



Commonwealth Edison Company

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Dresden Nuclear Power Station
R. R. #1
Morris, Illinois 60450
September 8, 1971



Dr. Peter A. Morris, Director
Division of Reactor Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

SUBJECT: LICENSE DPR-19, DRESDEN NUCLEAR POWER STATION UNIT 2: REPORT
OF PARTIAL CONTROL ROD INSERTION FOLLOWING SPURIOUS REACTOR
SCRAM SIGNAL.

Dear Dr. Morris:

This letter is to report a condition that occurred during surveillance testing of the reactor protection system. The condition caused a partial control rod insertion following a spurious reactor scram signal. This partial control insertion ultimately resulted in a turbine trip, which produced an Average Power Range Monitor trip and a reactor scram.

A. Sequence of Events

The reactor was in the run mode and operating at 406 MW_e on July 20, 1971. Surveillance testing of the main steam line radiation monitor was in progress with tests on the "A", "B", and "C" monitors satisfactorily completed. A high radiation signal was then simulated to the "D" monitor and resulted in a trip of Reactor Protection System (RPS) Channel B, as expected. Following normal surveillance procedures the operator began to reset the trip, first turning the reset switch to the group 2&3 position. He then began to turn the switch to the group 1&4 position but, before he reached that position, a spurious trip occurred and cleared on the "C" steam line radiation monitor in RPS Channel A. Because the Channel B group 2&3 scram solenoids had already been reset, only the eighty-eight (88) rods associated with scram solenoid groups 1&4 began inserting. The operators reset motion then completed to the group 1&4 position. At this point the group 1&4 rods ceased their insert motion after moving approximately six (6) notches from their original positions. This rod insertion caused a drop in electrical load from 406 MWe to 320 MWe.

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The turbine control valves closed down to maintain turbine throttle pressure at 920 psig. A reactor pressure spike, resulting from the rapid, partial closure of the turbine control valves, caused steam voids in the reactor to collapse resulting in a reactor water level decrease of approximately 20 inches. The feedwater system went into the "runout" mode to regain reactor water level. Reactor water level then increased rapidly and tripped the turbine on high level. The reactor pressure spike (960 psig) caused by the rapid closure of the turbine stop valves resulted in void collapse and APRM Hi Hi Flux flow based scram.

B. Reactor Protection System Logic Description

The RPS is designed with two independent logic Channels A and B. Each of these channels is divided into two sensor operated and one manual operated subchannels as shown in Figure 1. Subchannels A-1, A-2, B-1, and B-2 are equipped with a sensor, a sensor relay, a scram relay and pilot scram valve solenoids (two for each reactor control rod hydraulic control unit). Two subchannels (A-3 and B-3) have a manual scram push button in place of the sensor and sensor relay.

The control rods are divided into four nearly equal groups, identified as Groups 1, 2, 3 and 4. Group 1 and 4 control rods are scrambled by Channel "A" relays 108A, 108E and 109A and Channel "B" relays 108B, 108F and 109B. Group 2 and 3 control rods are scrambled by Channel "A" relays 108C, 108G and 109C and Channel "B" relays 108D, 108H and 109D. (See Figure 1 & 5).

A scram requires that a Channel "A" and a Channel "B" scram relay must be de-energized causing the two pilot scram valve solenoids on the control rod hydraulic control unit to de-energize. A minimum of four scram relays, two in each channel, must de-energize to achieve a scram i.e.: a Group 1 and 4 plus a Group 2 and 3 scram relay in Channel "A" coincident with a Group 1 and 4 plus a Group 2 and 3 relay in Channel "B".

Resetting the scram relays is accomplished through the reset relay circuit shown in Figure 2. The operator uses a single reset switch as shown in Figure 3 for the reset circuit. When the reset switch is in the center position, all switch contacts are open. When the switch is operated to the right, scram relays for control rod Groups 2 and 3 in Channels "A" and "B" are reset (re-energized.) When the switch is operated to the left, scram relays for control rod groups 1 and 4 in Channel A and B are reset.

A reset circuit is provided and is so arranged that following a scram signal from Channel A & B there is a 10 second time delay before the scram relays can be reset. The time delay is provided to allow time for the control rods to move their full travel before the scram relays can be reset. This prevents stopping the control rods in an intermediate position in the core for a scram.

