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GPU Nuclear

MDD-OC-622-C DIV I

DIVISION I
MODIFICATION DESIGN DESCRIPTION
FOR

REPLACEMENT OF RECIRCULATION FLOW

MONITORING ELECTRONICS

(NUCLEAR SAFETY RELATED)

OYSTER CREEK GENERATING STATION

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TITLE
REPLACEMENT OF RECIRCULATION FLOW MONITORING ELECTRONICS

REV	SUMMARY OF CHANGE	APPROVAL	DATE
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1.0 PURPOSE AND SCOPE

The existing recirculation (recirc) flow monitoring electronics have had a history of problems mainly due to the age of the equipment. These problems include poor drift characteristics, difficulty in calibrating the system, and a lack of available spare parts. The drift problem with the electronics prevents them from being able to support a 24 month fuel cycle. System calibration must be performed with the plant shut down. The procedure can last for several days.

This modification replaces the existing recirc flow monitoring electronics with state-of-the-art hardware. This replacement includes the 10 flow transmitters (2 for each of the 5 recirc loops) and electronics on control room panels 3R and 5R. Control room equipment being replaced by this modification includes the transmitter power supplies (2), square root converters (10), summers (4), and the Average Power Range Monitor (APRM) flow units (2 flow converters, 2 power supplies).

2.0 REFERENCES

Unless otherwise specified, revisions of documents invoked below are the latest as defined by CARIRS at the time of the baseline engineering release.

2.1 1000-PLN-7200.01, "GPUNC Operational Quality Assurance Plan for Three Mile Island Unit 1 and Oyster Creek"

2.2 SP-9000-44-001, "Specification for Instrument and Control Equipment Mounting and Tubing Installation"

2.3 GPUN Engineering Standard ES-008, "Human Engineering Guide - Oyster Creek"

2.4 GPUN Engineering Standard ES-027, "Environmental Parameters - Oyster Creek NGS"

2.5 SQUG Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment

2.6 Oyster Creek Updated Final Safety Analysis Report:

Sections	Tables
7.2.1.1.1	Table 7.2-1
	Table 7.2-2
7.5.1.8.7	Table 7.5-2
7.6.1.1.4	Table 7.6-4

2.7 Oyster Creek Technical Specifications:

Sections	Tables
2.3 A/B/O	Table 4.1.1
2.3 Bases	

2.8 SP-9000-41-005, "Installation Specification for Cables and Raceways at Oyster Creek Nuclear Generation Station"

2.9 GPUN Engineering Procedure EP-011, "Methodology for Preparing the Quality Classification List"

2.10 GPUN Document 990-1468, "Oyster Creek Electrical Equipment Environmental Qualification Master List"

2.11 Regulatory Guide 1.29, "Seismic Design Classification", 1978

2.12 Regulatory Guide 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants", 1988

2.13 IEEE 344, "Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations", 1987

2.14 SDBD-OC-641, Rev. 1, "System Design Basis Document for the Reactor Protection System"

3.0 FUNCTIONS

The recirc flow monitoring system provides inputs to the Reactor Protection System (RPS) as discussed in the RPS System Design Basis Document (SDBD Ref. 2.14). The functions of the existing system are described below and are shown in block diagram form in Figure 1.

3.1 The recirc flow electronics consists of two independent divisions. Each division monitors the differential pressure (dP) in the five reactor recirculation loop venturis and converts the dP signals into flow signals by a square root function. Individual flow signals from division 1 are provided to the plant computer. Individual flow signals from division 2 are provided to indicators on the control room panel 3F.

3.2 The electronics in each division sum the individual flow signals to produce a total recirc flow signal from each division. The total flow signal from division 1 is provided to the following locations:

a) Flow recorder on panel 3F
b) The division 2 flow converter (for comparator function)
c) APRM 1,2,3, & 4 trip bias units
d) Meter on division 1 flow converter power supply module

The total flow signal from division 2 is provided to the following locations:

a) Total flow indicator on panel 4F
b) The division 1 flow converter (for comparator function)
c) APRM 5,6,7, & 8 trip bias units
d) Meter on division 2 flow converter power supply module

3.3 The electronics in each division provide the following trip functions:

a) Upscale Trip - This half scram function is designed to initiate on high flow. This trip also results in a rod block, illumination of the UPSCALE and INOP lights on the flow converter module, and the APRM FLO BIAS OFF NORMAL annunciator alarm on Panel G-5-f. The following conditions initiate an Upscale Trip:

