SCRAM INSTRUMENT VOLUME

DIVERSE INSTRUMENTATION

FOR

J. A. FITZPATRICK NUCLEAR PLANT

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POWER AUTHORITY OF THE STATE OF NEW YORK

ATTACHMENT TO JPN-83-41

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ILLUSTRATIONS

1. INTRODUCTION

A Scram Instrument Volume Diverse Instrumentation (SIVDI) design is proposed for the Fitzpatrick Nuclear Plant. This design modification establishes diverse and redundant water level instrumentation for the SIV reactor protection system (RPS) trip function. The design will also add diverse instrumentation to the SIV level rod block and alarm. The SIVDI has been developed in order to meet the requirements of the USNRC Generic Safety Evaluation Report - BWR Scram Discharge System, December 1, 1980 (Ref. 1).

2. DESIGN REQUIREMENTS

2.1 Functional Requirements

The SIVDI shall measure water level in the scram instrument volume and shall cause a high level alarm, rod block, and reactor scram at specific level setpoints.

Redundancy shall be provided in the automatic scram channel for each instrument volume to meet the single failure criteria. Diversity shall be implemented through the use of float switches and two analog transmitters for each instrument volume.
The design includes a half scram signal to be initiated whenever one channel is out of service for calibration or repair. A high level alarm and rod block will be actuated by water accumulated in either instrument volume prior to the RPS trip.

The SIVDI design requirements have been extracted from Reference 1 as follows:

(1) Redundancy shall be provided in the automatic scram (RPS) level instrumentation to meet the single failure criterion for each instrument volume.

(2) Diversity in the automatic scram (RPS) level instrumentation for each instrument volume shall be implemented through the use (Reference 2 and 3) of float switches and two channels of analog (differential pressure) transmitters.

(3) Common mode failure shall be taken into consideration when selecting the hardware for this system.

(4) The design shall include a half scram signal to be initiated when one RPS level channel requires repair or replacement.

(5) Both instrument volumes shall be instrumented to provide detection of water (alarm) prior to the scram initiation.

2.2 Environmental Requirements

All equipment to be supplied shall be classified as "Important to Safety" and shall be qualified to References 4, 5 and 6. The environmental conditions to which the transmitters were qualified is shown on Table 2-1, Part A. The trip units and relays are qualified to the control room environment shown in Table 2-1, Part B.

Table 2-1

ENVIRONMENTAL QUALIFICATION REQUIREMENTS

Environment or Conditions	Part A Reactor Building with High Energy Lines	Part B Control Room or Relay Room
Temperature Normal Abnormal	40°F Minimum 120°F Normal 150°F Maximum for one day per year Duration: For Equipment Qualified Life	40°F Minimum 90° Normal 104° Maximum for one day per year Duration: For Equipment Qualified Life
DBE	Figure 2-1	120°F for 8 hours
Static Pressure		
Normal	± 2 psig	± 2 psig
Abnormal	None	None
DBE	+35 psig for 1 hour 2 psig for next 24 hours	
Relative Humidity		
Normal Abnormal	20% Minimum 50% Normal 90% Maximum for one day per year	20% Minimum 50% Normal 90% Maximum for one day per year
DBE	Steam for six hours followed by 100% for 18 hours	95% for 8 hours
Radiation		
Normal	6×10^6 Rad total integrated dose, gamma accumulated in a 40 year life	2.0×10^4 Rad total integrated dose gamma, accumulated in a 40 year life.
DBE	3.8×10^7 Rad Gamma TID	None

