CHAPTER 7

EXTERNAL RADIATION HAZARDS

The external radiation hazards in a nuclear power station are:

gamma, neutron and beta radiation.

Many of the techniques that we use to minimize our radiation dose are identical to those used when working with other industrial hazards. For example, you should always plan your work.

Planning includes:

1) Recognizing the hazards.
2) Assessing the magnitude of each hazard.
3) Anticipating hazard changes.
4) Using appropriate protective equipment and procedures.
5) Using suitable dosimetry.

Primary Heat Transport (PHT) System

Tritium

Activation Products

Fe-59, Zr-95, Co-60, 0-19, N-16

Fission Products

gases (Kr, Xe)
Vapour (I)
water soluble (Cs)

Moderator System

Tritium

Mod D_2O spends more time in core (x15)
and at higher flux (x2), so H^3 conc. much greater

Activation Products

Co-60

Liquid Zone Control

Activation Products: Delay tank for O-19, N-16

Fuelling Machines

Tritium

Fission Products

High risk potential for large beta and gamma

ASSESSING THE HAZARD

a) Reactor power level

b) Time since first reactor startup

c) Time since the reactor was last brought up to power

d) If shut down, the time since shutdown

e) Removal of shielding to allow maintenance

f) Contaminated surfaces, liquids or air will increase the radiation fields.

g) Operating conditions may change the radiation fields if systems are isolated or opened.

h) The presence of a defective fuel bundle in the reactor will cause an increase in radiation fields from activation and fission products in the PHT and FM systems. Fields will decrease when the defective fuel is removed.

Must consider these factors before you start work

TYPICAL GAMMA FIELDS

Zone 1: 0

Zone 2: < 10 mSv/h

Zone 3: 10 mSv/h - 100 mSv/h (in access controlled areas)

GAMMA FIELDS 24 HOURS AFTER S/D
AFTER SIX YEARS OF OPERATION)

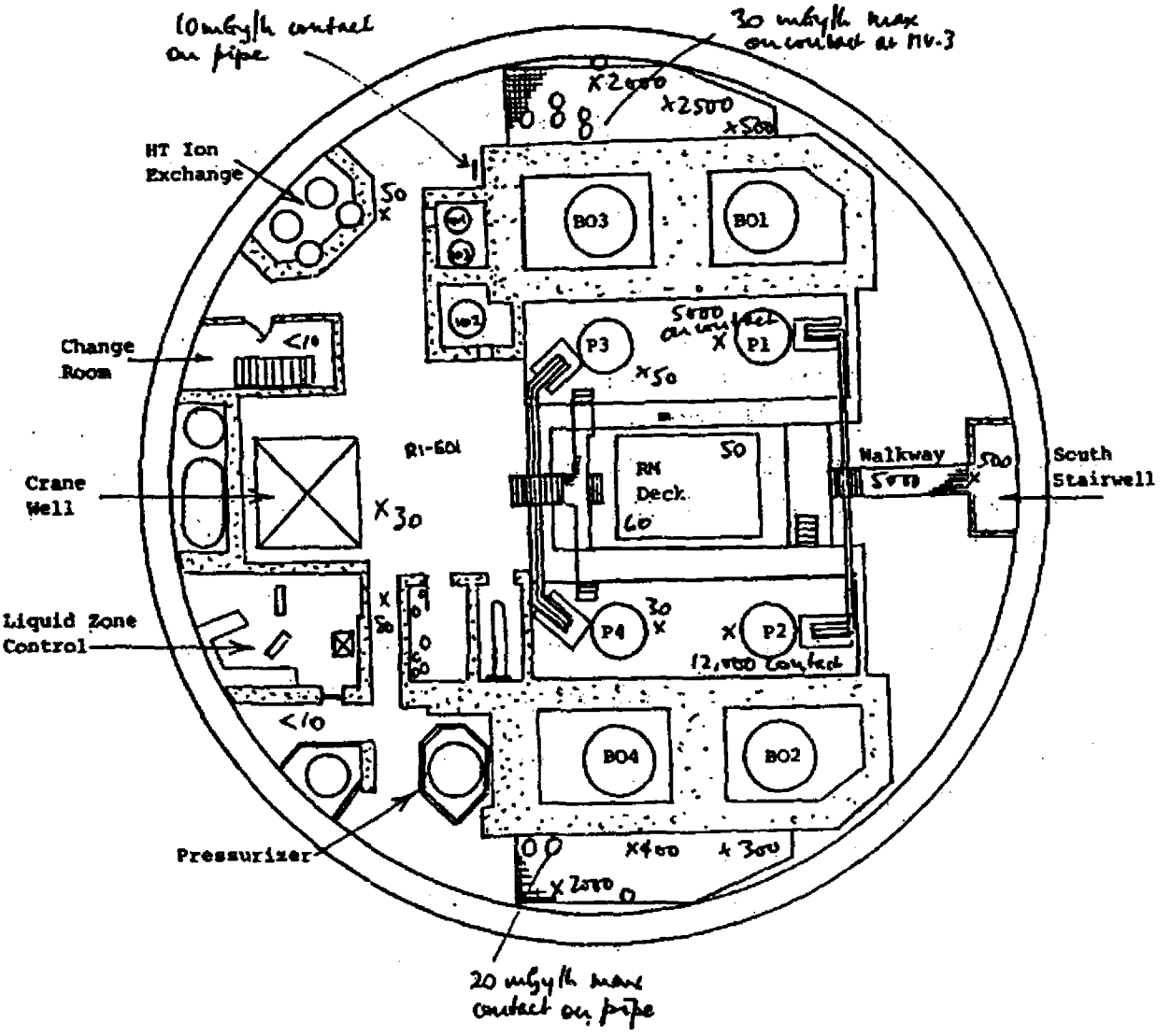
Location	Field
F/M Vaults:	
Below Calandria Face	1 - 2 mSv/h
General Area	100 - 300 mSv/h
Moderator Enclosure	100 - 500 mSv/h
Boiler Room	10 mSv/h

