



**AUSTRALIAN ATOMIC ENERGY COMMISSION
RESEARCH ESTABLISHMENT
LUCAS HEIGHTS**

**REACTOR HIFAR
THE TRIP AND WARNING ALARM CIRCUITS**

by

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ABSTRACT

This manual describes in detail the operation of the Trip and Warning Alarm Circuits in HIFAR and their relation to other parts of the safety circuits.

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Figure 1 Drawing AE3997 - Trip and Warning Alarm Circuits

INTRODUCTION

This manual must be read in conjunction with Manual AAEC/ML, 'An Introduction to HIFAR Guard and Safety Circuits'. It is one of a group of manuals whose titles appear in Appendix 1.

2. BASIC PRINCIPLE OF OPERATION

All the circuits operate in the same way. A high speed relay WA is controlled by a long series chain of relay contacts wired and adjusted so that the circuit is completed in both the operated and released states of the relays. The circuit is broken only during the operation or release of the relays for the transit period of the relay contacts which is of the order of 4 to 6 ms.

The high speed relay WA is held operated via resistor WR2 which reduces the holding current to a safe minimum value and allows the relay to be released well within the transit period available.

Relay WA released:

- (a) disconnects its holding circuit through contacts 2, 4 and 6;
- (b) by the same contacts releases relay WB which then rings the appropriate bell.

Operation of the Warning Bells Cancel switch in Control Room Panel No. 5 operates relay $\frac{W-CO}{4}$ which causes the WA relays to be re-operated so that they now self-hold through contacts 2, 4 and 6 and the new conditions in their respective circuits.

3. DESCRIPTION OF THE CIRCUITS

3.1 COMPLETE SHUTDOWN NETWORK

The left hand vertical string of contacts 24, 25 and 26 are associated with the COMPLETE SHUTDOWN state of the reactor. The associated high speed monitoring relay is $\frac{X-WA}{1}$ and the relay $\frac{X-WB}{2}$ is used via contacts 1 and 2 only to ring TRIP and CONTROL REVERSAL alarm bells either in Control Room Panel No. 5 or in the Office Block Remote State Indicator. They are all mounted in relay set No. 1.

In addition to COMPLETE SHUTDOWN contacts the string also includes the following relay contacts:

- (a) Contacts 27, 28 and 29 of relay $\frac{Bl-I}{6}$ which monitor the six pole faces of the control arms. If any one comes off the magnet then relay $\frac{Bl-I}{6}$ is released.

(b) Contacts 31, 32 and 33 of the CONTROL REVERSAL primary guard line monitoring relay $\frac{CR-P2}{8}$.

(c) Contacts 27, 28 and 29 of the trip guard monitoring relay $\frac{T-G1}{5}$.

3.2 RESTRICTED TRIP Network

The second vertical string of contacts 24, 25 and 26 are all associated with parameters concerned with the RESTRICTED TRIP state of the reactor and the contacts are on the appropriate secondary guard monitoring relays. They are all mounted in relay set No. 3.

3.3 CONTROL REVERSAL Network

The third vertical string of contacts 24, 25 and 26 are all associated with parameters concerned with the CONTROL REVERSAL state of the reactor and the contacts are on the appropriate secondary guard monitoring relays. They are all mounted in relay set No. 4.

3.4 Fine Control Rod and Lockout Switch No. 1 Alarm Circuit

The fourth small vertical string of contacts 24, 25 and 26 cause the warning bell to sound continuously and cannot be cancelled by the Warning Bells Cancel switch in Control Room Panel No. 5, that is, this is a special circuit.

Relay $\frac{G-WB}{2}$ is the controlling component and the circuit to relay $\frac{G-WB}{2}$ depends on the state of the reactor. Before start-up, relay $\frac{B2-A}{4}$ in the Fine Control Rod circuit is released, leaving relay $\frac{G-WB}{2}$ dependent only on Lockout Switch No. 1 and relay $\frac{LO-G}{6}$ which is controlled by the remaining lockout switches in the Lockout/Bypass Panel in Control Room Panel No. 1.

If Lockout Switches No. 2 to 8 are in the Operational position then relay $\frac{LO-G}{6}$ is operated and Lockout Switch No. 1 may be switched from the Operational to the OFF position without releasing relay $\frac{G-WB}{2}$. If, however, any of the Lockout Switches No. 2 to 8 are in the OFF position, relay $\frac{LO-G}{6}$ is released and then switching Lockout Switch No. 1 to the OFF position releases relay $\frac{G-WB}{2}$ and thus operates the warning bell continuously until the appropriate lockout switch is returned to its Operational position.

Lockout Switch No. 1 is operated by HIFAR Key No. 4 which fits only one other lock, namely that on the 9 inch diameter helium isolating valve in the sub-reactor area. This valve is closed when fuel is changed to isolate the helium on top of the reactor aluminium tank. During fuel changing it is required to prevent maintenance taking place on control absorbers, dump valve, pumps etc. Mechanical inter-

locking between Lockout Switch No. 1 and all the other lockout switches could have provided a more effective safeguard but as this was impractical, the continuous bell warning was substituted.