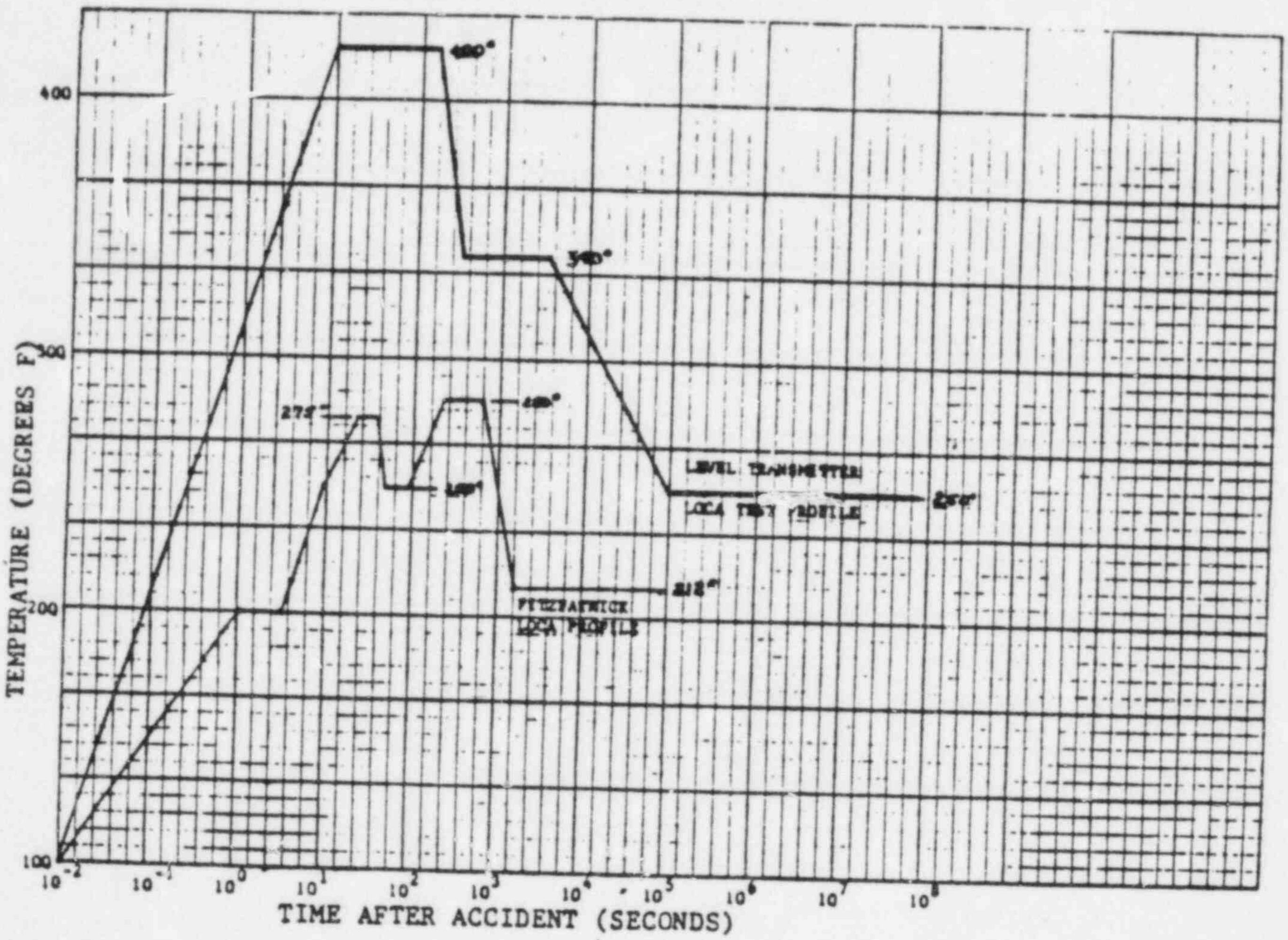

Figure 2-1 DBE Temperature Profile

3. TECHNICAL DESCRIPTION

3.1 System Design

The SIVDI is designed to provide the diverse and redundant water level monitoring for the RPS SIV trip function. The design also provides diverse instrumentation to the SIV water level rod block and alarm. The system utilizes cabinet space and components in an Analog Transmitter Trip System which interfaces with the Reactor Protection System and Manual Reactor Control System.

A new channel of water level measurement instrumentation on the instrument volume consists of an analog level transmitter, a master trip unit and associated relays. The relays will combine the logic of water level switches with the new trip channel signals. Rod block and alarm signals will be produced from slave trip units driven by the master trip units. A slave trip unit monitors the output of each master trip unit in the level channel connected to the instrument volume.

The system block diagram is shown in Figure 3-1. Scram initiating float switches are denoted A-D while transmitters being added are donoted A'-D'. Figure 3-2 illustrates how the level transmitters and level switches interface with the instrument volume.

3.2 Instrumentation

A typical SIVDI instrument channel is shown in Figure 3-3. The level detectors are reverse acting differential pressure transmitters with sealed sensors. A 4-20 milliamp (mA) current is produced in proportion to the level in the instrument volume. The power supply for the transmitters is 24 VDC supplied through the Analog Trip System (ATS) master

trip units. There is one master trip unit for each transmitter. The master trip unit monitors this current and, at a preset value, provides a 24 VDC signal to the trip relay in the Analog Trip Cabinet. Contacts in the relay open resulting in a trip signal to the RPS. The relay contacts are connected in one-out-of-two-twice logic with the existing level switches for each instrument volume. High water level in either instrument volume will cause a full reactor scram.

