC422	Diesel Generator A Remote Control Generator Panel
1BC422	Diesel Generator B Remote Control Generator Panel
1CC422	Diesel Generator C Remote Control Generator Panel
1DC422	Diesel Generator D Remote Control Generator Panel
1AC423	Diesel Generator A Remote Engine Control Panel
1BC423	Diesel Generator B Remote Engine Control Panel
1CC423	Diesel Generator C Remote Engine Control Panel
1DC423	Diesel Generator D Remote Engine Control Panel
1AC428	Diesel Generator A Load Sequencer Panel
1BC428	Diesel Generator B Load Sequencer Panel
1CC428	Diesel Generator C Load Sequencer Panel
1DC428	Diesel Generator D Load Sequencer Panel
1AC482	Electric Heater Control Panel 1AVH403
1BC482	Electric Heater Control Panel 1BVH403
1AC483	Diesel Area HVAC Control Panel
1BC483	Diesel Area HVAC Control Panel
1CC483	Diesel Area HVAC Control Panel
1DC483	Diesel Area HVAC Control Panel
1AC485	Control Area HVAC Control Panel
1BC485	Control Area HVAC Control Panel
1AC486	Diesel Area Panel Room Supply System
1BC486	Diesel Area Panel Room Supply System
1AC487	Water Chiller Panel
1BC487	Water Chiller Panel
1AC488	Chiller AK403 Power Panel
1BC488	Chiller BK403 Power Panel
1AC489	Electric Heater Control Panel 1AVH407
1BC489	Electric Heater Control Panel 1BVH407

1AC490	Water Chiller A Control Panel
1BC490	Water Chiller B Control Panel
1AC491	Water Chiller A Power Panel
1BC491	Water Chiller B Power Panel
1AC492	Electric Heater Control Panel
1BC492	Electric Heater Control Panel
1AC493	Control Panel - Auxiliary Building Diesel
1AC494	Control Panel - Auxiliary Building Diesel
1AC495	Control Panel - Auxiliary Building Diesel
1BC495	Control Panel - Auxiliary Building Diesel
1CC495	Control Panel - Auxiliary Building Diesel
1DC495	Control Panel - Auxiliary Building Diesel
1AC515	Traveling Screen Control Panel
1BC515	Traveling Screen Control Panel
1CC515	Traveling Screen Control Panel
1DC515	Traveling Screen Control Panel
1AC516	Service Water Pump Panel
1BC516	Service Water Pump Panel
1CC516	Service Water Pump Panel
1DC516	Service Water Pump Panel
1AC581	Intake Structure HVAC Control Panel
1BC581	Intake Structure HVAC Control Panel
1CC581	Intake Structure HVAC Control Panel
1DC581	Intake Structure HVAC Control Panel
1OC601	RRCS Division 1 Panel
1OC602	RRCS Division 2 Panel
1OC604	Class 1E Radiation Monitoring Instrumentation Cabinet
1OC617	Division 1 RHR and Core Spray Relay Vertical Board
1OC618	Division 2 RHR and Core Spray Relay Vertical Board
1OC620	HPCI Relay Vertical Board
1OC621	RCIC Relay Vertical Board
1OC622	Inboard Isolation Valve Relay Vertical Board
1OC623	Outboard Isolation Valve Relay Vertical Board
1OC628	ADS Division 2 Relay Vertical Board
1OC631	ADS Division 4 Relay Vertical Board
1AC633	Post LOCA H_2 Recombiner A Control Cabinet
1BC633	Post LOCA H_2 Recombiner B Control Cabinet
1OC640	Division 4 RHR and Core Spray Relay Vertical Board
1OC641	Division 3 RHR and Core Spray Relay Vertical Board
1OC650	Main Control Room Vertical Board
1OC651	Unit Operators Console
1AC652	1E Solid State Logic Cabinet Channel A
1BC652	1E Solid State Logic Cabinet Channel B
1CC652	1E Solid State Logic Cabinet Channel C
1DC652	1E Solid State Logic Cabinet Channel D
1AC655	1E Analog Logic Cabinet Channel A
1BC655	1E Analog Logic Cabinet Channel B
1CC655	1E Analog Logic Cabinet Channel C
1DC655	1E Analog Logic Cabinet Channel D
1AC657	1E Digital Termination Cabinet Channel A
1BC657	1E Digital Termination Cabinet Channel B
1CC657	1E Digital Termination Cabinet Channel C

1DC657 1E Digital Termination Cabinet Channel D
1AC680 1E Electrical Auxiliary Cabinet Channel A
1BC680 1E Electrical Auxiliary Cabinet Channel B
1CC680 1E Electrical Auxiliary Cabinet Channel C
1DC680 1E Electrical Auxiliary Cabinet Channel D

Instrument Racks

10C002	Reactor Water Clean-up Rack
10C004	Reactor Vessel Level and Pressure A Rack
10C005	Reactor Vessel Level and Pressure C Rack
10C009	Jet Pump Rack A
10C014	HPCI A/HPCI Leak Detection A Rack
10C015	Main Steam C/D and Recirc A Flow Rack
10C018	RHR A and ADS Rack
10C021	RHR B and ADS Rack
10C025	Main Steam C/D and Recirc A Flow Rack
10C026	Reactor Vessel Level and Pressure D Rack
10C027	Reactor Vessel Level and Pressure B Rack
10C037	RCIC D/RCIC Leak Detection D Rack
10C041	Main Steam A/B and Recirc B Flow Rack
10C042	Main Steam A/B and Recirc B Flow Rack
10C069	RHR D and ADS Rack
10C208A	RCIC/Reactor Cooling
10C211	RCIC Pump
10C212	RCIC Pump

Instrument racks are separated into channels. No two redundant piped or tubed safety-related instruments are located on the same rack.

Where a 6-inch air space cannot be maintained between instrumentation and control circuits of different channels (both Class 1E to Class 1E and Class 1E to non-Class 1E), barriers are provided in accordance with IEEE Standard 384. These barriers are metallic conduit, structural steel barriers, or non-metallic wrap (Havey Industries Siltemp Sleeving Type S or Siltemp Woven Tape Type WT65). The metallic conduit and structural steel barriers are noncombustible materials. The nonmetallic wrap (Siltemp) was successfully tested for use as an isolation barrier (reference Wyle Laboratories Test Report Number 56669).

For certain types of isolation devices, barriers of the type noted above are not feasible. For these cases, requirements of Section 7.2.2.1 of IEEE Standard 384 are met, as follows:

> "The separation of the wiring at the input and output terminals of the isolation device may be less than 6 inches (0.15 m) as required in 6.6.2 provided that it is not less than the distance between input and output terminals.

Add Insert A

— INSERT A —

At HCGS, three isolation devices are used which do not satisfy the 6 inch air space requirement and, by design, barriers of the type identified above are not feasible. The 6 inch air space requirement is maintained for wiring associated with these devices except at the device itself where the separation is maintained not less than the physical distance between the input and output terminal of the isolation device. These devices are:

a) TEC analog isolator, model 156 – provides class 1E to non-class 1E isolation for low level analog inputs to the plant computer,

b) Struthers Dunn type 219 relay – provides class 1E to non-class 1E isolation for inputs to the plant annunciator (125 vdc contact interrogation voltage is used by the plant annunciator),

c) Allen Bradley model 700-200A12P relay – provides class 1E to non-class 1E isolation for inputs to the plant annunciator.

