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RESEARCH ESTABLISHMENT
LUCAS HEIGHTS

REACTOR HIFAR - THE WARNING CIRCUITS

by

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ABSTRACT

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

CONTENTS

1. INTRODUCTION

This manual must be read in conjunction with Manual AAEC/M1 'Reactor HIFAR - An Introduction to the Guard and Safety Circuits'. It is one of a group of manuals whose titles are listed in Appendix 1.

2. GENERAL PRINCIPLE OF OPERATION

2.1 Circuit Operation

The Warning Guard circuits provide visual and audible indications only of abnormal operating conditions. The circuits are shown in Figures 1, 2 and 3. The relays are accommodated at the rear of Control Room Panel No. 5 in relay sets No. 9, 10 and 11. Each parameter being measured has a monitoring relay associated with it, having, typically four sets of changeover contacts. Normally an abnormal value of the monitored parameter will cause contacts controlling the monitoring relay to open circuit, thereby releasing the monitoring relay. In a very few cases it was not possible to provide contacts which open circuited on fault conditions, so in these cases the monitoring relay is normally released and is operated on fault condition.

Each monitor relay on fault condition:

(a) Provides via contacts 1, 2 and 3 a visual indication, on the fault analysis unit in Control Room Panel No. 5, of the particular warning condition.

(b) Lights via contacts 4, 5 and 6 a group lamp on the annunciator display in Control Room Panel No. 6.

(c) Provides a self holding set of contacts 21, 22 and 23 which require resetting to re-energise the relay.

(d) Sounds, via contacts 24, 25 and 26, an audible alarm in the Control Room.

A separate distinctive bell from that registering trips or control reversals is used for the warning alarms. However, the bell is cancelled by the same Warning Bell Cancel Switch in Control Room Panel No. 5. Each relay set is complete with its own audible warning circuit so that no audible alarm is given when a relay set is removed. It is possible to invalidate the operation of the Warning Bell by manual operation of a switch AL/CO at the rear of Panel 1 so that only visual indication remains on the Fault Analysis Panel and the Panel 6 annunciator (see Manual M23). The circuit actions of the audible alarms are discussed in

Manual M23.

2.2 Resetting Warning Guards

All the circuits are arranged to be self holding so that transient warning conditions or circuit faults will be registered. The relays are reset by operating a Warning Reset switch on Control Room Panel No. 5. Operation of the Warning Reset switch either directly or indirectly energises relays $\frac{W\text{-}RZ_a}{6}$ to $\frac{W\text{-}RZ_n}{6}$ in relay sets 9, 10 and 11. The details of resetting are discussed in Manual M1.

3. LISTS OF WARNING GUARD CONDITIONS

3.1 Relay Set No. 9

	Guard Condition	Fault Analysis	Associated Relay	Group Annunciator Panel No. 6	
				Title	Lamp No.
1	Excess D_2O Dump Tank	5/FA-F/L1	$\frac{L12\text{-}W}{6}$	D_2O Levels	6-L24
2	Reactor D_2O Level High	5/FA-F/L2	$\frac{L1\text{-}W}{6}$	D_2O Levels	6-L24
3	D_2O Level (Min) Storage Vessel	5/FA-F/L3	$\frac{L2B\text{-}W}{6}$	D_2O Levels	6-L24
4	No Weir Overflow	5/FA-F/L4	$\frac{NWF\text{-}W}{6}$	D_2O Levels	6-L24
5	D_2O Conductivity High	5/FA-F/L5	$\frac{K\text{-}W}{4}$	D_2O Analysis	6-L6
6	D_2O pH High	5/FA-F/L6	$\frac{pH\text{-}W2}{4}$	D_2O Analysis	6-L6
7	D_2O pH Low	5/FA-F/L7	$\frac{pH\text{-}W1}{4}$	D_2O Analysis	6-L6
8	D_2O Gamma Radiation High	5/FA-F/L8	$\frac{D\gamma\text{-}W}{4}$	D_2O Analysis	6-L6
9	D_2O Leaks	5/FA-F/L10	$\frac{D/LK\text{-}W}{4}$	D_2O Leaks	6-L18
10	D_2O in H_2O	5/FA-F/L11	$\frac{D/H_2O\text{-}W}{4}$	D_2O Leaks	6-L18
11	D_2O/H_2O Press Diff. Low	5/FA-F/L12	$\frac{PI22\text{-}W}{4}$	D_2O Leaks	6-L18
12	Main D_2O Pumps Motor Temp. High	5/FA-F/L14	$\frac{T54\text{-}W}{4}$	D_2O Pumps	6-L12
13	Recombination Unit	5/FA-G/L17	$\frac{RU\text{-}W}{4}$	Reactor Helium	6-L16
14	Negative Helium Pressure	5/FA-G/L18	$\frac{HeP\text{-}W}{4}$	Reactor Helium	6-L16
15	Pond Temp. Low	5/FA-G/L1	$\frac{T37\text{-}W}{4}$	Main Cooling Water	6-L23
16	H_2O Pond Level Low	5/FA-G/L2	$\frac{L10\text{-}W}{4}$	Main Cooling Water	6-L23