A half scram reset is permitted without time delay because a half scram does not produce control rod movement.

Relays 114A, B, C and D are the reset relays. The 114 relays are energized through the reset switch following a scram. When the 114 relays are energized their contacts close and energize the scram relay thereby returning the scram relays to their normal energized position. When the reset switch is released, the 114 relays de-energize (see figure 3) but the scram relays remain energized through their own seal-in contacts (see figure 2).

The 114 relays are energized through the reset switch (303 device) and either the 125 relay contacts or the 122 relay contacts (see figure 3). Energizing through the 125 relay contacts permits immediate resetting (as permitted for a half scram). Energizing through the 122 relay contacts results in a ten second time delay before resetting the scram relay (as required for a full scram.)

The 125 A and B relays (see figure 4) are not energized for a half scram but they are energized for a full scram. When energized (full scram) the 125 relay contacts energize the 122A and B time delay relays. When the 122 relay contacts close after a ten second time delay the reset relays (114) are energized to reset the scram relays.

C. Analysis of Events

During surveillance testing, a Main Steam Line Radiation Monitor sensor was operated on Channel "B" which de-energized scram relays 108F, Groups 1 and 4, and 108H, Groups 2 and 3 (See Figure 1 subchannel B-2). The Channel "A" relays remained energized and, therefore, there was no movement of the control rods. This is a half scram condition. The test was completed and the operator was restoring the RPS to normal by resetting the scram relays. Relay 108H was reset (re-energized) by operating the reset switch in Figure 3 to the right to reset the Groups 2 and 3 scram relays and re-energize their scram solenoids. The operator was in the process of moving the reset switch to the left reset position when a Main Steam Line Radiation Monitor on Channel "A" generated a spurious trip.

This spurious trip de-energized scram relays 108 E and 108G in Channel "A" (See Figure 1 subchannel A-2). Scram relay 108F in Channel "B" had not yet been reset and, therefore, the pilot scram valve solenoids de-energized and initiated insertion of Groups 1 and 4 control rods into the core (scram) because their A & B scram solenoids were de-energized. The Groups 2 and 3 control rods did not scram since only a Channel "A" Groups 2 and 3 scram relay (108G) and scram solenoids were de-energized. The channel "B" Groups 2 and 3 scram relay (108H) tripped during surveillance testing, had already been reset.

At this time relays 108E, 108F, and 108G were de-energized. Relay 125B was energized and time delay relay 122B was timing out. Relay 125A could not be energized because relay 108H had been re-energized. (See figures 3 & 4.)

September 8, 1971

The operator then completed his reset action by turning the switch to the group 1 & 4 position. This successfully energized reset relay 114A and re-energized scram relay 108E in Channel "A" and the pilot scram valve solenoids in Channel "A" groups 1 & 4. This left the solenoids of Channel "A" groups 2 & 3 and Channel "B" groups 1 & 4 de-energized; no rod group had both Channel "A" and "B" solenoids de-energized. (See figure 5).

This reset occurred before the control rods were fully inserted and resulted in stopping the rod movement at an intermediate position in the core.

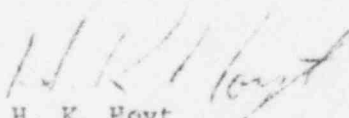
Stopping the rods at an intermediate position in the core resulted in dropping about 86 MWe of load. The load rejection resulted in a pressure transient which in turn caused a high flux scram. All control rods scrambled normally and shutdown the reactor.

D. Conclusions

A review of the RPS circuitry by Commonwealth Edison and General Electric indicated that:

1. The circuit functioned as designed and no component failures occurred.
2. The aborted scram described herein could only occur with a partially reset trip on one channel coincident with a short duration trip on the second channel occurring precisely as the operator is in the process of completing the reset of the trip on the first channel.
3. A trip on both channels would override the reset function and go to completion even with the reset switch held in a reset position. A test was successfully performed on Dresden Unit #2 on July 23, 1971 to verify this.
4. The unit is safe to operate and the RPS provides the necessary protection to safely shutdown the reactor.

The Station Review Board and Nuclear Review Board have each reviewed the sequence of events and analysis and concur with the above conclusions.