These devices are fully qualified for their applicati as described in part (d) of the response to question 421.12

Minimum separation requirements do not apply for wiring and components within the isolation device; however, separation shall be provided wherever practicable."

Testing, in accordance with IEEE Standard 472 (Surge Withstand Capability) will be performed to ensure that the Class 1E inputs to the isolation devices are not affected by short-circuit failures, ground faults or voltage surges on the output side of the isolation devices.

~~The only~~ Single Failure analysis ~~that will be~~ were performed to support air spaces less than 6 inches, ~~since the requirements of IEEE Standard 384 are satisfied, is~~ for the Neutron Monitoring System Panel (10C608) and the Process Radiation Monitoring System Panels (10C635 and 10C636). This report was submitted under separate cover (R.L. Mittl to A. Schwencer dated September 7, 1984.)

No associated circuits have been identified in the non-NSSS panels, instrument racks, or control boards. Internal wiring identification is done using color coded insulation or insulation marked with color coded tape. For panel sections of one channel only, internal wiring identification may not be done. Where common terminations are used, the requirements of IEEE Standard 384 are satisfied as stated above.

Electrical equipment and wiring for the reactor protection system (RPS), the nuclear steam supply shutoff systems (NSSSS) and the engineered safeguards subsystems (ESS) are segregated into separate divisions designated I and II, etc., such that no single credible event is capable of disabling sufficient equipment to prevent reactor shutdown, removal of decay heat from the core, or closure of the NSSSS valves in the event of a design basis accident.

No single control panel section (or local panel section or instrument rack) includes wiring essential to the protective function of two systems that are backups for each other (Division I and Division II) except as allowed below:

a. If two panels containing circuits of different separation divisions are less than 3 feet apart, there shall be a steel barrier between the two panels. Panel ends closed by steel end plates are considered to be acceptable barriers provided that terminal boards and wireways are spaced a minimum of one inch from the end plate.

b. Floor-to-panel fire proof barriers must be provided between adjacent panels having closed ends.

c. Penetration of separation barriers within a subdivided panel is permitted, provided that such penetrations are sealed or otherwise treated so that an electrical fire could not reasonably propagate from one section to the other and destroy the protective function.

d. Where, for operational reasons, locating manual control switches on separate panels is considered to be prohibitively (or unduly) restrictive to normal functioning of equipment, then the switches may be located on the same panel provided no single event in the panel can defeat the automatic operation of the equipment.

With the exception of panels 10C608, 10C635 and 10C636, internal wiring of the NSSS panels and racks has color-coded insulation. Associated circuits are treated within a panel or rack in the same manner as the essential circuits. Where common terminations are used, the requirements of IEEE Standard 384 are satisfied.

Electrical protection assemblies have been added between the power range NMS panel (10C608) and its two 120V ac UPS power feeders as described in revised Section 7.6.1.4.2.

CHAPTER 7

FIGURES (Cont)

coaxial cable. The amplifier is a linear current amplifier whose voltage output is proportional to the current input and therefore proportional to the magnitude of the neutron flux. Low level output signals are provided that are suitable as an input to the computer, recorders, etc. The output of each LPRM amplifier is isolated to prevent interference of the signal by inadvertent grounding or application of stray voltage at the signal terminal point.

Power for the LPRM is supplied ~~by~~ from two non-Class 1E uninterruptible power sources (see Figure 8.3-11, Sht. 3). Approximately half of the LPRMs are supplied from each bus. Each LPRM amplifier has a separate power supply in the main control room, which furnishes the detector polarizing potential. The LPRM amplifier cards are mounted into pages in the NMS cabinet, and each page is supplied operating voltages from a separate low voltage power supply.

– INSERT A – (REV #1)

The trip circuits for the LPRM provide signals to actuate lights and annunciators. Table 7.6-3 lists the LPRM trips.

Each LPRM may be individually bypassed via a switch on the LPRM amplifier card. Placing an LPRM in "bypass" sends a signal to the assigned APRM, electronically causing it to adjust its averaging amplifier's gain to allow for one less LPRM input. In this way, each APRM can continue to produce an accurate signal representing average core power even if some of the assigned LPRMs fail during operation. If the number of functional assigned LPRMs drops to 50% of the normal number, the APRM automatically goes inoperative and a half scram (one trip logic channel deenergized), rod block, and appropriate annunciation are generated. Administrative controls ensure that a minimum number of LPRMs at each level (A, B, C, and D) in the core are maintained or the APRM is declared inoperative and manually placed in the tripped state.

In addition to the signals supplied to the APRMs, the LPRMs also send flux signals to the rod block monitor (RBM). When a central control rod is selected for movement, the output signals from the amplifiers associated with the nearest 16 LPRM detectors are displayed on the main control room vertical board meters and sent to the RBM. The four LPRM detector signals from each of the four detector assemblies are displayed on 16 separate meters. The operator can readily obtain readings from all the LPRM detectors by selecting the control rods in order. These signals from the

INSERT A (REV #1)

Electrical protection assemblies (EPAs) identical to those used in the reactor protection system (RPS) (described in Section 8.3.1.5.4) are installed between the power range NMS and the two 120V AC feeders from the UPS power sources (see Figure 7.6-11). The EPAs ensure that the power range NMS never operates under degraded bus voltage or frequency conditions (undervoltage, overvoltage, underfrequency). The power range NMS panel (10C608) was analyzed with this power supply configuration to ensure that no single failure of the power range NMS could inhibit the proper operation of the reactor protection, ~~system or any other safety system~~ required for the safe operation of the plant. The interfaces between the power range NMS and the RPS have adequate provisions for separation. The RPS cabling external to the NMS panel conforms to the separation guidelines of Regulatory Guide 1.75, which the RPS must satisfy. within the panel, where the cable and wiring runs to the different RPS divisions do not conform to the Regulatory Guide 1.75 separation criteria, fire-resistant "Sil-Temp" tape is wrapped around the cables and wires. This eliminates the possibility of fault propagation between the RPS divisions. In accordance with paragraph 5.6.2 of IEEE Standard 384, this tape has been demonstrated to be acceptable. Separation criteria for the rod block monitor, recirculation flow control, reactor manual control, and the redundant reactivity control systems has not been changed.

rod block monitor, recirculation flow control, reactor manual control, and the redundant reactivity control systems four LPRM strings (16 detectors) surrounding the selected rod are used in the RBM to provide protection against local fuel overpower conditions.

7.6.1.4.3 Average Power Range Monitor Subsystem

The APRM subsystem monitors neutron flux from approximately 1% to above 100% power. There are six APRM channels, each receiving core flux level signals from 21 or 22 LPRM detectors. Each APRM channel averages the 21 or 22 separate neutron flux signals from the LPRMs assigned to it, and generates a signal representing core average power.