Instrument volume rod block, and alarm signals are initiated by slave trip units which monitor a 1-5 VDC signal from the master trip units and, at a preset value, trip relays in the Analog Trip Cabinet. Each slave trip unit monitors a different master trip unit. Contacts in one relay are connected into the alarm annunciator circuitry. The other is connected into the reactor manual control system for the rod block signal.

3.3 Process Sensors

The level transmitters provided use remotely mounted sensor assemblies to detect the process variable. Pressure changes are transmitted from a bellows in the sensor housing to the differential pressure measuring element by a fill liquid through capillary tubing. The configuration of the transmitter capillary tubing and sensor housing are shown in Reference 7. The sensor housing connected to the "high pressure" side of the transmitter shall be mounted at the lower tap on the instrument volume and shall be the reference leg of the system. The other sensor housing shall be connected to the "low pressure" side of the transmitter and shall be mounted at the upper tap. This will be the variable leg.

Both sensor housings are exposed to the pressure in the instrument volume equally thereby cancelling out the effect of a pressure buildup. Only the increase in water level in the instrument volume is sensed as a change in differential pressure between the variable and the reference leg. Minimum differential pressure occurs when the level in the instrument volume is up to the upper tap, that is, the reference leg is equal

5. CONCLUSIONS

The proposed SIVDI provides the diverse and redundant water level instrumentation for the scram instrument volume RPS function. The design will also add diverse instrumentation to the SIV level rod block and alarm. The logic of the previously installed water level switches along with the new trip channel signals will improve the reliability and performance of the SIV trip functions. The modification poses no unreviewed safety question or risk to the health and safety of the public, as discussed in Section 4.

to the variable leg.

The transmitters are calibrated such that when the instrument volume is empty, the maximum differential pressure is sensed and the transmitter current output is 4 mA. When level in the instrument volume is 50 inches above the lower tap, the transmitter current output is calibrated to be 20 mA. The instrument volume level sensed by transmitter A' is also sensed by float switch A. The float switch contact and the analog trip relay contact are wired in series so that high level detected by either device will cause a trip in one RPS channel. Placing the channel A trip unit in test or pulling the trip card out of its slot in the trip cabinet with the switch in "Normal" will also cause a trip in one RPS channel.

3.4 System Hardware Configuration

The level transmitter sensor housings are connected to the instrument volume upper and lower taps. The transmitters are to be locally mounted at an elevation near that of the lower tap. The capillary tubing between the sensor housing and transmitter is factory connected and filled. Capillary tubing must be secured to supports and protected from damage or kinking during installation and operation.

Wiring from the transmitter to the Analog Trip System cabinets shall be 18 AWG twisted shielded pair cable. The master and slave trip units shall be mounted in Analog Trip System RPS cabinets.