RADIATION SURVEY SHEET Form RS-5

REACTOR BUILDING - El. 29.9 m

DATE 89-10-26 TIME 12:10 % FULL POWER 100 SURVEYOR R.S. Hold

INSTRUMENTS AND NUMBERS Low Range Gamma Meter #2046



NOTE

Radiation readings are in ☑ uGy/h ☐ mGy/h

Indirect contamination readings are in ☐ cps ☐ cpm > background

Direct contamination readings are in cps > background

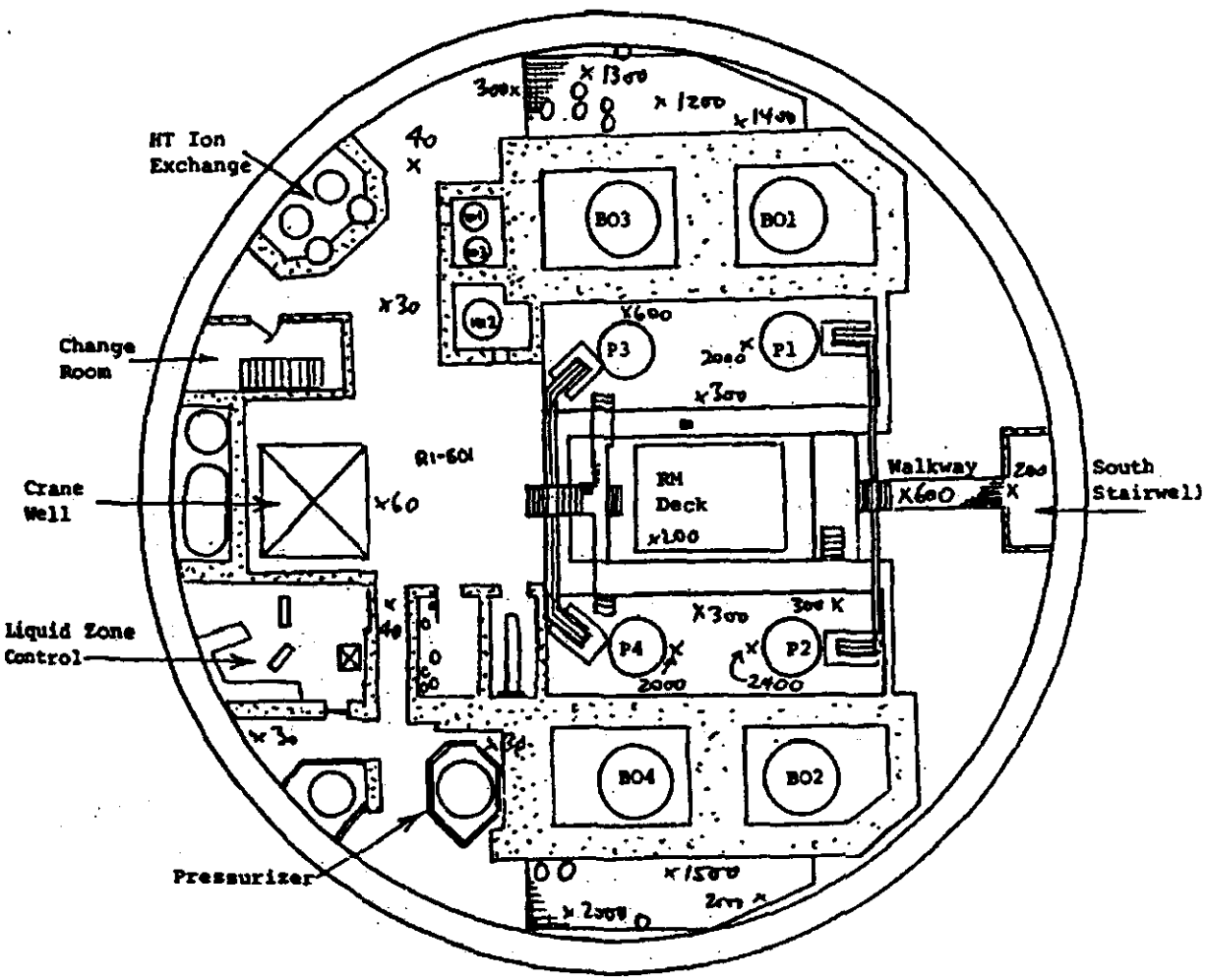
Fig. 7.1. Typical Gamma Fields in the Boiler Room; 100% Full Power, Six Years of Operation