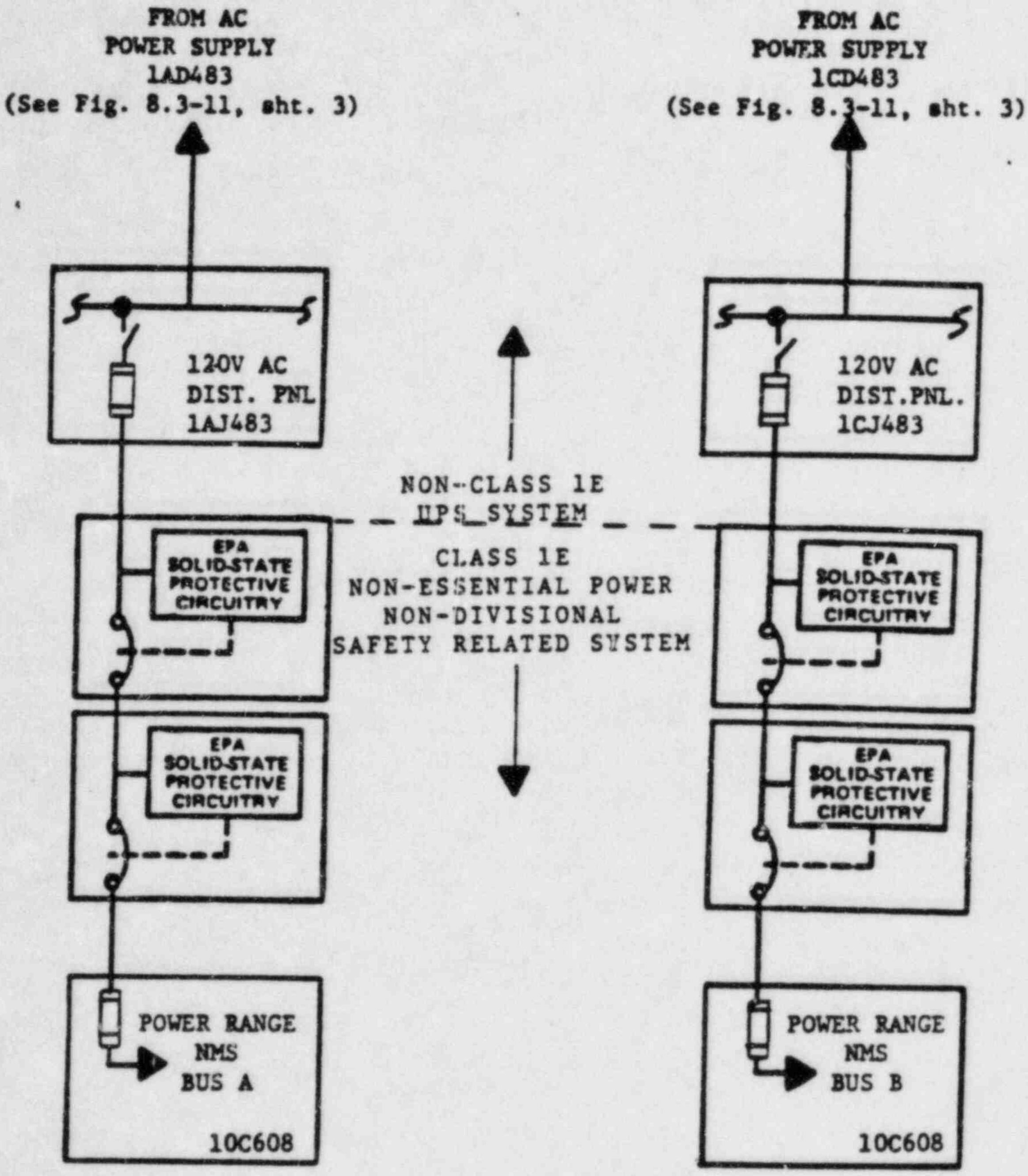
This signal is used to drive a local meter and a remote recorder located on the main control room vertical board. It is also applied to a trip unit to provide APRM downscale, inoperative and upscale alarms, and upscale reactor trip signals for use in the RPS or RMCS.

Refer to Section 7.2.1.1 for a description of the APRM inputs to the RPS, and Figure 7.6-5 for the RPS trip circuit input arrangement. APRM trips are summarized in Table 7.6-2.

The APRM scram units are set for a reactor scram at 15% core power in "refuel" and "startup" modes. When the mode switch is in "run," the APRM trip reference signal is provided by a signal that varies with recirculation flow. This provides a power following reactor scram setpoint. As power increases, the reactor scram setpoint also increases up to a fixed setpoint above 100%. Reactor power is always bounded with a reactor scram, yet the change in power required to generate the reactor scram does not vary greatly with the operating power level.

Provision is made for manually bypassing one APRM channel at a time. Calibration or maintenance can be performed without tripping the RPS. Removal of an APRM channel from service without bypassing it, by unplugging a card, by taking the APRM function switch out of "operate," or by having too few assigned LPRM signals to the APRM, will result in an APRM "inoperative" condition which causes a half scram, a rod block, and annunciation