Continued...

3.1 Relay Set No. 9 (Continued)

	Guard Condition	Fault Analysis	Associated Relay	Group Annunciator Panel No. 6	
				Title	Lamp No.
17	H_2O Flow Low to Reactor	5/FA-G/L3	$\frac{F15\text{-}W}{4}$	Main Cooling Water	6-L23
18	H_2O Outlet Temp. High	5/FA-G/L4	$\frac{T39\text{-}W}{4}$	Main Cooling Water	6-L23
19	H_2O Inlet Temp. High	5/FA-G/L5	$\frac{T42\text{-}W2}{4}$	Main Cooling Water	6-L23
20	Shield Circuits Fault	5/FA-G/L8	$\frac{Sh\text{-}W}{4}$	Shield Cooling	6-L17
21	Experimental Circuits Fault	5/FA-G/L9	$\frac{Exp\text{-}W}{4}$	Experimental Cooling	6-L11
22	Fine Control Rod Coolant Level Low	5/FA-G/L11	$\frac{L14\text{-}W}{4}$	Fine Control Rod	6-L5

Note: (1) Relays $\frac{L12\text{-}W}{6}$, $\frac{L1\text{-}W}{6}$ and $\frac{L2B\text{-}W}{6}$ have two contacts more than the other monitoring relays. These contacts are used in interlock circuits in the transfer and liquid level pump circuits (see Manual M15 for details).

(2) Relays $\frac{Sh\text{-}W}{4}$ and $\frac{Exp\text{-}W}{4}$ are each associated with a string of relay contacts. In these cases parameters are monitored and detailed warning given in a Motor Control Cabinet in the sub-reactor area with only a group warning being given in the Control Room Fault Analysis Unit in Control Room Panel No. 5.

3.1.1 Shield cooling circuits

In Motor Control Cabinet No. 4, the various warning parameters are associated with monitoring relays which are used in the same manner as above to give audible and visible warnings at the Motor Control Cabinet. The audible warning is achieved in an identical way with a high speed relay sensing the 5 ms changeover of a pair of relay contacts and ringing a bell mounted on the Motor Control Cabinet. Re-setting is also achieved in an identical fashion.

	Guard Condition	Associated Relay	Associated Instrument
1	Coolant Temperature High	S7-A / 4	5-T8-A to 5-T46-A
2	Coolant Flow Low	S7-B / 4	5-F14-A
3	Coolant Makeup Low	S7-C / 4	5-LA-8
4	Shield Gasholder - High Level	S7-D / 4	6-L7-A
5	Shield Gasholder - Low Level	S7-E / 4	5-L7-B
6	Shield Head Tank Full		5-LA-8 (visual warning in sub-reactor area only)
7	5P7/1 Failed	$P7_1$-N / 4	
8	5P7/2 Failed	$P7_2$-N / 4	

3.1.2 Experimental cooling circuits

In Motor Control Cabinet No. 5 the various warning parameters are associated with monitoring relays which are used in the same manner as above to give audible and visible warnings at the Motor Control Cabinet. The audible warning is achieved in an identical way with a high speed relay sensing the 5 ms changeover of a pair of relay contacts and ringing a bell mounted on the Motor Control Cabinet. Resetting is also achieved in an identical fashion.