H. K. Hoyt
Superintendent

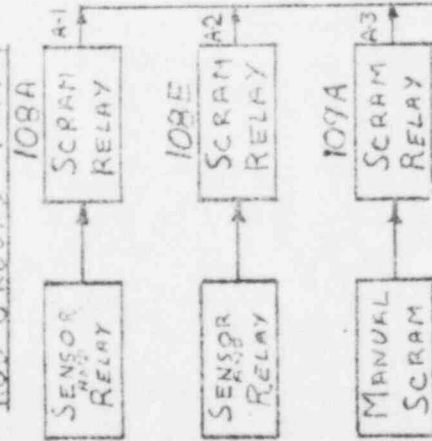
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SIMPLIFIED LOGIC DIAGRAM REACTOR PROTECTION SYSTEM SCRAM SIGNAL FLOW

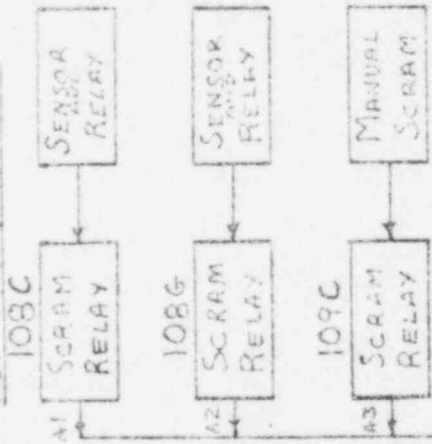
CHANNEL A

SUBCHANNEL A-1, A-2, A-3

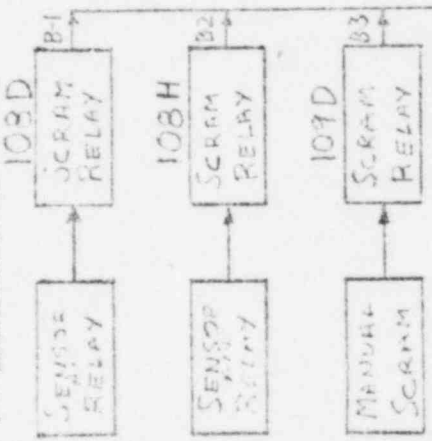
ROD GROUPS 1 AND 4



ROD GROUPS 2 AND 3

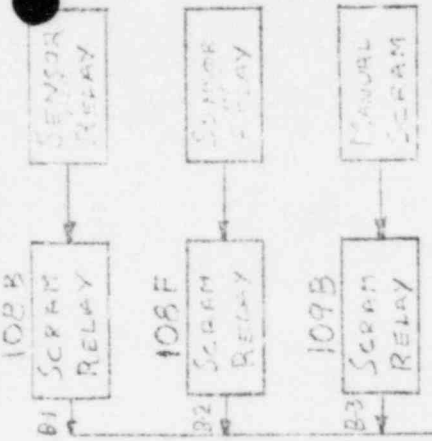