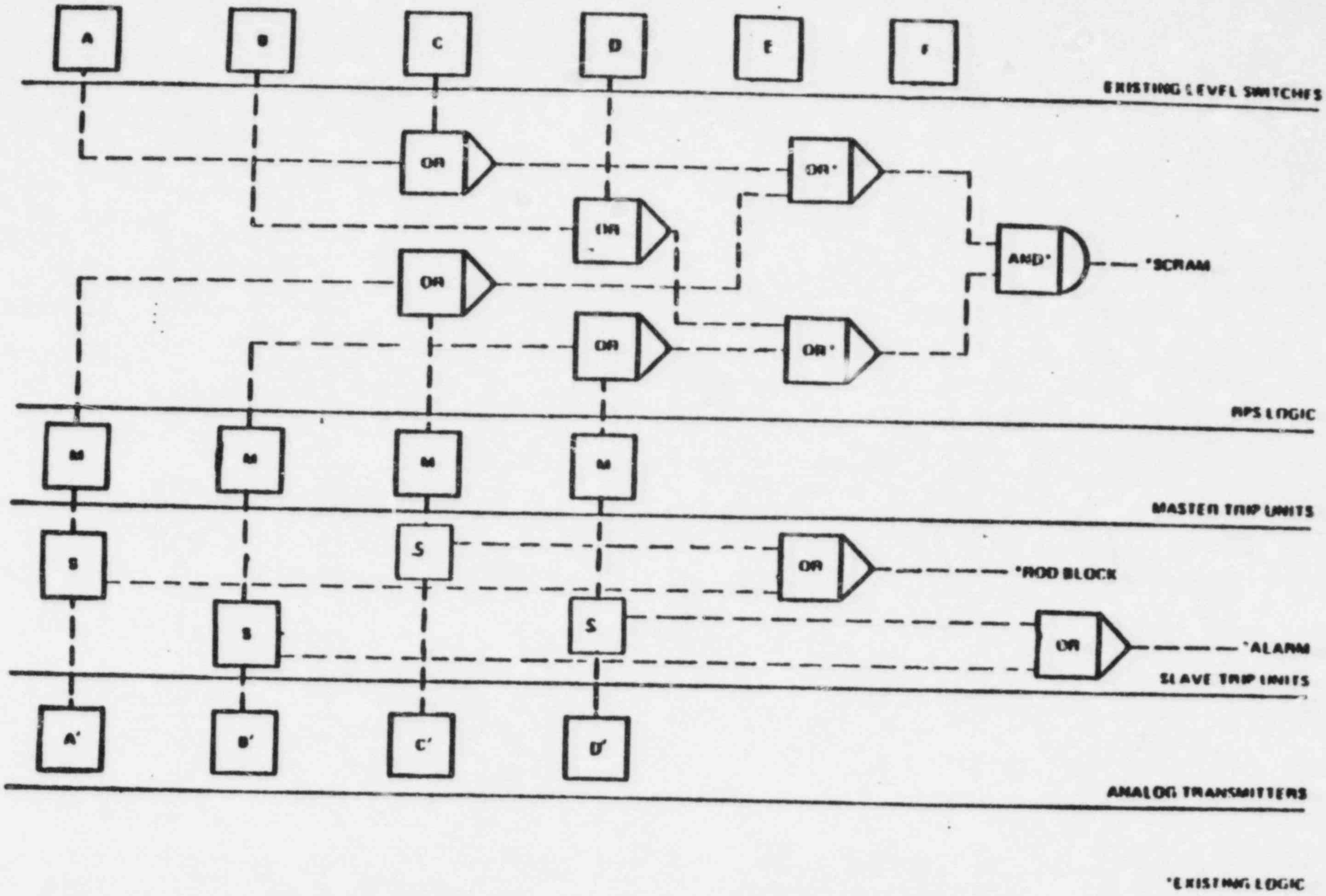

Figure 3-1. Instrument Logic Diagram

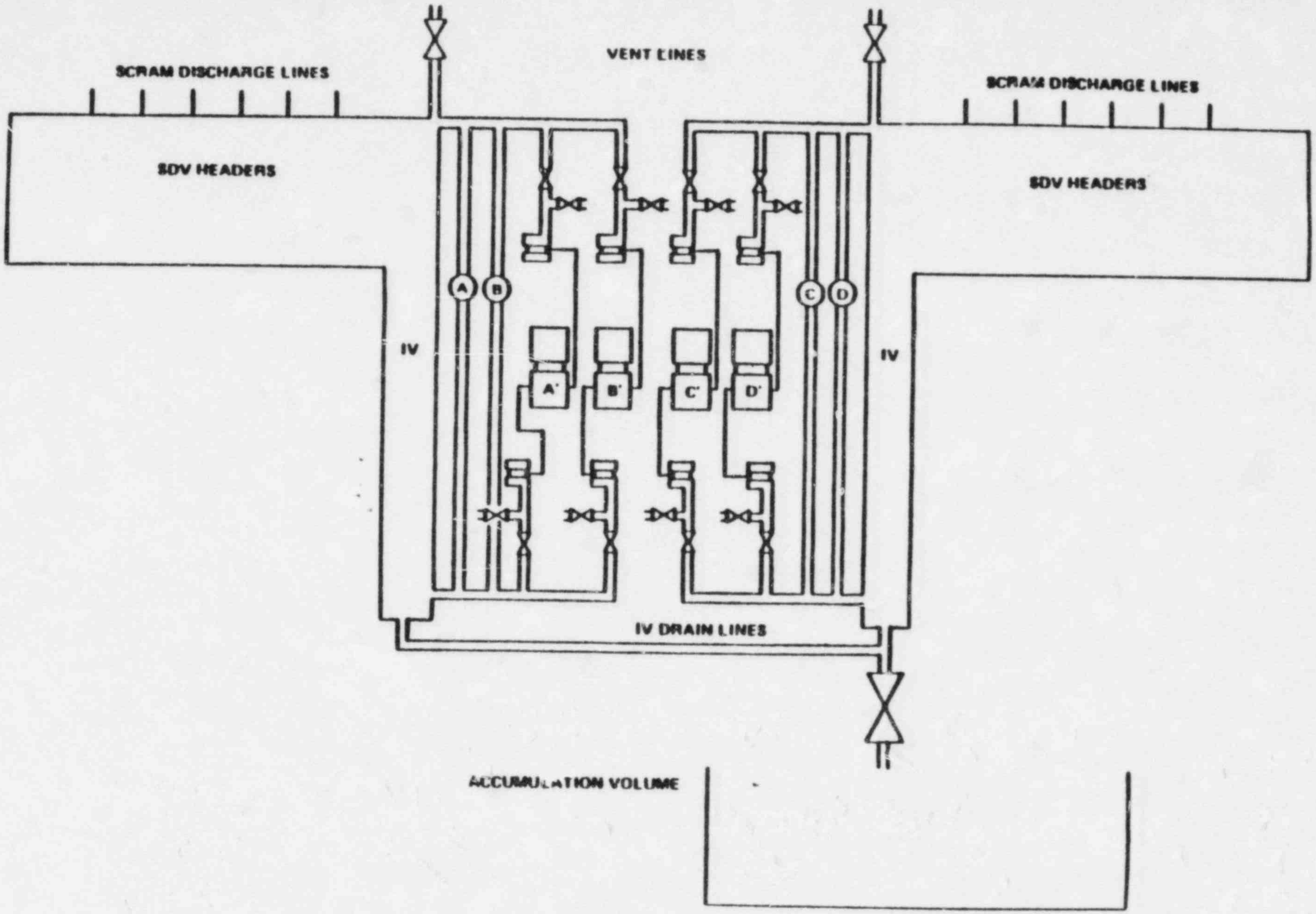

Figure 3-2. Water Level Measurement Instrumentation

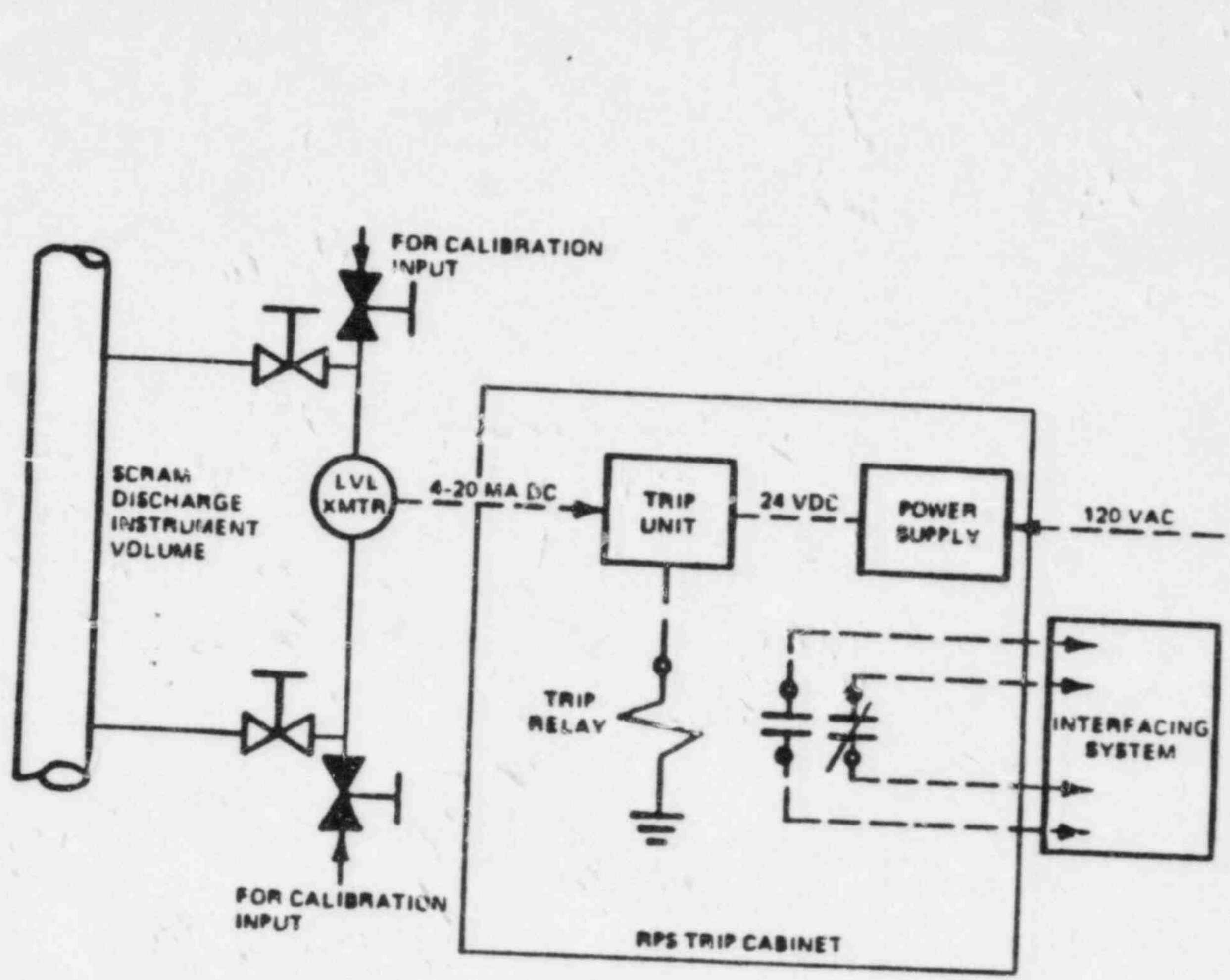

Figure 3-3. Water Level Transmitters and Switches

3.5 Interfaces

The level transmitters are connected to the top and bottom taps of the instrument volume by remote sensor housings. The methods used for making the connection is shown on Reference 4. Output from the transmitters is directed to trip units in the analog trip cabinet and is compared to the trip setpoint. When the trip setpoint is exceeded, the trip unit causes a relay in the cabinet to change state. Contacts in the relays are wired into the reactor protection system, reactor manual control system, alarm system and to the process computer. The wiring changes are shown on References 8 through 13.

4.0 SAFETY EVALUATION

The objective of a safety evaluation is to demonstrate that the design modifications will not reduce the level of protection offered by the current plant design. It is also intended to show that the design modifications would not pose an unreviewed safety question as required by 10CFR50.59.