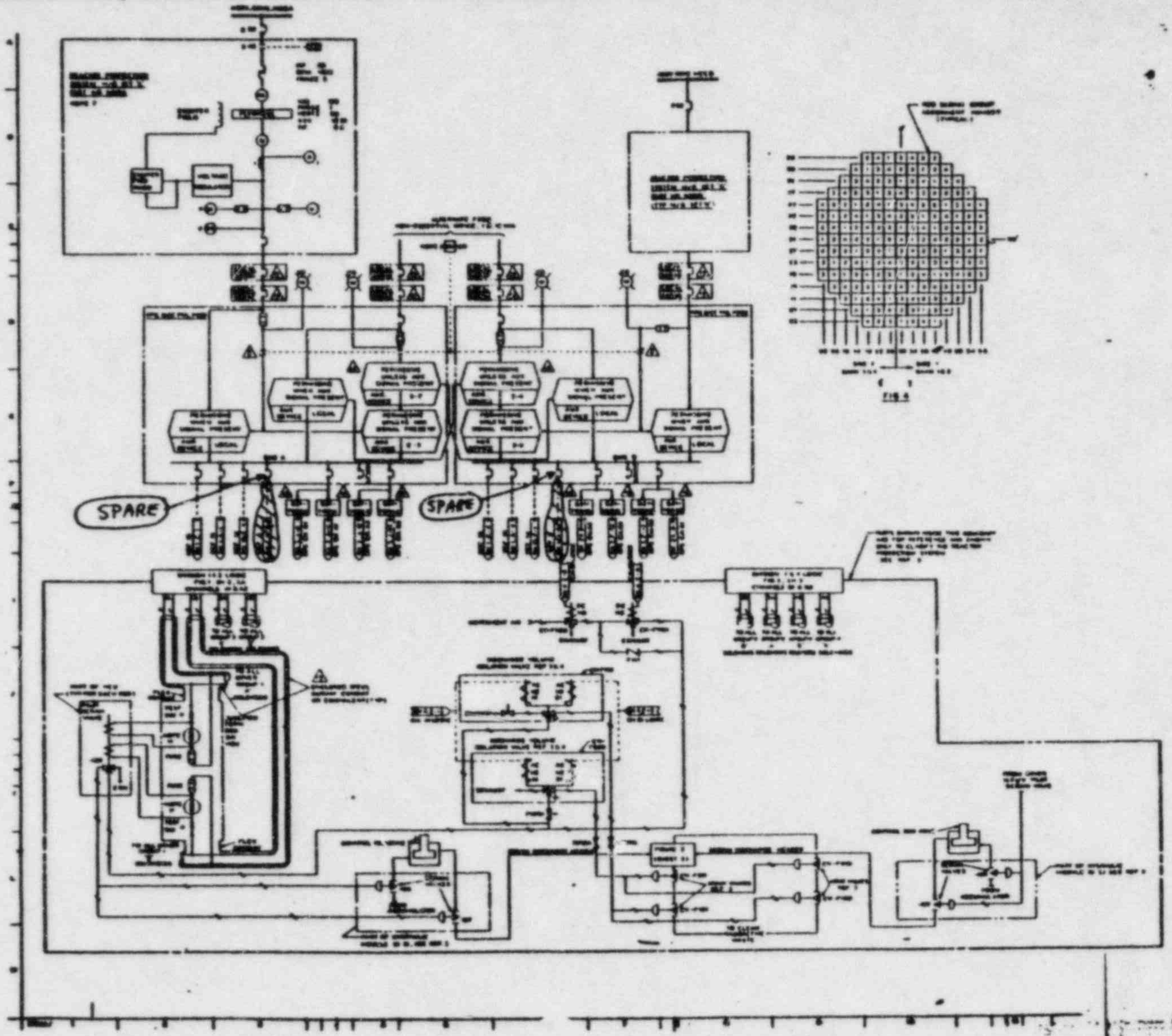
The APRM channels receive power from [the same] non-Class 1E uninterruptible power sources [that supply the LPRMs (see Section 7.6.1.4.2)]. Power for each APRM trip unit is supplied from



HOPE CREEK
GENERATING STATION
FINAL SAFETY ANALYSIS REPORT

ELECTRICAL PROTECTION ASSEMBLIES (EPAs) IN THE POWER RANGE NEUTRON MONITORING SYSTEM

FIGURE 7.6-11 Amendment



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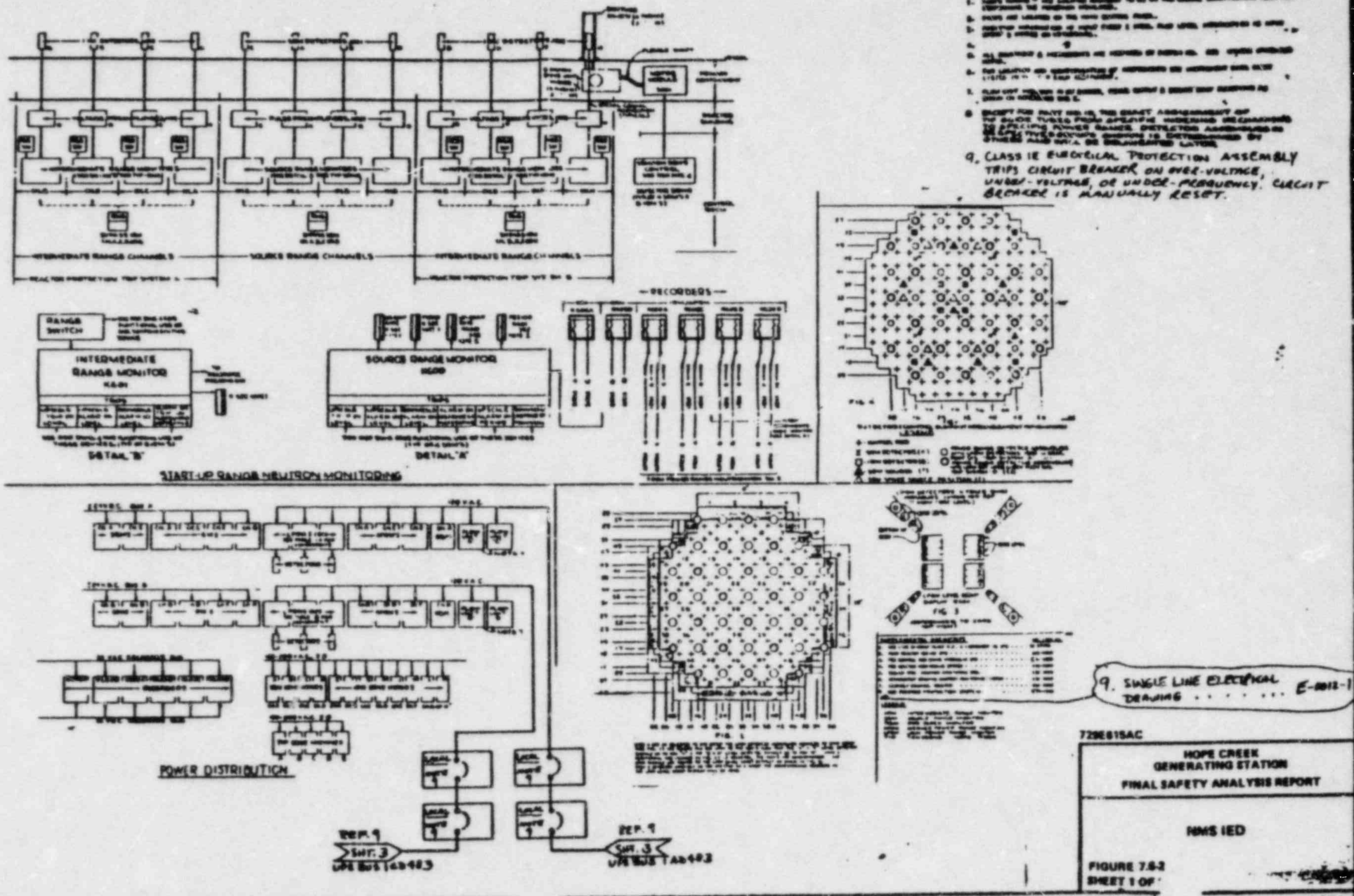
REACTOR PROTECTION SYSTEM

