HEALTH PHYSICS DATA ACQUISITION SYSTEM AT THE NATIONAL MEDICAL CYCLOTRON

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ABSTRACT

A data acquisition system for health physics radiation monitoring instruments at the National Medical Cyclotron Facility has been developed. Analogue outputs from the radiation monitors, placed at various locations within the facility are connected to an industrial datalogger with RF shielded, twisted pair cables. A driver software has been written for the presentation of various real time mimics and trend graphs, automatic sequential data storage in a 600 Mega Byte optical disk and for the delivery of digital alarm outputs for safety interlock circuitry.

1. INTRODUCTION

The National Medical Cyclotron (NMC) located at Sydney Australia, has been operating since July 1991. The NMC is a variable energy cyclotron, accelerating negative hydrogen ions (H^-) up to 30 MeV. It has a dual beam capability for simultaneous production of PET (^{18}F,^{13}N, ^{15}O, ^{13}C) and SPECT (^{67}Ga, ^{111}In and ^{201}Tl) isotopes and ^{123}I for domestic use and for the export to neighbouring countries.

During the routine operation of the cyclotron, the solid targets are bombarded with an intense proton beam of up to 130 μA and strong gamma and neutron radiation fields are produced. Therefore, radiological shielding comprising a 2.3 metre thick low sodium content concrete wall for the cyclotron vault and the beam room[1] and a reliable radiation surveillance system have been developed in order to reduce the radiation exposure to the cyclotron workers and the members of the public.

2. LAYOUT OF THE MONITORING SYSTEM

The radiation monitoring system at the NMC has been structured into three sections.

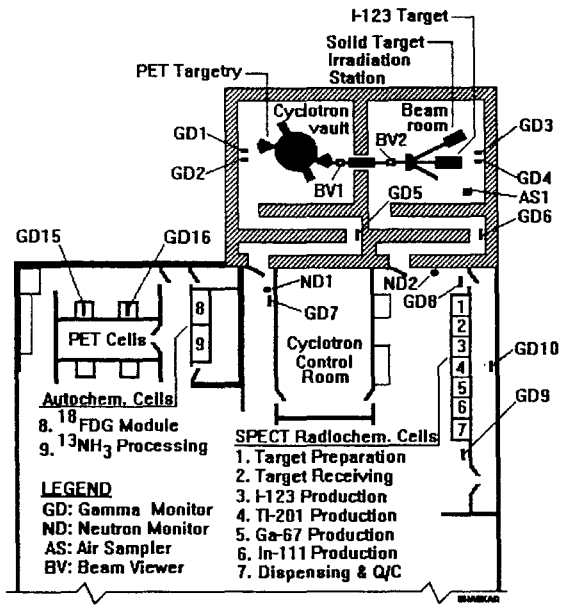

Fig. 1. Schematic diagram of the Australian National Medical Cyclotron Facility showing the Cyclotron vault, Beam room, Radiochemical Hot-Cells, Automatic Chemistry modules, PET Research Cells and the Targets.

2.1) Cyclotron vault, Beam room and Hot cell Monitoring

Gamma and neutron monitors are placed at various locations near the targets, maze and entrance door as shown in Figure 1. The local door interlock relays are connected to the monitors.

2.2) Stack Monitoring

Gamma detectors are fixed near the high efficiency particulate (HEPA) and iodine filters. Additionally, a noble gas monitor, developed by the Occupational Health and Safety Program of ANSTO is connected directly to the stack for a continuous assessment of radioactive ^{41}Ar produced in the target room due to the neutron activation of stable ^{40}Ar present in air[2] and is shown in Figure 2.

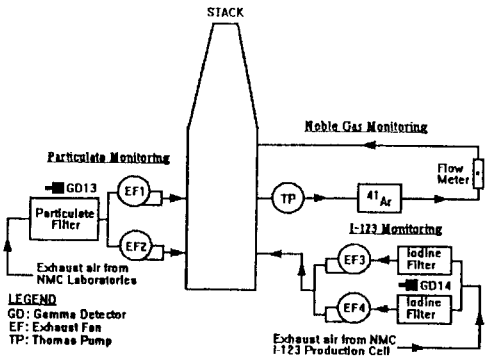

Fig. 2. Schematic Diagram of the Stack monitoring system showing the Filters, Radiation monitors and Pumps.

2.3) Liquid Waste Monitoring

Gamma monitors are fixed at the critical delay tanks, located in the basement of the facility as shown in Figure 3. All monitors are connected to the central health physics data acquisition system.