RADIATION SURVEY SHEET Form RS-5

REACTOR BUILDING - El. 29.9 m

DATE 89-10-26 TIME 12:00 % FULL POWER 100 SURVEYOR C.J. Hold

INSTRUMENTS AND NUMBERS Neutron Rate
HP-427Z



NOTE

Radiation readings are in ☑ µSv/h ~~µGy/hr~~ ☐ mGy/h

Indirect contamination readings are in ☐ cps ☐ cpm > background

Direct contamination readings are in cps > background

Fig. 7.2. Typical Neutron Fields in the Boiler Room; 100% Full Power, Six Years of Operation

Anticipate Changes

Surveys

Pre-op checks
Check warning signs
Check entrance
Do survey at waist height
Use Hot Spot stickers
Signpost above 10 m Gy/h
Fill out survey sheet
Enter data in Hazard Info program

Signposting

CAUTION: Radiation Area (> 10 mSv /h)
DANGER: Restricted Rad. Area (> 5 mSv/h)
Record: general dose rate, type of radiation
any contact readings
your name
date and time

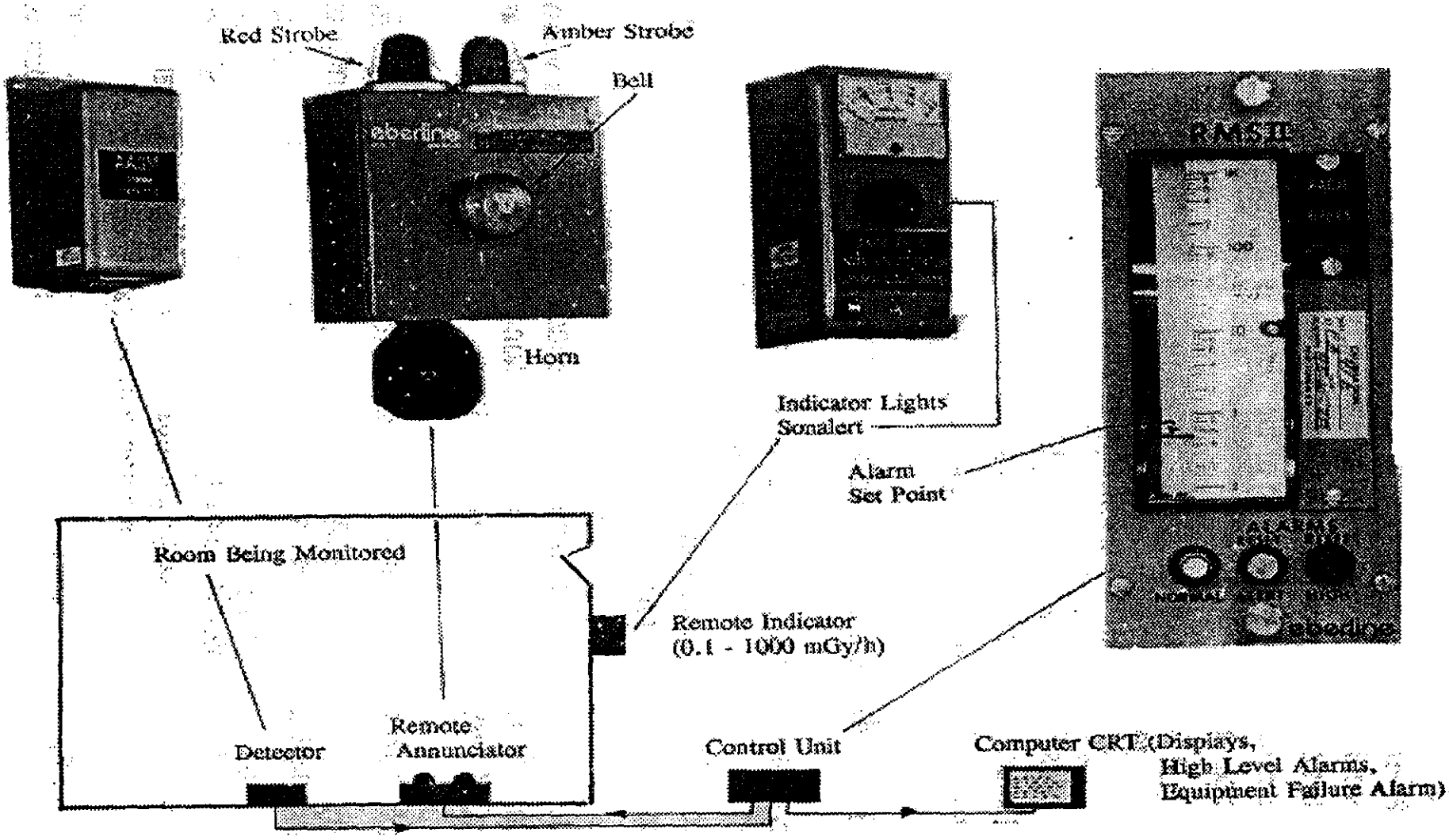


Fig. 7.4. Alarming Area Gamma Monitoring System

ALARMING AREA GAMMA MONITORS

give audible and visual alarms of preset dose rates are exceeded. System (Fig. 7.4, p.290) has the following components:

a) **Detectors and Remote Annunciators**

b) **Remote Annunciator** has visual and audible alarms for high dose rate (red strobe and siren) or equipment failure (amber strobe and bell).

c) **Remote Indicator** at entrance to each area.

d) **Control Unit** for each monitor in the Control Equipment Room.

e) The AAGM system is connected to the station control computer.