SHEET
FIGURE



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HOPE CREEK
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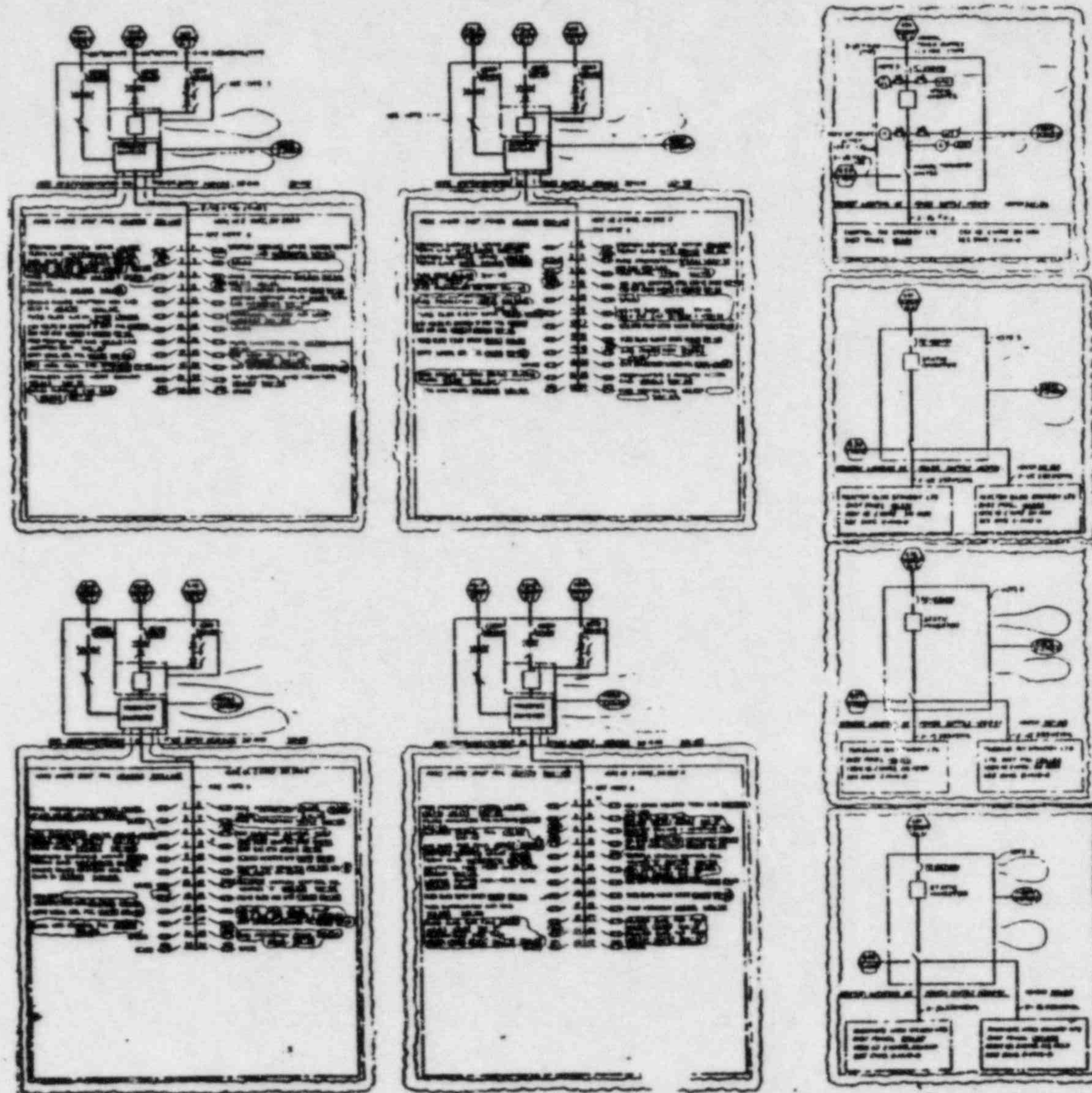
FINAL SAFETY ANALYSIS REPORT

NMS IED

FIGURE 7.6-2
SHEET 1 OF



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FINAL SAFETY ANALYSIS REPORT

SINGLE LINE METER &
RELAY DIAGRAM 120 V AC
INSTRUMENT TION & MISC. SYSTEMS

FIGURE 8.3-
SHEET 3 OF

To: Bruce Preston
From: Dean James
Date: 9/4/84

SINGLE-FAILURE ANALYSIS FOR THE NEUTRON MONITORING AND PROCESS RADIATION MONITORING SYSTEMS

HOPE CREEK GENERATION STATION
PUBLIC SERVICE ELECTRIC AND GAS

AUGUST 1984

DBJ:rm/A08311*-1
8/31/84

SINGLE-FAILURE ANALYSIS FOR THE NEUTRON MONITORING AND PROCESS RADIATION MONITORING SYSTEMS

Some of the safety-related portions of the neutron monitoring system (NMS) and the process radiation monitoring system (PRMS) for the Hope Creek Generating Station (HCGS) are not designed and built to conform to the literal separation guidelines of Regulatory Guide 1.75. This analysis establishes the acceptability of these portions of the NMS and PRMS by demonstrating that they meet the single-failure criteria of IEEE Standard 279, which requires that the consequences of any single, design-basis failure event in a safety-related portion of the systems be tolerated without the loss of any safety function.

Portions of NMS and PRMS External to the NMS and PRMS Panels

See Figure 7.1-1 of the HCGS FSAR for the separations concept of the reactor protection system (RPS) and its relationship to the NMS.

Under the reactor vessel, cables from the individual, local power-range monitor (LPRM) detectors and from the individual intermediate-range monitor (IRM) detectors are grouped to correspond with the RPS trip channel designations. These cable groupings are run in conduit from the vessel pedestal area to the NMS and PRMS panels.

The radiation monitors on the main-steam lines are physically separated. The cabling from the individual sensors to the panels is run in separate metallic conduit.

Cabling from the NMS and PRMS panels to the RPS cabinets is also run in metallic conduit, providing electrical isolation and physical separation of the NMS and PRMS cabling associated with the RPS system.

It is concluded that the safety-related portions of the NMS and PRMS external to the NMS and PRMS panels adequately conform to the separation criteria of Regulatory Guide 1.75.

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Single Failure in the NMS and PRMS Panels

Figures 1 and 2 depict schematically the physical arrangement of the equipment in NMS and PRMS panels H11-P608, H11-P635, and H11-P636. The designs of these panels are similar to those of NMS and PRMS panels used in several BWR plants accepted by the NRC.

The layouts of the panels and the assignments of specific RPS trip logic circuitry provides the designs with the required tolerance to postulated single failures. The worst-case single failure would be the loss of any combination of trip signals within one bay of any panel. However, the loss of any bay and its associated wiring would not prevent a scram. A valid scram signal would be transmitted via the other bays because of the redundancy in the panel designs and the interconnections to the RPS (see Figure 7.1-1 of the HCGS FSAR).

The eight IRM channels and the six average power range monitor (APRM) channels are electrically isolated and physically separated. Within the IRM and APRM modules, analog outputs are derived for use with control room meters, recorders, and the process computer. Electrical isolation at the interfaces would prevent any single failure from influencing the trip unit output.

Physical Separation in the NMS and PRMS Panels

Adequate separation in the NMS and PRMS panels is achieved by using the bay design depicted in Figures 1 and 2, by using relay coil-to-contact as sufficient separation/isolation, and by separation between divisions/channels/wiring. Where conformation with Regulatory Guide 1.75 separation criteria cannot be achieved, the best-effort design is used.

Circuits that provide inputs to different divisions of the RPS are physically separated by airgaps or by the walls between the bays. Within the panels, where the cable and wiring runs to the different RPS divisions do not conform to the Regulatory Guide 1.75 separation criteria, fire-resistant "Sil-Temp" tape is wrapped around the cables and wires. This eliminates the possibility of fault propagation between the RPS divisions. In accordance with paragraph 5.6.2 of IEEE Standard 384, this tape has been demonstrated to be acceptable.