* Total flow $\geq$114% $\pm$ 1% rated (177,600 GPM)
* Mode switch not in OPERATE position

* Loss of power (trip is initiated but status lights do not illuminate due to power loss)

b) Comparator Trip - This rod block function is designed to detect a mismatch between divisions. This trip also results in the illumination of the COMP and INOP lights on the flow converter module, and the APRM FLO BIAS OFF NORMAL annunciator alarm on Panel G-5-f. The following conditions initiate a Comparator Trip:

* Flow mismatch between divisions $\geq$10% $\pm$ 1% rated (16,000 GPM)
* Loss of power (trip is initiated but status lights do not illuminate due to power loss)

The Upscale and Comparator Trips reset automatically when flow conditions return to normal. The status of the trips indicated at the flow converter module must be manually reset. The above trip functions can be tested using internal calibration signals.

3.4 The new system configuration performs the above functions with some exceptions and enhancements. These include the following:

Exceptions

a) External test signals are required to test the trip functions.

b) The indicator built in to the flow converter power supply is not incorporated into the new system.

c) The Mode switch on the flow converter, and the meter switch on the flow converter power supply are not needed in the new system configuration.

Enhancements (See figures 2.1 and 2.2 for details)

a) "Smart" transmitters are used which incorporate the square root function. This reduces the number of modules required in the control room. The smart feature also allows simplified calibration of the control room electronics.

b) Test blocks are added to the Foxboro electronics where needed to facilitate surveillance and calibration using external test signals. These test blocks are shown on figures 2.1 and 2.2.

c) The total flow signal between divisions (used for comparator function) is provided through isolators to ensure separation between RPS divisions.

d) Trip Functions

* Upscale Trip

The Upscale trip remains unchanged except for the trip status indication The Inop light does not illuminate due to an Upscale trip.

* Comparator Trip

The Comparator trip remains unchanged except for the trip status indication. The Inop light does not illuminate due to a Comparator trip.

* Inop Trip

Each division of the Foxboro electronics consists of two nests. Each nest contains an individual nest power supply. A power supply failure in the lower nest results in a fail safe Upscale and Comparator trip when the relays de-energize. The trip status lights do not illuminate due to the power loss. This is essentially unchanged from the existing system configuration.

A total flow voltage signal (2.5-12.5 V) from the upper nest is monitored by an alarm module in the lower nest. If this signal falls below the 2.5V zero flow level (setpoint to be determined by calculation), an Inop trip is initiated. This would be an indication of a power supply or module failure. The logic for this trip function is shown in figure 3. The Inop trip results in the same actions as the existing Upscale trip with the exception of the trip status indication. If power is not lost, the Inop light is the only indicator that illuminates due to an Inop trip.

4.0 DESIGN REQUIREMENTS

4.1 Licensing and Regulatory Requirements

The design and installation of the flow transmitters and control room electronics will comply with IEEE 344 (Ref. 2.13). IEEE 323 does not apply to this modification since all components are located within a mild environment and are not contained within the EQ Master List (Ref. 2.11). Regulatory Guides 1.29 and 1.100 (Refs. 2.11 & 2.12) apply to the recirc flow portion of the Reactor Plant Instrumentation system (RPIS) being impacted by this modification.

4.2 Process and Operational Requirements

The design of the modification must not reduce the capability of the recirc flow monitoring system to be able to perform its function as defined in the Oyster Creek Technical Specifications (Ref. 2.7) and the Updated Final Safety Analysis Report (UFSAR)(Ref. 2.6).

4.3 Configuration and Essential Features

The design of this modification shall be in accordance with the requirements of SP-9000-44-001 (Ref. 2.2) for the installation of the new flow transmitters at RK-04. The control room electronics are installed in the standard 19" racks in control room panels 3R and 5R. Existing field wiring is reused as much as practical. New wiring and flexible conduit at the transmitters, and new wiring in the control room panels shall be in accordance with SP-9000-41-005 (Ref. 2.8). Existing separation will be maintained or enhanced.

4.4 Interfacing Systems

4.4.1 Main Control Room Panels (611)

The new electronics are mounted in the control room panels 3R and 5R where the old equipment was located. Additional vacant space below is also utilized.