f) The AAGM system is interlocked with the Access Control System. The alarms are normally set at 0.5 mGy/h, except for the FM Vaults and the Moderator Enclosure which are set at 1 mGy/h: disabled when areas are vacant.

g) If you have to enter an Access Controlled area and the alarm is on, the Control Room Operator would have to get the alarm setpoint raised until the alarm clears. Otherwise, you would have no warning of an increase in fields above the present level.

666 badge no.	H. WALLBANGER name
84-10-01 period commencing	H Wallbanger signature

date	location or operation	readings mSv			
		initial	final	net	total net
84-10-01	dosimeter check	0.2	4.4	4.2	X
10-01	RI-406	0	0.2	0.2	0.2
10-02	R1B Survey	0.2	0.3	0.1	0.3
10-03	R1B Survey	0.3	0.3	0	0.3
10-04	PHT Resin Slurry	0.3	0.7	0.4	0.7
10-05	Dent/dedent	0.7	0.9	0.2	0.9
10-08	RI-107/108	1.0	1.2	0.2	1.1
10-09	Boiler Room	1.2	1.5	0.3	1.4
	" , neutrons	——	——	0.3	1.7
10-09	Rezero	0.1			
10-10	RPT Requal.	0.1	0.3	0.2	1.9
10-11	"	0.3	0.3	0	1.9
10-12	"	0.3	0.4	0.1	2.0
10-13	R/B Continues	0.4	0.5	0.1	2.1
10-14	R/B Continues	0.5	0.5	0	2.1

cont'd on reverse

dosimeter record card
RECORD NEUTRON AND DRD DOSES

Fig. 7.7. Harvey Wallbanger's DRD Card

USING SUITABLE DOSIMETRY

Everybody entering Zones 2 and 3 wears dosimeters to measure external radiation dose. These are:

Thermoluminescent Dosimeters (TLD),

Direct Reading Dosimeters (DRD),

Personal Alarming Dosimeters (PAD).

For neutron dosimetry, our only suitable device is the neutron meter/integrator.