Separated ducts are provided in the panel for the incoming circuit wires from the sensors that belong to UPS Bus 1 or Bus 2.

As shown in Figure 3, the isolation/separation precludes the propagation from outside the NMS cabinets of failures that could cause the loss of any safety function.

NMS/PRMS Interface to RPS

Although the LPRM sensors are not required to meet Class 1E requirements, the design bases of the APRMs specify that the LPRM signals used for the APRMs be so selected, powered, and routed that the APRMs do meet applicable safety criteria. The LPRM signal conditioners and associated power supplies are isolated and separated into groups.

The logic circuitry for the NMS and PRMS scram trip signals conforms to the single-failure criteria. The contact configurations and failure consequences associated with IRM A (see Figure 4) and APRM A (see Figure 5) are typical of the other trip channels and are described in what follows.

- With the reactor scram mode switch in the "Shutdown," "Refuel," or "Startup" positions, IRM A upscale or inoperating signals (unless bypassed) or APRM A upscale or inoperative signals (unless bypassed) would produce a channel trip of the output relay.

- With the reactor system mode switch in the "Run" position, IRM A upscale or inoperative signals (unless bypassed) and an APRM A downscale signal (unless bypassed) or APRM A upscale neutron trip or upscale thermal trip or inoperative signals (unless bypassed) would produce a channel trip of the output relay.

- A trip of the channel output relay for IRM A and APRM A or a trip of the channel output relay for IRM E and APRM E would produce an RPS A1 channel trip. In PRMS, the log radiation monitor A would produce an RPS A1 channel trip (see Figure 6).

For NMS, one tripped (unbypassed) channel on the RPS trip system would cause a half scram. If one APRM bay were to fail in an untripped condition, the remaining bays would be capable of sending RPS sufficient scram signals to produce a full scram, even if one of them were bypassed.

As shown in Figures 2 and 7, if one bay of panels H11-P635 or H11-P636 were to fail in an untripped condition, the remaining bays would be capable of sending sufficient RPS signals even if one of the IRM channels were bypassed. The IRM bypass switches can bypass one IRM channel at a time.

Similarly for PRMS, if one bay were to fail in an untripped condition, the remaining bays would be capable of sending sufficient RPS trip signals to produce a full scram.

Common Power Supply Justification

The NMS is supplied with 120-Vac, 60-Hz power from UPS busses 1 & 2. A design change has been authorized for the installation on each bus of redundant electrical protection assemblies (EPAs), which will monitor the incoming voltage and frequency.

Any fault in one NMS channel could not cause an unsafe failure in another channel sharing the same low voltage power supply because 10-amp fuses are installed for wire protection, and the power supplies are designed with over-voltage and over-current protection circuitry at their output.

The PRMS is supplied with 120-Vac, 60-Hz power from RPS busses A and B. EPAs are already installed on each bus to provide voltage and frequency protection.

Any fault in one PRMS channel could not cause an unsafe failure in another channel sharing the same power supply because 5-amp fuses are installed for wire protection, and the power supplies are designed with over-voltage and over-current protection circuitry at their output.

Because of the fail-safe NMS/PRMS logic configuration, a loss of one supply would result in a half scram signal to RPS. Loss of both supplies would result in a full scram.

Common Associated Circuit Interfaces

Nonessential (associated) circuits to common information equipment are current limited and protected such that their failure cannot jeopardize an adjacent circuit.

Figure 8 provides an example of an associated circuit interface on LPRM card Z11. At the zero-to-160-mV computer output, the card is protected with a 30-MA fuse. The zero-to-10-V output to the rod block monitor has an additional isolator protection for the card.