ROD GROUPS 2 AND 3

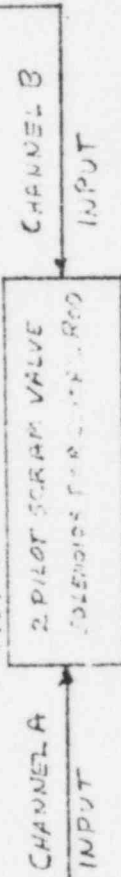


SUBCHANNEL B-1, B-2, B-3

ROD GROUPS 1 AND 4



ROD GROUPS 2 AND 3



ROD GROUPS 1 AND 4

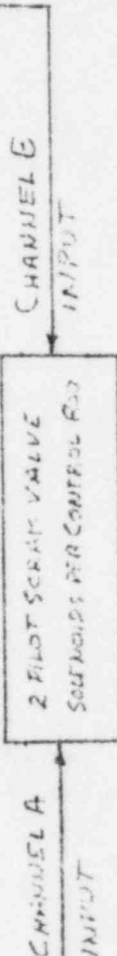


FIGURE 1

2 SIMPLIFIED CIRCUIT DIAGRAM REACTOR PROTECTION SYSTEM SCRAM AND RESET RELAYS

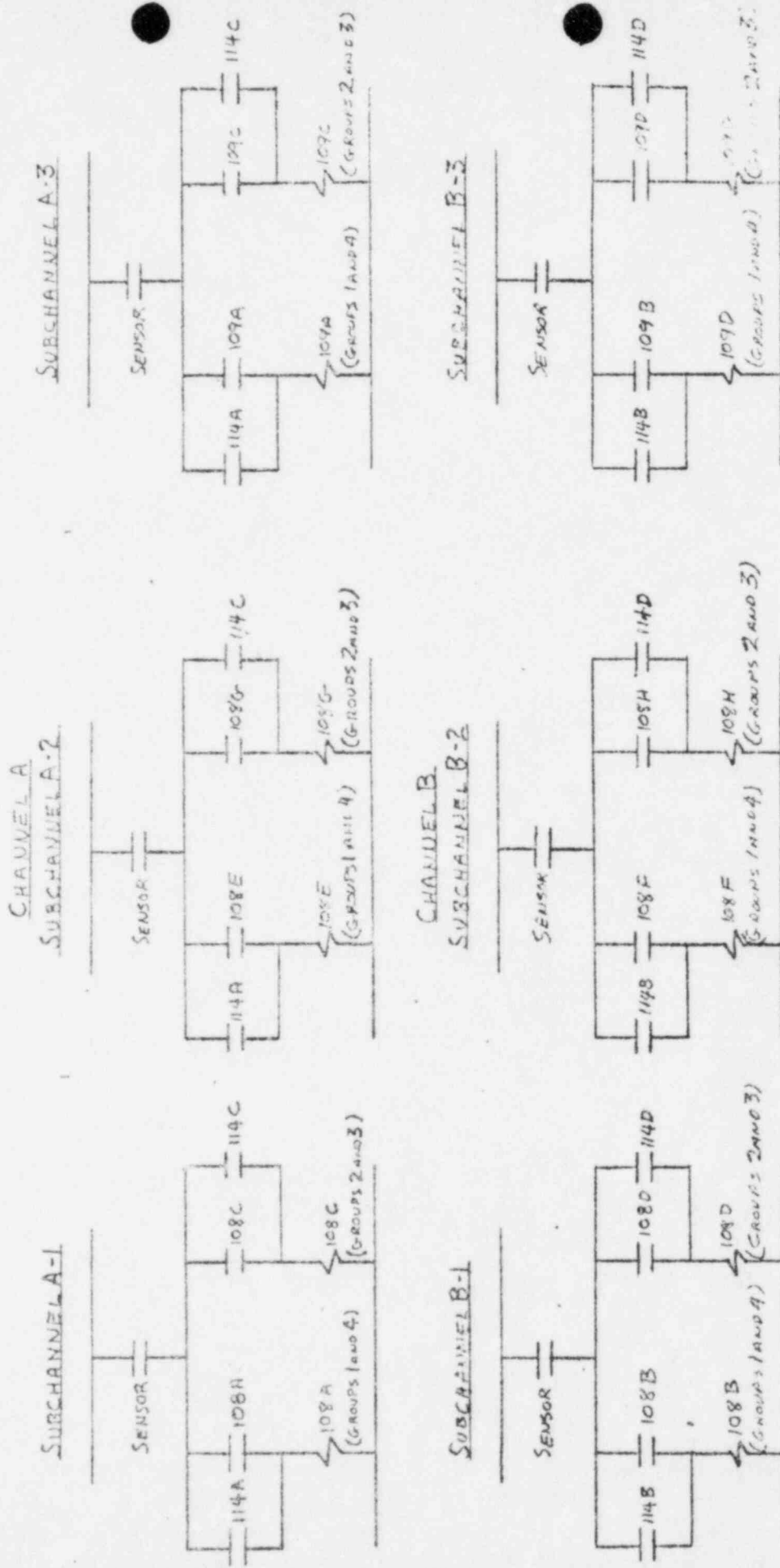
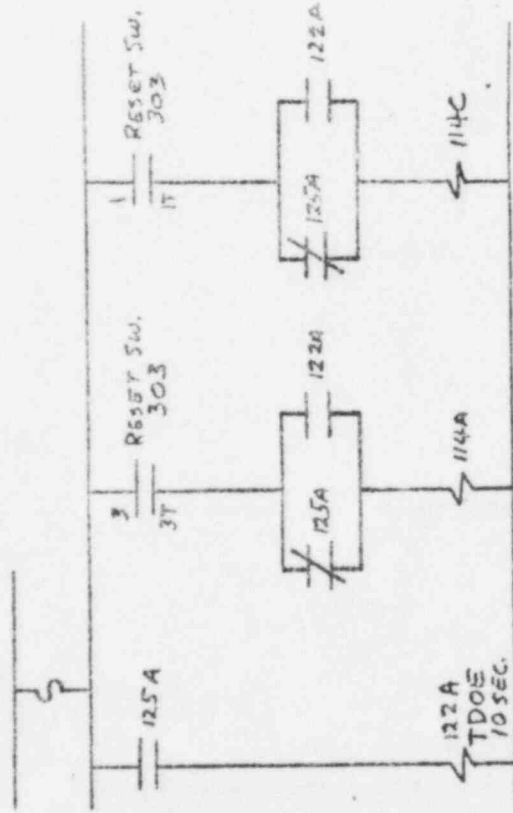