4.4.2 Local Control/Instrument Racks (614)

The new flow transmitters are mounted in place of the old transmitters at RK-04 in the reactor building north west corner room, elevation (-)1'-11".

4.4.3 Plant Annunciator System (616)

Outputs from the recirc flow monitoring electronics produce the APRM FLO BIAS OFF NORMAL annunciator alarm on Panel G-5-f as discussed in section 3.3. The Inop trip is a new initiating condition for this alarm along with the existing Upscale and Comparator Trip.

4.4.4 Core Monitoring System (621)

The recirc flow monitoring system provides total flow voltage signals to the Average Power Range Monitor (APRM) system. The APRM trip bias units use this signal to determine the flow biased rod block and scram setpoints.

4.4.5 Reactor Plant Instrumentation (622)

The equipment replaced by this modification monitors the flow through the reactor recirculation loops. Division 1 of the recirc flow monitoring electronics provides a total flow signal to a recorder on panel 3F. Division 2 provides individual loop flow signals to indicators on panel 3F, and a total flow signal to an indicator on panel 4F.

4.4.6 Reactor Manual Control System (628)

Outputs from the recirc flow monitoring system provide a control rod withdrawal block in the reactor manual control system as discussed in section 3.3. This rod block function is provided based on a comparison between the division 1 and division 2 total flow signals. The total flow signal from each division to the other is provided through class 1E isolators to ensure division separation.

4.4.7 Reactor Protection System (641)

Outputs from the recirc flow monitoring system provide a reactor scram in the reactor protection system as discussed in section 3.3.

4.4.8 Plant Computer System (651)

The existing recirc flow monitoring system provides individual loop flow signals from division 1 to the plant computer. This interface remains unchanged with the new system configuration.

4.4.9 120V AC Vital Power System (733)

Division 1 of the recirc flow monitoring system is powered from 120V AC protection system panel 1 (PSP 1, Ckt. 7). Division 2 is powered from PSP 2 (Ckt. 9). This modification does not change the source of power to the divisions.

4.4.10 Cable, Raceway, and Conduit Systems (770)

The cables connecting the flow transmitters to the control room electronics travel through this system. Existing cables between the terminal boxes at RK-04 and the control room are reused. New wires are used to connect the transmitters to these local terminal boxes. New flex conduit is used between the transmitters and the panel. This modification has no impact on the cable, raceway, and conduit system.

4.5 Structural Requirements

This modification replaces existing flow transmitters and control room electronics. Seismic class 1 integrity of equipment and supports must be maintained. Supports for and/or mounting of components for this modification shall be seismically qualified using SQUG methodology (Ref. 2.5).

4.6 Mechanical Requirements

The replacement of the recirc flow transmitters requires replacement of tubing connecting the existing valve manifolds to the flow transmitters. The transmitter and tubing installation shall be in accordance with SP-9000-44-001 (Ref. 2.2).

4.7 Electrical Requirements

To the extent possible, existing field cable shall be reused for the electrical installation of the control room electronics. The affected control room wiring will be removed back to the vertical terminal strips located behind the panels. Some existing field wiring is terminated directly to plug type connectors. These wires will be cut and landed on existing spare terminals on the vertical terminal strips. Any necessary splicing shall be performed in accordance with SP-9000-41-005 (Ref. 2.8).

Two existing field cables (single conductor shielded) routed between divisions are being replaced by two new cables (twisted shielded pair). This new field wiring shall be in accordance with the requirements of SP-9000-41-005 (Ref. 2.8).

Wiring between the transmitters and the local terminal boxes at RK-04 is being replaced with new wiring. This wiring shall be in accordance with the requirements of SP-9000-41-005 (Ref. 2.8).

4.8 Instrumentation and Control

The replacement electronics perform the same basic functions as the existing system. Enhancements provide simplified calibration and troubleshooting using the dP transmitter smart feature. The configuration of the electronics is shown in Figure 2.1 and 2.2 and is described below.

a) Differential pressure signals are square rooted at the flow transmitters to convert the dP signals to individual loop flow signals.

b) These individual loop flow signals are sent to the control room to be processed by the new electronics. From there the individual loop flow signals are sent to indicators on panel 3F (division 2) and to isolators for the plant computer (division 1).

c) The individual loop flow signals are summed in each division to produce total recirc flow signals. The total flow signal from division 1 is sent to a recorder on panel 3F. The total flow signal from division 2 is sent to an indicator on panel 4F. The total recirc flow signals from both divisions is sent to Foxboro alarm modules, to 4 APRM trip bias units, and to the other system via class 1E Foxboro isolators.