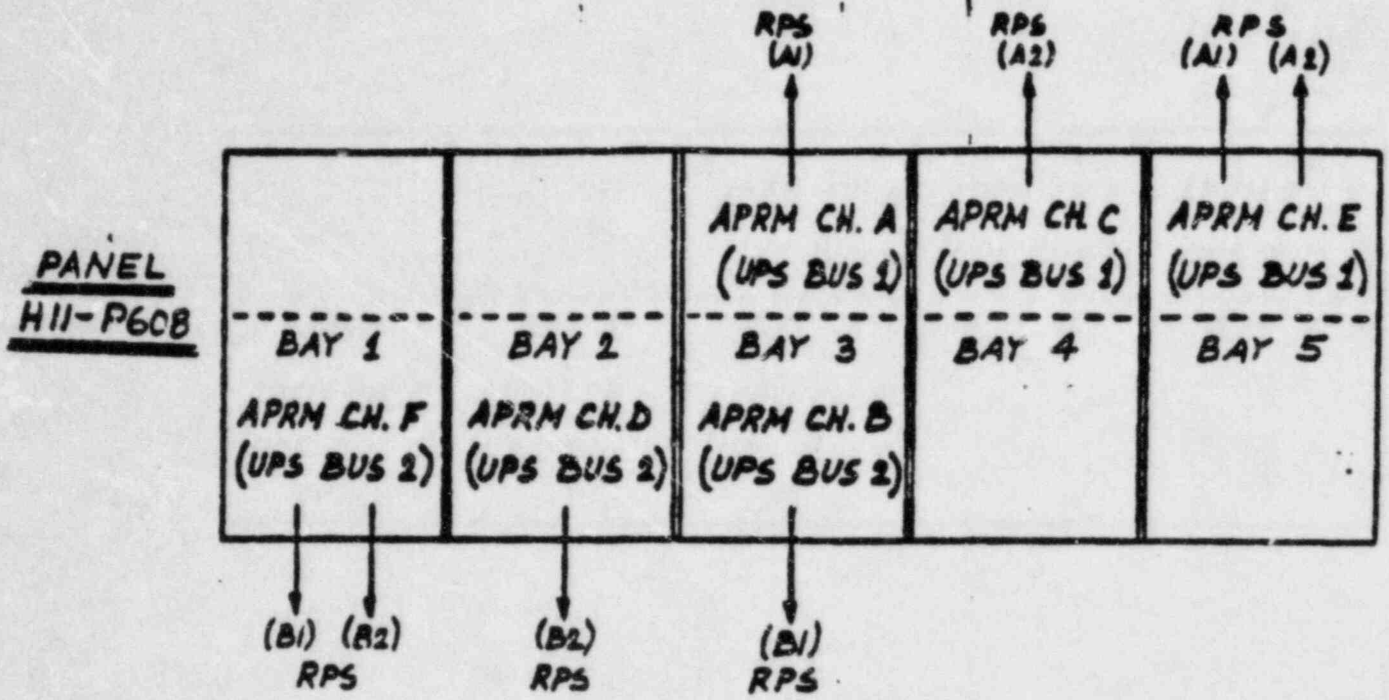

FIGURE 1 - APRM Panel Assignment

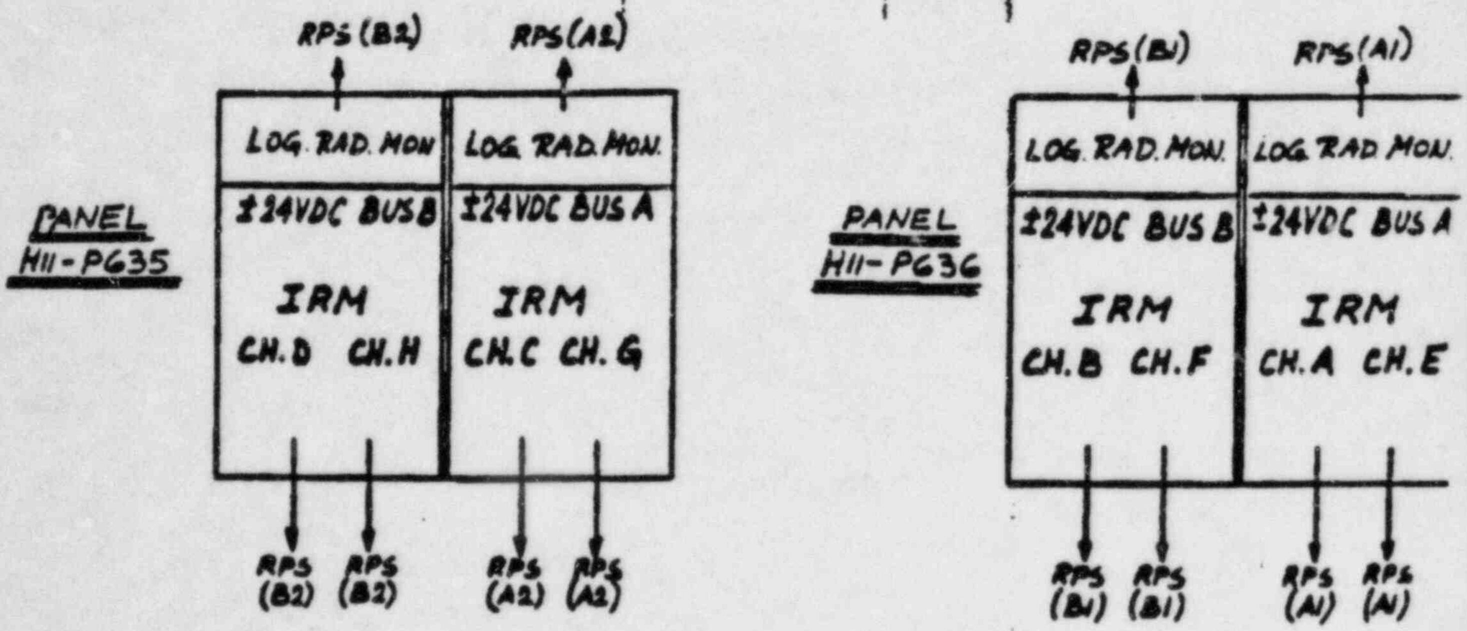

FIGURE 2 - Radiation Monitoring Panels

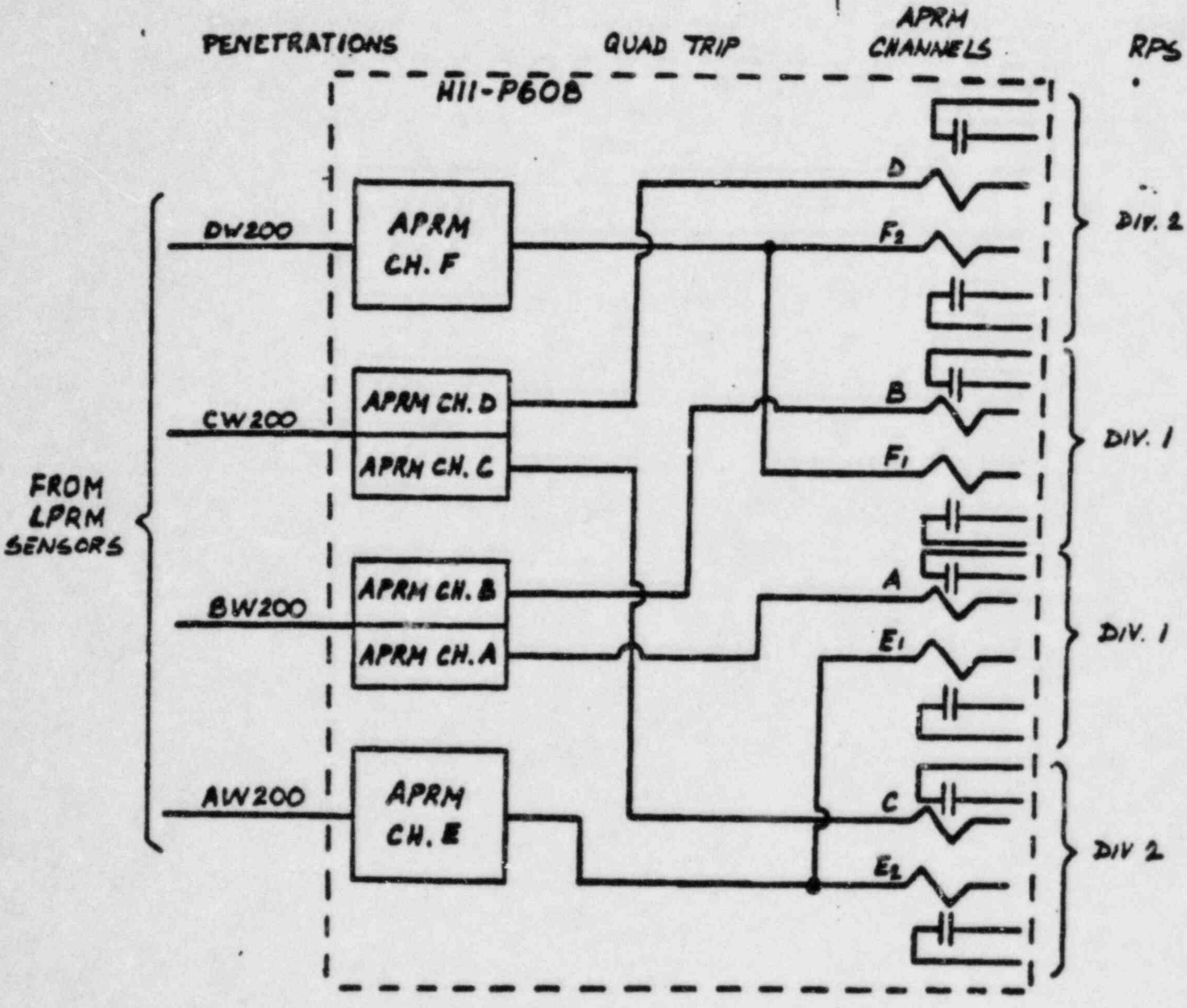

FIGURE 3 - APRM/RPS Signal Separation

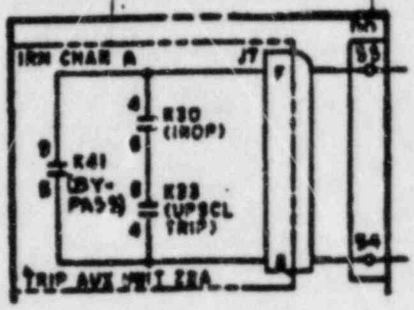