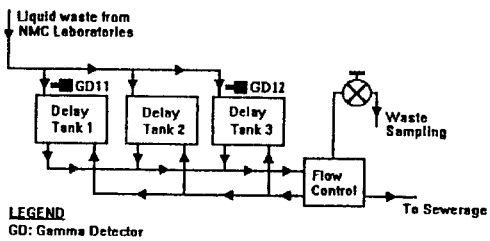

Fig. 3. Schematic Diagram of the Liquid Waste Monitoring System showing the delay tanks, Gamma monitors and Flow control unit.

3. HARDWARE CONFIGURATION

The NMC radiation monitoring system is basically comprised of two types of hardware.

3.1) Radiation Monitor

Gamma ray monitors using energy compensated Geiger-Mueller counters with the following specifications have been chosen (Fig. 4):

(a) Wide range dose measurement
(b) Local alarm contact with preset threshold
(c) Visual and audible alarm
(d) Preset local alarm contacts
(e) Large analogue display
(f) Analogue voltage output (0-5V)
(g) Built in low activity check source
(h) Uninterrupted power supply (240V, 50 Hz)

The neutron detectors with polyethylene moderated BF_3 tubes are connected to a similar type of monitoring instrument.

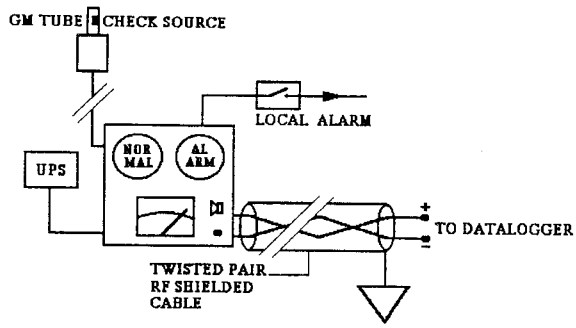

Fig. 4. Schematic Diagram of the basic Radiation Monitoring unit with its various components and Data and Alarm pathways.

3.2) Datalogger

A robust industrial standard datalogger (Australian made) of 15 bit resolution and with the following specifications has been chosen:

(a) 25 differential analogue input channels
(b) 21 digital I/O channels
(c) 8 high power (solid state relay) digital output channels
(d) Internal NiCad battery buffered power supply
(e) RS232 serial interface with a Personal Computer.

3.3) Personal Computer

An IBM compatible PC (386SX) with 6 MB RAM, a 80 MB hard disk and a 600 MB optical WORM drive has been used with a 24 pin dot matrix printer.

4. DATA ACQUISITION SYSTEM

Dataloggers have already been used for low level radiation monitoring around high energy particle accelerators[3]. Commercially available PLC based centralised radiation data acquisition systems are suitable for large complexes like nuclear research centres and nuclear power stations[4]. The present system, on the other hand, uses a datalogger in conjunction with inexpensive radiation monitors having analogue signal outputs and a supervisory control and acquisition software, developed specially for high current compact medical cyclotrons located in urban hospitals.

4.1) Software Description

Supervisory Control and Data Acquisition (SCADA) software developed by an Australian company with the following features was used as the host software:

(a) Bi-directional communication with the external datalogger
(b) High resolution mimic and graphics generation
(c) Statistical data base and data analysis capability
(d) Production of reports and print-outs
(e) Data archive in optical WORM drive
(f) File transfer capability to Lotus 1-2-3
(g) Remote data transfer capability via modem or LAN
(h) Password protection

4.2) System Description

The cyclotron health physics data acquisition (driver) software (TLCYCLO) has been written within the host software package with the following unique characteristics:

(a) Real time data acquisition
(b) Automatic calibration of the radiation monitors
(c) Linearisation of the outputs with multi-order polynomials
(d) Tamperproof alarm set up capability with pass word
(e) Delivery of remote alarms
(f) Delivery of start-up signal to cyclotron interlock PLC
(g) Display of the high resolution mimic of the facility
(h) Password protection upto 3 different priority levels

The schematic diagram of the NMC radiation monitoring system is shown in Figure 5.

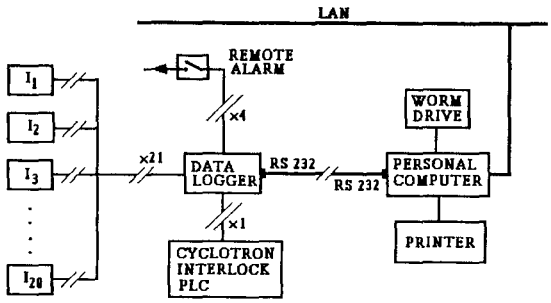

Fig. 5. Schematic Diagram of the Radiation Monitoring System showing the various Radiation monitors (I_1, I_2....I_{20}), Dataloger, Remote alarms (x4), Cyclotron interlock PLC (x1) and the Computer system.

5. ACKNOWLEDGMENT

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