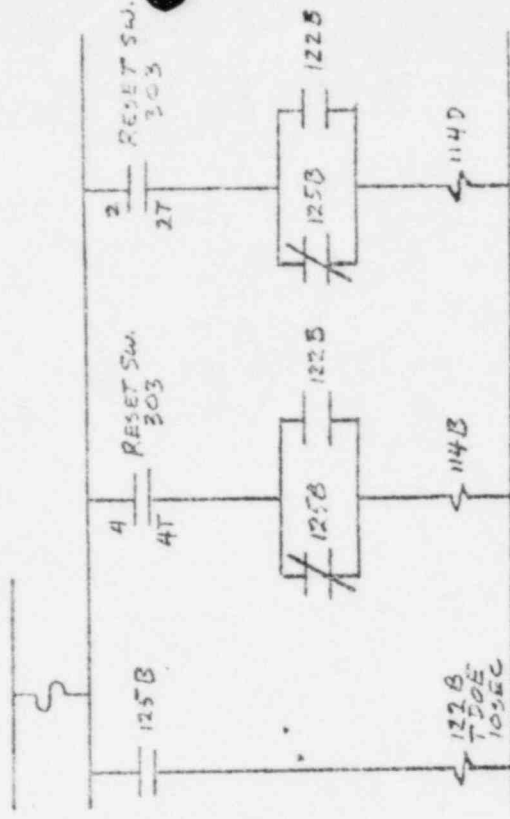
FIGURE 2

SIMPLIFIED REACTOR PROTECTION SYSTEM SCRAM AND RESET RELAY DIAGRAM

CHANNEL A



CHANNEL B



RESET SWITCH

303

NORMAL



CONTACTS	GROUP 1	GROUP 2	GROUP 3	GROUP 4
114	X	X		
122			X	X
125				

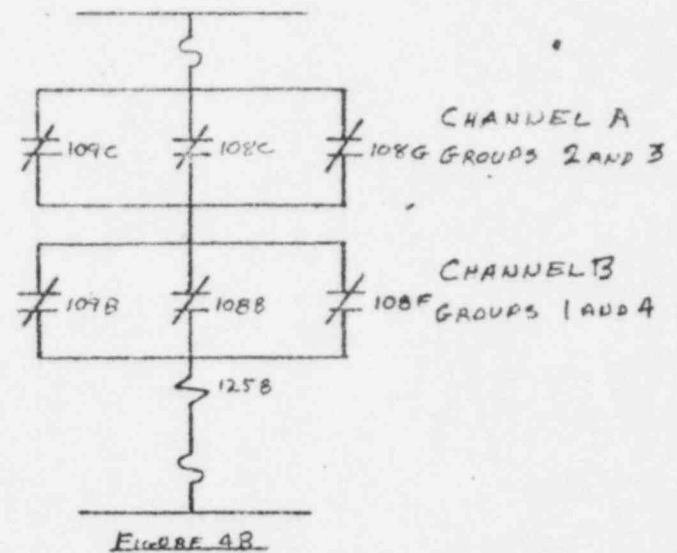
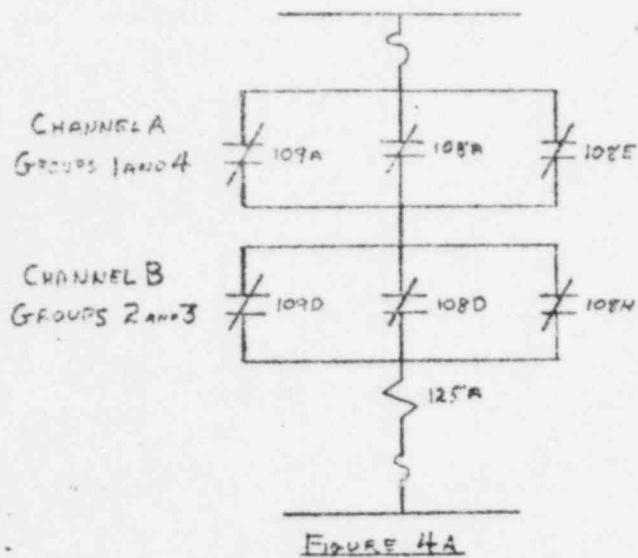
114 - RESET RELAY