d) The Foxboro alarm modules provide the high flow scram, inop scram, and the flow mismatch rod block functions discussed in e), f), and g) below.

e) Excess total recirculation flow results in an upscale trip (scram) in a 2 out of 2 logic configuration.

f) Loss of 120V AC power, failure of either nest power supply, or a downscale total flow voltage signal (<2.5V) results in an inop trip (scram) in a 2 out of 2 logic configuration.

g) Total flow mismatch between divisions results in a comparator trip (rod withdrawal block) in a 1 out of 2 logic configuration.

h) The conditions in e),f), and g) result in the APRM FLO BIAS OFF NORMAL annunciator alarm on panel G-5-f.

The Oyster Creek technical specifications (Ref. 2.7) require calibration by application of a test pressure once per 20 months. However, the new system is capable of supporting a 24 month fuel cycle.

4.9 Environmental Conditions

The environmental parameters for Oyster Creek are discussed in engineering standard ES-027 (Ref. 2.4).

The location of the new flow transmitters places them in EQ zone 37 (RB NW corner room, El. (-)1'-11", RK-04). This area is considered a mild environment during normal operation. The recirc flow transmitters are not required to function during conditions that produce a harsh environment in this area. The replacement transmitters do not impact the existing provisions at this location.

The Rosemount transmitters are capable of operation under the mild environmental conditions which are discussed below.

The new electronics are located in the control room which is a mild environment (EQ zone V). The Foxboro electronics are capable of operation under these environmental conditions which are discussed below.

Oyster Creek Environmental Conditions

Parameter	RB NW Corner Room	Control Room
Aging Temperature:	85°F	80°F
Pressure:	14.7 psia	14.7 psia
Humidity:	100% RH	100% RH
Radiological:	7.9×10^3 Rad	Negligible

4.10 Thermal Requirements

The new control room electronics have less than 200 watts of thermal output per division. This has a negligible impact on the control room HVAC. Otherwise, there are no other impacts on thermal requirements.

4.11 Materials

Material requirements are compatible and consistent with existing equipment and with plant requirements.

4.12 Maintenance

The new transmitters are installed on RK-04. No change to access or space requirements will be made or are necessary at this location.

The control room electronics are installed in panels 3R and 5R. Access to this equipment requires removal of a transparent cover plate that serves to protect the equipment. Routine preventative maintenance will be done in accordance with site I&C maintenance procedures prepared based on manufacturers recommendations.

4.13 Surveillance and In-Service Inspection

The existing electronics are calibrated once per 20 months per the Oyster Creek technical specifications (Ref. 2.7). A quarterly surveillance is also performed to test the trip points.

The new equipment will be calibrated in accordance with the requirements of the Oyster Creek Technical Specifications.

4.14 Testing Requirements

The new recirc flow monitoring system will have site acceptance testing to verify operability. This will include simulation of inputs and verification of outputs.

The testing will include the following:

a) Verification of proper flow signals (individual loop and total flow) based on actual or simulated flow input signals

b) Verification of proper flow indication (flow indicators, recorder, and plant computer)

c) Verification of proper trip functions at the appropriate setpoints and upon loss of power or downscale (inop)

d) Proper operation of the flow biased rod block and scram functions within the APRMs

4.15 Human Factors

Panel layout and labeling subject to Human Factors review in accordance with ES-008 (Ref. 2.3). No annunciator points are being added or deleted; however, an inoperative trip function is being added to the initiating causes of this alarm. This new trip must be incorporated along with the upscale and comparator trip into the alarm response procedure.