When the reactor is operational, relay $\frac{B2-A}{4}$ is operated and relay $\frac{G-WB}{2}$ is dependent on the fine control rod near limit warning relays $\frac{B2-W1}{6}$ and $\frac{B2-W2}{4}$. Initially at switch-on, relay $\frac{B2-W1}{6}$ will be released ('nearly in' limit) (see Manual M11 for details) and a contact of the time guard relay $\frac{G-TG}{6}$ bridges contacts 24, 25 and 26 of relay $\frac{B2-W1}{6}$ during the start guard time interval. It is necessary to raise the fine control rod above the 'nearly in' limit to operate relay $\frac{B2-W1}{6}$ during the period relay $\frac{G-TG}{6}$ remains operated if relay $\frac{G-WB}{2}$ is to be held operative. Once the start guard time interval has elapsed, movement of the fine control rod either above the 'nearly up' limit or below the 'nearly in' limit releases relay $\frac{G-WB}{2}$ via either relay $\frac{B2-W2}{4}$ or $\frac{B2-W1}{6}$ respectively and so rings the warning bell.

It should be noted that the warning initiated by releasing relay $\frac{G-WB}{2}$ cannot be cancelled by the Warning Bells Cancel switch in Control Room Panel No. 5. The conditions allowing the release of relay $\frac{G-WB}{2}$ must be returned to normal to stop the bell ringing.

3.5 Warning Networks

The fifth, sixth and seventh strings of contacts 24, 25 and 26 are all associated with warning conditions, the parameters being monitored in relay sets No. 9, 10 and 11 respectively. In addition the fifth string contains monitoring contacts for the heavy water shutdown pumps. Also the sixth string contains monitoring relays for the D₂O liquid level pumps and the fine control rod cooling pumps.

3.6 Operation during Resetting of Guard Circuits

When the guard circuits are reset after failure, a contact of the appropriate reset relay is arranged to hold the high speed WA relay operated (if already operated) so that the transient disconnection of the normal circuit as the guard relays re-operate is not noticed.

3.7 Warning Bells Cutoff Switch

At the back of Control Room Panel No. 1 a toggle switch AL/CO is located. It cuts off the alarm bells in the event of fault conditions preventing relays WA and WB in the respective relay sets holding after the normal cancel action has

has been carried out. Operation of the switch energises relay $\frac{W-CO}{4}$ continuously which then applies the bell cancel condition continuously by holding all the WA relays operated. Relay $\frac{W-CO}{4}$ operated also operates relay $\frac{P3-D}{4}$ and so prevents the transfer pump alarm buzzer from working (see Manual M15 for details).

- Note:
- (1) The warnings associated with the fine control rod position and maloperation of Lockout Switch No. 1 are not affected by the cutoff switch. A lamp is lit on the shutdown fault analysis (5/FA-L10) panel while the warning cutoff switch is in use.
 - (2) Under SCRAM conditions those warnings which are cancelled by the Cutoff switch are also automatically cut off by contacts 4, 5 and 6 of SCRAM primary and secondary guard relays $\frac{SCR-P1}{4}$, $\frac{SCR-P2}{4}$ and $\frac{SCR-Z}{6}$ respectively. In the event of evacuation of the control room, the bells would not continue to sound because there would be no-one to cancel them.

3.8 Warning Bells

Associated with the alarm circuits given in Figure 1 there are two bells in the Control Room, namely, TRIP and CONTROL REVERSAL and Warning Bell. These have different tones so that they cannot be confused. The former sounds for any COMPLETE TRIP, RESTRICTED TRIP or CONTROL REVERSAL faults. The latter sounds for those faults associated with the three warning networks and also a Fine Control Rod/Lockout Switch No. 1 fault. The TRIP bell is repeated in the remote state indicator in the ground floor of the Office Block.

APPENDIX 1

REACTOR HIFAR - LIST OF INSTRUMENTATION MANUALS

- M1 Introduction to HIFAR Guard and Safety Circuits
- M2 Complete Shutdown Circuits
- M3 Trip Circuits
- M4 Control Reversal Circuits
- M5 Warning Circuits
- * M6 Primary Search Unit
- M7 Start Guard Circuits
- * M8 Flux Trip Circuits
- * M9 Safety Rod Circuits
- * M10 Coarse Control Arm Circuits
- * M11 Fine Control Rod Circuit
- * M12 Dump Valve Circuit
- * M13 Main Heavy Water Pump Circuit (S1)
- * M14 Shutdown Heavy Water Pump Circuit (S2)
- * M15 Transfer and Liquid Level Pump Circuits (S3 and S4)
- * M16 Main H₂O Pump Circuits (S6)
- * M17 H₂O Shutdown Circuits (S8)
- * M18 Cooling Tower Fan Circuits (G8)
- * M19 Shield Cooling Pump Circuits (S7)
- * M20 Experimental Pump Circuits (S9)
- * M21 Fine Control Rod Pump Circuits (S14)
- * M22 Miscellaneous Circuits
 - 24V circuits 4-LIA-10 circuit
 - 50V d.c. circuits 4-L-15 circuit
 - 240V circuits Panel N
- M23 Trip and Warning Alarm Circuits
- * M24 Ventilation Flow Diagram Circuit
- * M25 Main Flow Diagram and Cooling Tower Lamp Circuits
- * M26 Annunciator Lamp Circuits
- * M27 Fault Analysis Lamp Circuits
- * M28 Principles of Operation of the Nucleonic Instruments
- M29 The Control Room
- * M30 The Coarse Control System
- * M31 The Fine Control System

Continued...

APPENDIX 1 (Continued)

- * M32 The Safety System
- * M33 Fine Control Drive System
- M34 Leak Detectors
- * M35 Modifications for Low Power Operation
- * M36 Recorders
- * M37 Physical Instrumentation of HIFAR
- * M38 Ionisation Chambers and Health Monitors
- M39 Test Schedule for Guard, Safety, and Interlock Circuits

* Not yet published