	Guard Condition	Associated Relay	Associated Instrument
1	Coolant Temp. High	S9-A / 4	6-TIA-17
2	Coolant Pressure Low	S9-B / 4	6-PIA-57
3	Coolant Makeup Water Low	S9-C / 4	6-PST-2
4	Experimental Head Tank Full		6-LIA-8 (visual warning in sub-reactor area only)
5	6P9/1 Failed	$P9_1$-N / 4	
6	6P9/2 Failed	$P9_2$-N / 4	

3.2 Relay Set No. 10

	Guard Contacts	Fault Analysis	Associated Relay	Group Annunciator Panel No. 6	
				Title	Lamp No.
1	He Gasholder Full	5/FA-G/L19	L6A-W/4	Reactor Helium	6-L16
2	He Gasholder Low	5/FA-G/L20	L6B-W/4	Reactor Helium	6-L16
3	Health - γ Radiation High	5 FA-H/L1	Hγ-W/4	Health	6-L10
4	Fuel Temp. High	5/FA-H/L4	T7-W/4	Fuel Temp.	6-L21
5	Shield/Graphite Temp. High	5/FA-H/L5	T50-W/4	Shield/Graphite Temp.	6-L15
6	Plant Room Air Supply Failed	5/FA-H/L7	EA-W/4	Air Supply	6-L9
7	Instrument Air Supply Failed	5/FA-H/L8	IA-W/4	Air Supply	6-L9
8	D_2O Level Pumps Stopped	5/FA-H/L12	P4-W/4	D_2O Pumps	6-L12
9	Extract Ventilation Both Fans Failed	5/FA-H/L13	V-W2/4	Ventilation	6-L3
10	High Flux - One out of 4 Channels	5/FA-F/L19	Ø-W/4	Flux	6-L4
11	Fission Products (not installed)	5/FA-F/L17	FP-W/4	Fission Products	6-L20
12	Doubling Time Low. 1 out of 3 Channels	5/FA-F/L18	RY-W/4	Flux	6-L4
13	Battery Half Exhausted	5/FA-H/L15	Bat-W/4	Battery	6-L14
14	Storage Block No. 1 Fault	5/FA-H/L9	SB1-W/4	Storage Blocks	6-L8
15	Storage Block No. 2 Fault	5/FA-H/L10	SB2-W/4	Storage Blocks	6-L8
16	Bypass Switch off Normal	5/FA-H/L20	BP-W/4	Bypass switches	6-L1
17	Bypass Relay Fault *	5/FA-F/L20	BP-G/6	Bypass switches	6-L1

* This function is not installed at the date of this report, but is expected to be operational by December 1967.

Note: The No. 1 Storage Block relay SB1-W/4 is shown connected to only one contact breaking on fault. In fact there are seven parameters all in series (see Dwg E2449 for details) and these are concerned with water levels in Gravity Tank, Burst Fuel Element Tank and Main Tank as well as flow and pump condition and γ-activity of Main Tank and Burst Fuel Element Tank.

3.3 Relay Set No. 11

	Guard Contacts	Fault Analysis	Associated Relay	Group Annunciator Panel No. 6	
				Title	Lamp No.
1	Experimental Rig if required	5/FA-E/L1	R1-W/4	Rigs	6-L19
2	"	5/FA-E/L2	R2-W/4	"	"
3	"	5/FA-E/L3	R3-W/4	"	"
4	"	5/FA-E/L4	R4-W/4	"	"
5	"	5/FA-E/L5	R5-W/4	"	"
6	"	5/FA-E/L6	R6-W/4	"	"
7	"	5/FA-E/L7	R7-W/4	"	"
8	"	5/FA-E/L8	R8-W/4	"	"
9	"	5/FA-E/L9	R9-W/4	"	"
10	"	5/FA-E/L10	R10-W/4	"	"
11	"	5/FA-E/L11	R11-W/4	"	"
12	"	5/FA-E/L12	R12-W/4	"	"
13	"	5/FA-E/L13	R13-W/4	"	"
14	"	5/FA-E/L14	R14-W/4	"	"
15	"	5/FA-E/L15	R15-W/4	"	"
16	"	5/FA-E/L16	R16-W/4	"	"
17	"	5/FA-E/L17	R17-W/4	"	"
18	"	5/FA-E/L18	R18-W/4	"	"
19	"	5/FA-E/L19	R19-W/4	"	"
20	"	5/FA-E/L20	R20-W/4	"	"
21	"	5/FA-H/L16	R21-W/4	"	"
22	"	5/FA-H/L17	R22-W/4	"	"
23	"	5/FA-H/L18	R23-W/4	"	"

Note: Twenty-three channels are available in this relay set to connect to experimental rigs if it is desired that they should give audible and visible warnings in the Control Room. Usually the rigs have detailed fault analysis information displayed on their own consoles but the Control Room warning draws attention to some maloperation of the rig.

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 H_2O Pump Circuits (S6)
*	M17	H_2O 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-LLA-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

* 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