4.16 Safety, Health, and Security Requirements

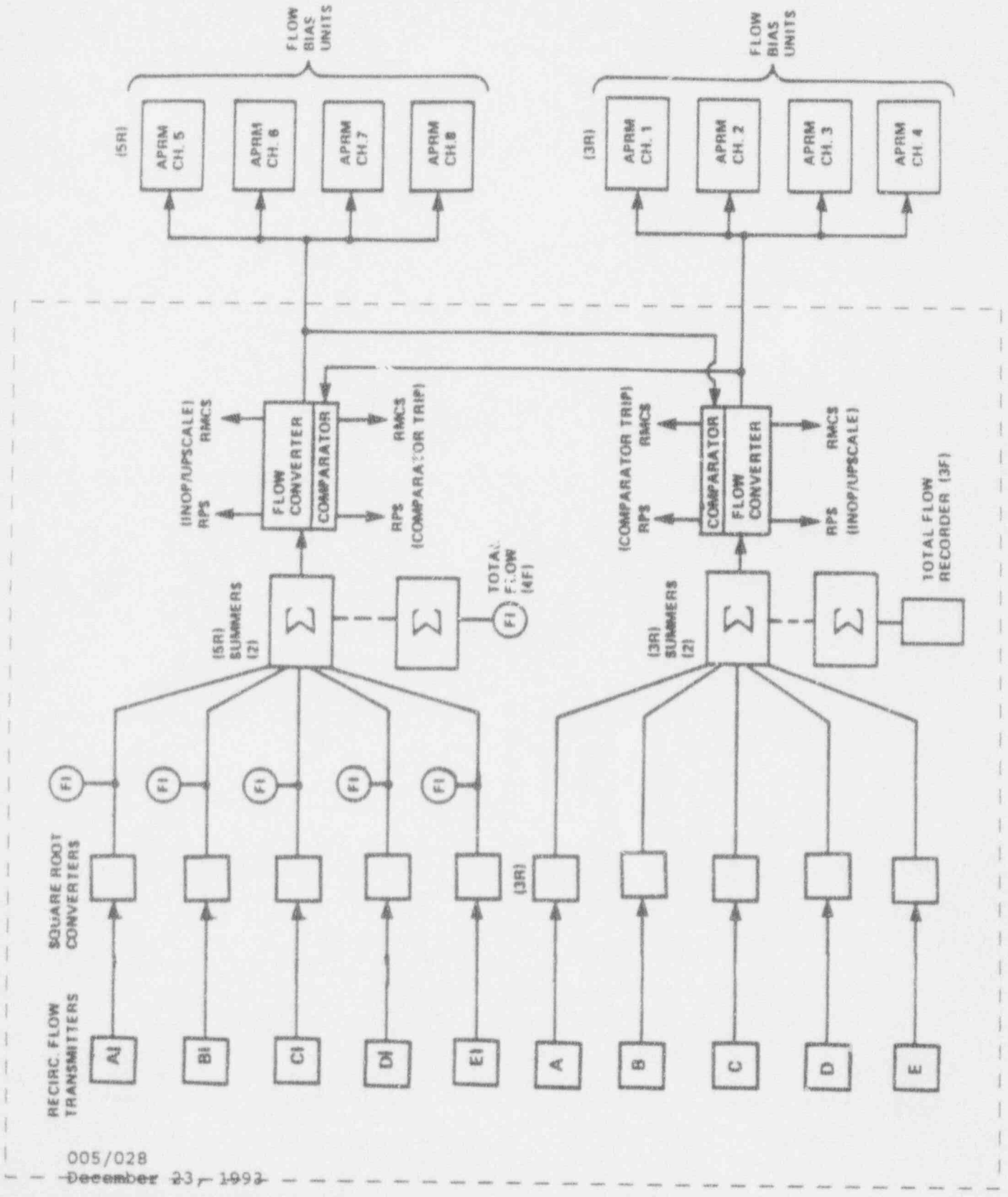
These are not a consideration for this modification.

4.17 Quality Classification/Assurance

The recirc flow monitoring system is classified as Nuclear Safety Related (NSR) in EP-011 (Ref. 2.9). The design of this modification must comply with the requirements of the GPUN Operational Quality Assurance Plan (Ref. 2.1). System and component classifications are unchanged by this modification.