122 - RESET TIME DELAY RELAY

125 - PERMISSIVE RELAY - PERMITS RESET IMMEDIATELY AFTER K_L SCRAM

FIGURE 3

SIMPLIFIED RESET CIRCUIT



108 AND 109 - SCRAM RELAY CONTACTS
 125 - PERMISSIVE RELAY, PERMITS
 RESET OF SCRAM RELAYS
 IMMEDIATELY AFTER $\frac{1}{2}$ SCRAM
 (SEE FIGURE 3)

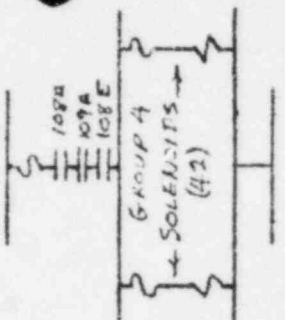
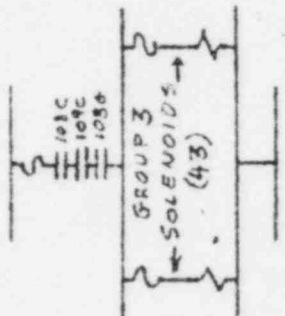
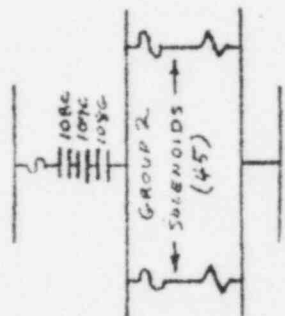
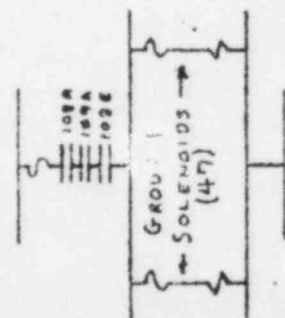
$\overline{\text{X}}$ - CONTACTS CLOSE ON RELAY DE-ENERGIZING

FIGURE 4

SIMPLIFIED SCHEMATIC DIAGRAM

REACTOR PROTECTION SYSTEM PILOT SEAM VALVE SOLENOIDS

CHANNEL A



CHANNEL B

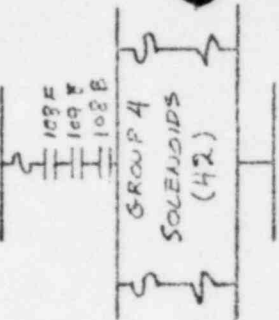
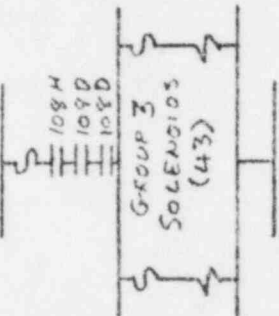
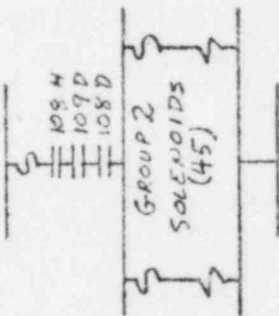
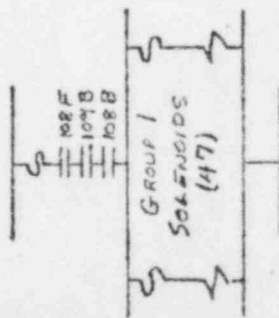


FIGURE 5