The SIVDI system provides redundancy in that each instrument volume will have two independent channels of level detection in addition to the existing float switches. Diversity is provided in that each trip signal from the existing float switches now has an analog trip signal connected in series such that failure of one type of device will not prevent a system trip by the other. The analog components and relays of the modification are at least as reliable as the current trip system. They represent an upgrade in reliability and performance. Incorporation of the relays, transmitters and trip units of this modification in no way challenges the safety evaluation in place for the current system documented in FSAR Chapter 7. The modification does not increase the consequences or frequency of any accident or equipment malfunction, create the possibility for an unanalyzed event, nor does it reduce the safety margin of any technical specification. Therefore, the proposed design modification does not pose an unreviewed safety question.

6. REFERENCES

1. U.S. Nuclear Regulatory Commission Generic Safety Evaluation Report - BWR Scram Discharge System, December 1, 1980.

2. General Electric SIL 331, Supplement 2, Functional Testing of SDV Instrumentation, August 28, 1980.

3. General Electric SIL 331, Supplement 3, Failure of Magnetrol SDV Level Switches, September 26, 1980.

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

5. IEEE 344-1975 "Recommended Practices for Seismic Qualification of IE Equipment for Nuclear Generating Stations"

6. NUREG-0588 "Interim Staff Position on Environmental Qualification of Safety Related Equipment, July 1981."

7. RPS & ECCS Analog Trip System (GE Drawing No. 9132E702).

8. Reactor Protection System Elementary Diagram (GE Drawing No. 791E456).

9. Analog Trip System Elementary Diagram (GE Drawing No. 865E365).

10. Trip Unit Cabinet 9-93 Connection Diagram (GE Drawing No. 913E7120.

11. Trip Unit Cabinet 9-94 Connection Diagram (GE Drawing No. 913E713).

12. Reactor Manual Control System Elementary Diagram (GE Drawing No. 791E455) Cabinet Assembly Drawing (GE Drawing No. 915E259).

13. Installation Spec. (GE Drawing No. 22A5968)

14 Analog Trip System Equipment and System Testing Instructions (GE Drawing No. 22A5969)