FIGURE 1

Processing of Recirculation Flow Signals



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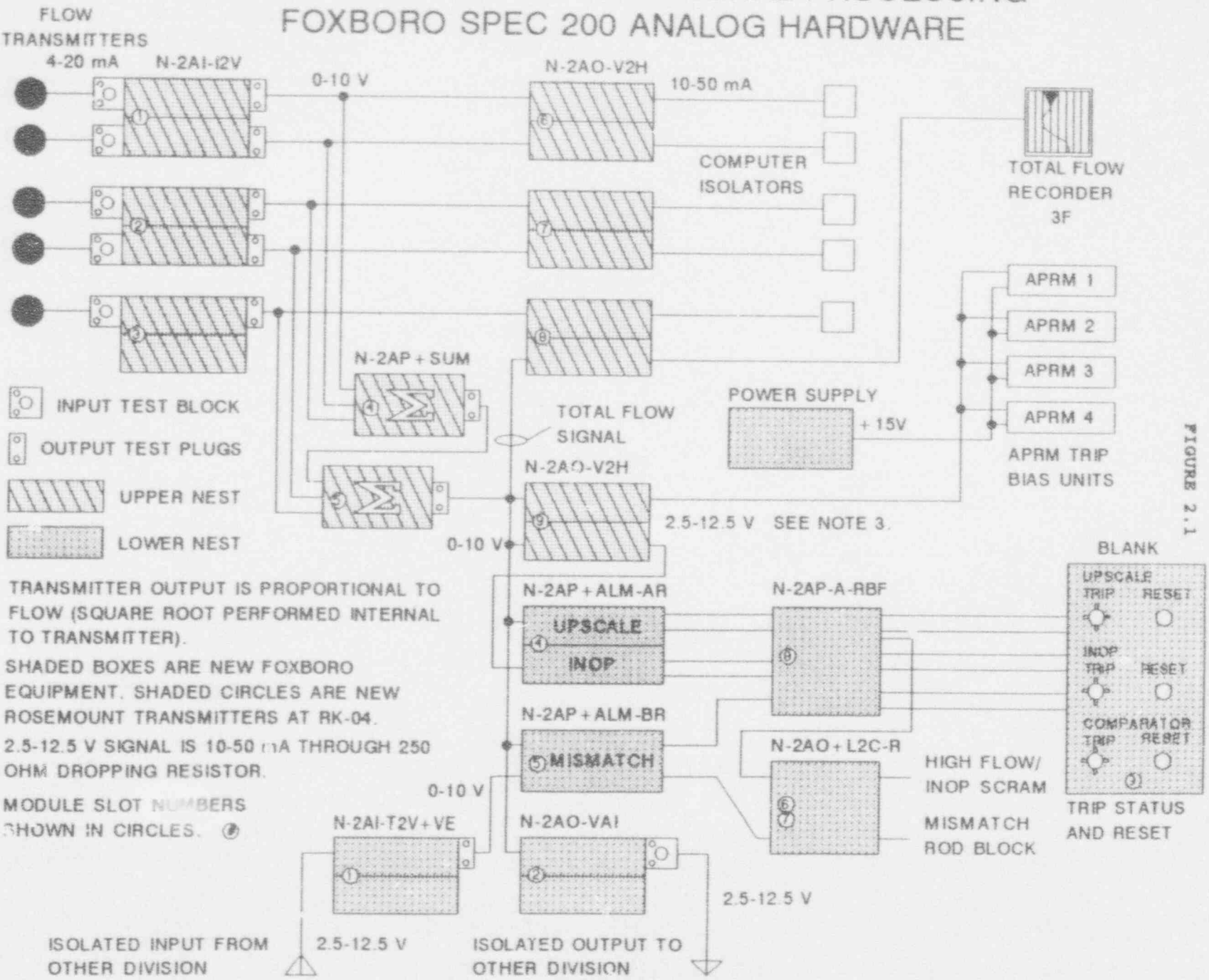
~~December 23, 1992~~