FIGURE 4 - IRM Channel A

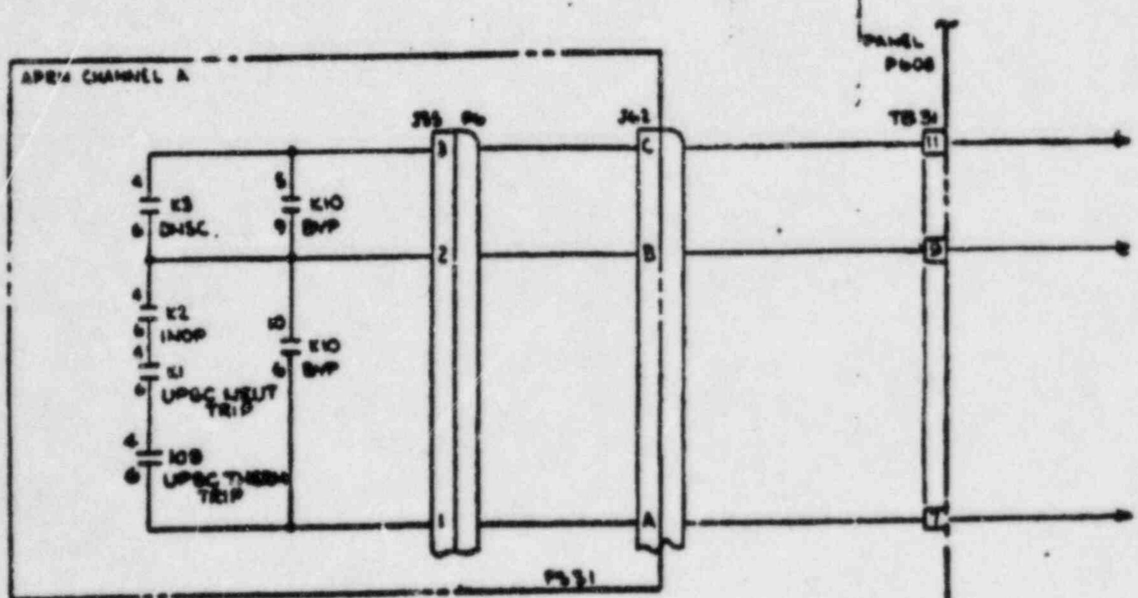

FIGURE 5 - APRM Channel A

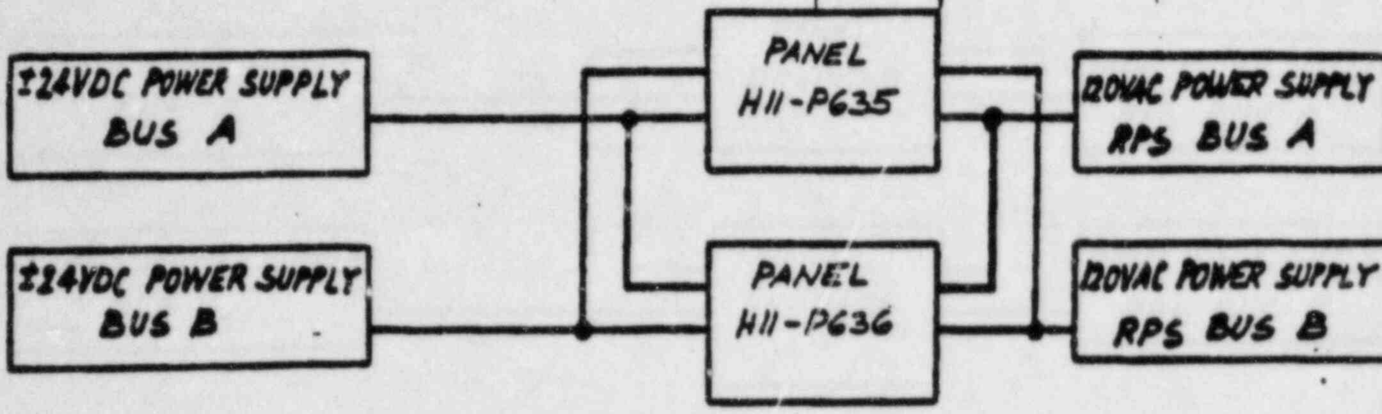

FIGURE 7 - Radiation Monitoring Panels Power Sources

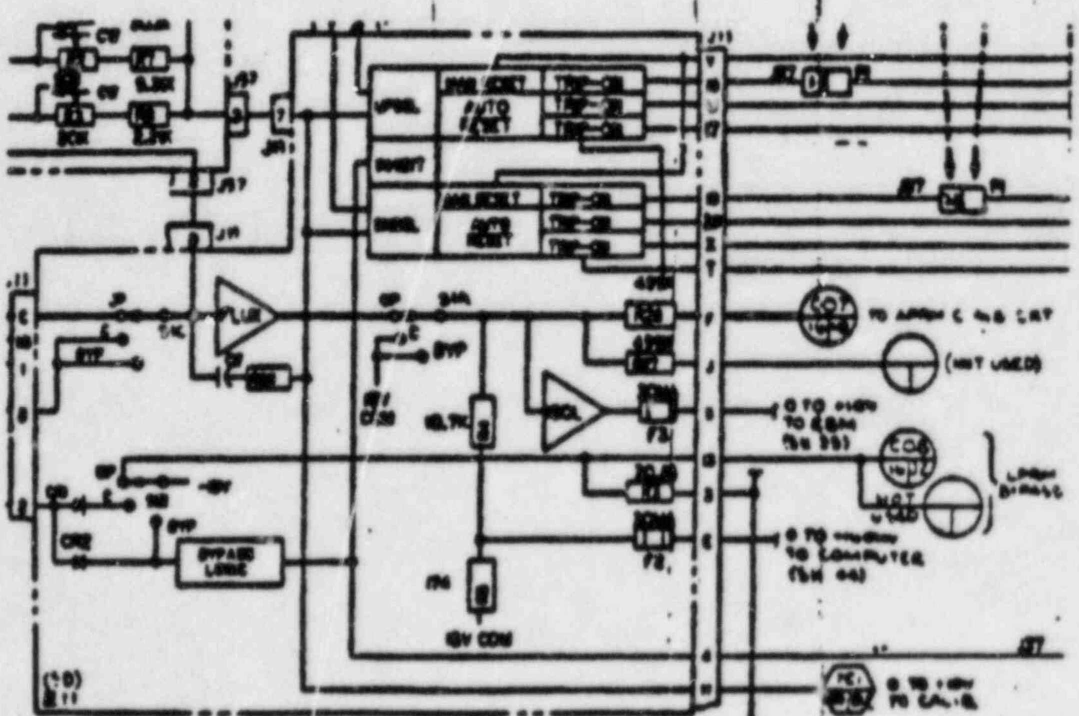

FIGURE 8 - LPRM Circuit Card