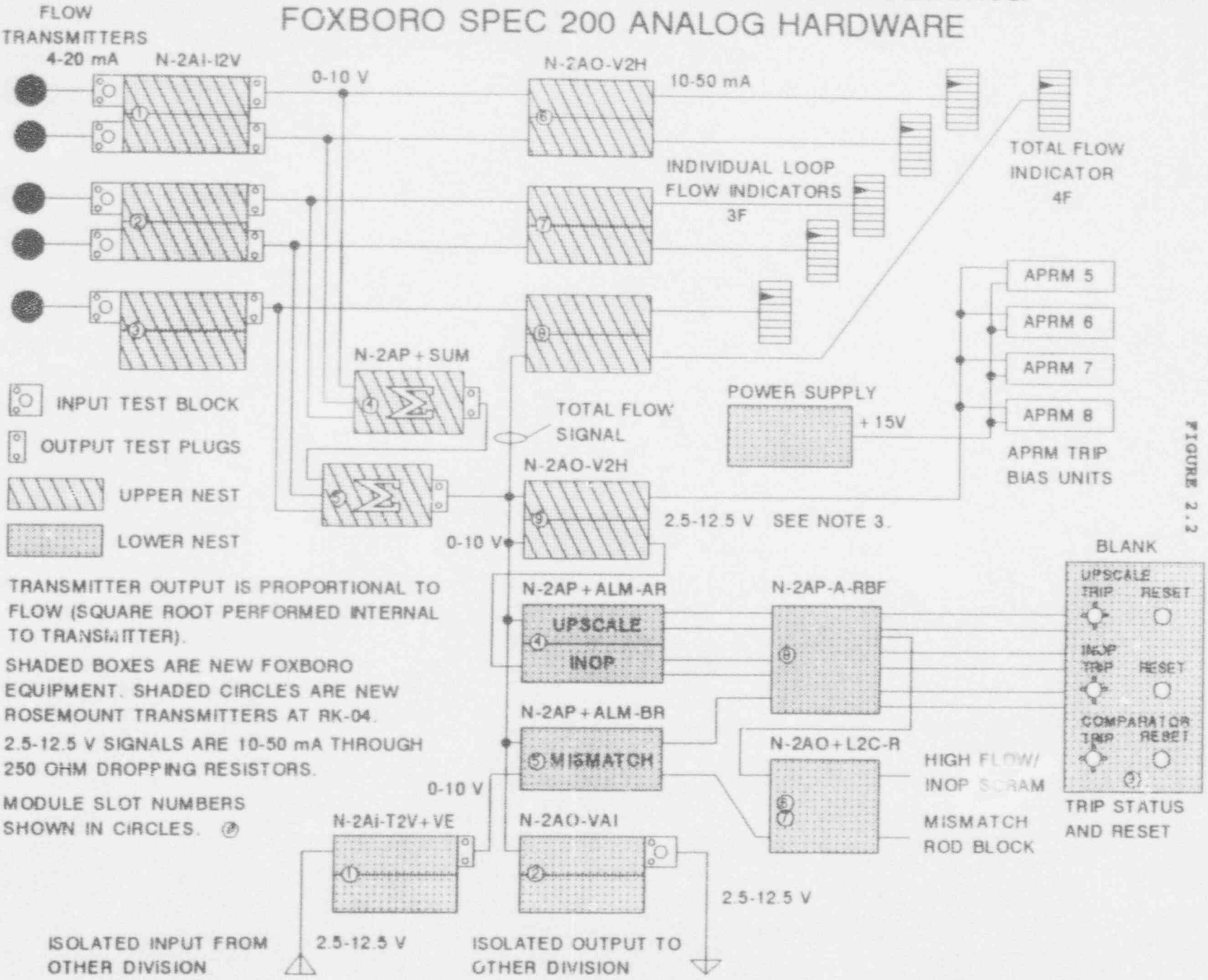
DIVISION 1 RECIRC FLOW SIGNAL PROCESSING
FOXBORO SPEC 200 ANALOG HARDWARE



1. TRANSMITTER OUTPUT IS PROPORTIONAL TO FLOW (SQUARE ROOT PERFORMED INTERNAL TO TRANSMITTER).
2. SHADED BOXES ARE NEW FOXBORO EQUIPMENT. SHADED CIRCLES ARE NEW ROSEMOUNT TRANSMITTERS AT RK-04.
3. 2.5-12.5 V SIGNAL IS 10-50 mA THROUGH 250 OHM DROPPING RESISTOR.
4. MODULE SLOT NUMBERS SHOWN IN CIRCLES.

FIGURE 2.1

DIVISION 2 RECIRC FLOW SIGNAL PROCESSING
FOXBORO SPEC 200 ANALOG HARDWARE



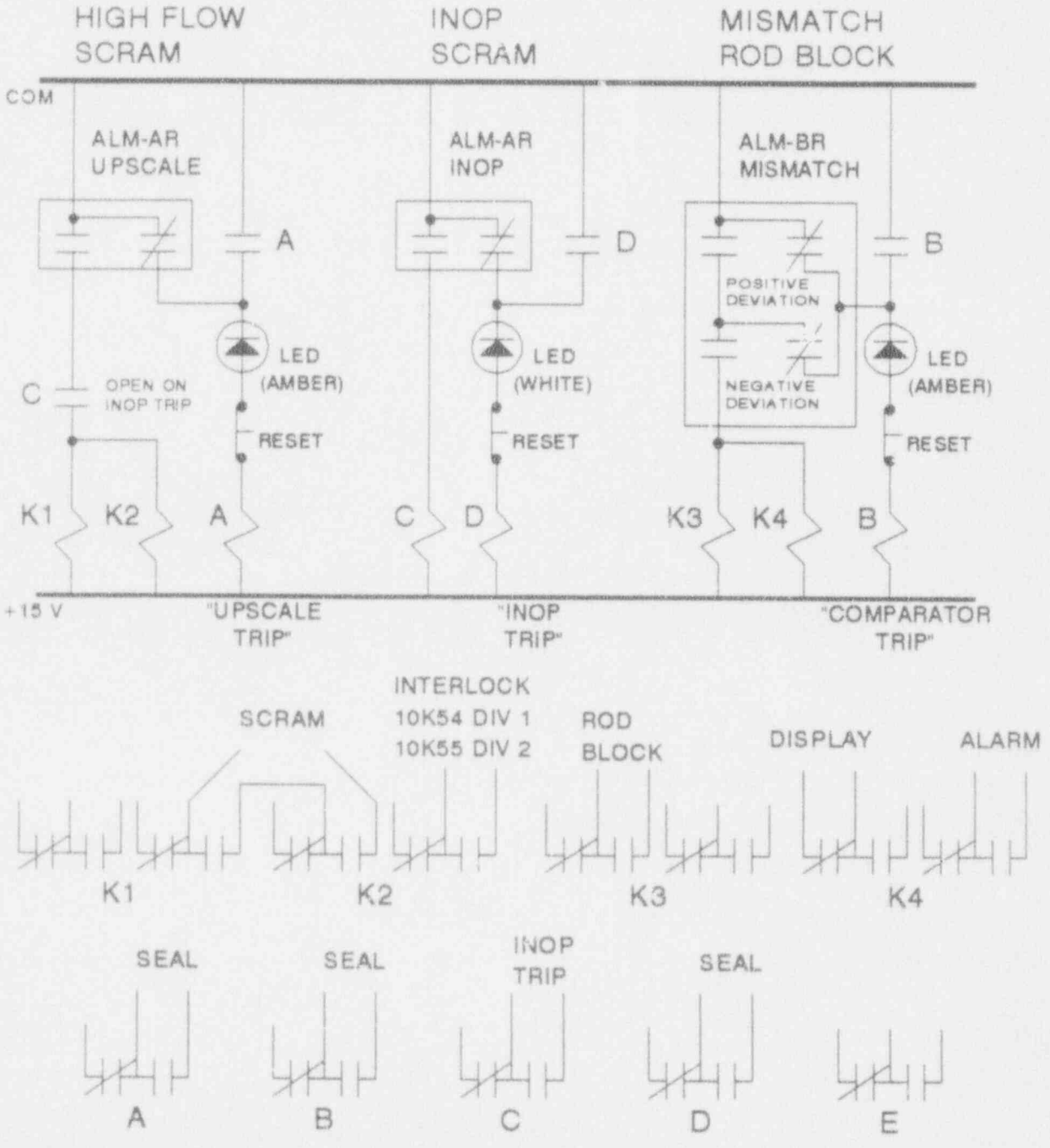
1. TRANSMITTER OUTPUT IS PROPORTIONAL TO FLOW (SQUARE ROOT PERFORMED INTERNAL TO TRANSMITTER).
2. SHADED BOXES ARE NEW FOXBORO EQUIPMENT. SHADED CIRCLES ARE NEW ROSEMOUNT TRANSMITTERS AT RK-04.
3. 2.5-12.5 V SIGNALS ARE 10-50 mA THROUGH 250 OHM DROPPING RESISTORS.
4. MODULE SLOT NUMBERS SHOWN IN CIRCLES. Ⓐ

FIGURE 2.2

RFDIV2

FIGURE 3

RELAY LOGIC FOR UPSCALE, INOP AND COMPARATOR TRIP FUNCTIONS



1. RELAYS K1-K4 ARE PART OF N-2AO+L2C-R. DEENERGIZE TO TRIP.
2. RELAYS A-E ARE PART OF N-2AP-A+RBF. A, D, & B ENERGIZE TO INDICATE TRIP.
3. RESET SWITCHES AND LEDS ARE MOUNTED ON BLANK MODULE IN LOWER NEST.
4. FOXBORO ALARM MODULES SHOWN IN TRIPPED CONDITION.