Real-Time Radiation Monitoring in SRRC

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Abstract

The structure and functions of the real-time radiation monitoring system installed in SRRC have been described. It was demonstrated that from the measured radiation levels delivered by this real-time monitoring system variety of valuable information could be extracted including operating conditions, beam life time, electron loss pattern, ratio of neutron to gamma-ray dose,and residual activity.

1.INTRODUCTION

Synchrotron Radiation Research Center (SRRC) facility consists of an injector, a transport line, and a storage ring with a circumference of 120 meters. The injector contains a 50-MeV LINAC and a 1.3 GeV Booster ring. The designed machine specifications are 1.3 GeV electron energy, 200-mA stored current, 10-Hz repetition rate, and 5-mA injection current. The radiation environment around SRRC machine consists of bremsstrahlung produced through electron-photon cascade radiation and high-energy neutrons induced by photonuclear reactions. Since electron loss pattern and therefore radiation level around synchrotron radiation machine depends strongly on operation condition and in many circumstances can not be predicted precisely, real time radiation monitoring is essential not only for the radiation protection and control but for the provision of valuable information for the machine study and operation.

2.SYSTEM DESCRIPTION

2.1 System Configurations

The real-time radiation monitoring system of SRRC [1,2] consists of radiation monitors, personal computers, software program, and computer network. Figure 1 shows the configuration diagram of the system. Twelve area monitors were installed all around the radiation controlled area, among them seven were in storage ring and five in booster ring as shown in FIG. 2 . Each of the area monitors [3,4] was essentially equipped with both gamma-ray and neutron detectors. Gamma-ray detectors are essentially high pressure ionization chambers and neutron detectors are conventional neutron rem counters. Four environmental monitors which are high pressure ionization chambers [5] were installed around the site boundary of SRRC. Radiation monitors around storage ring, booster ring and site boundary were connected through RS-232/RS-422(RS-485) interface to one of the three PCs, respectively. Each of the two area monitors which have no built-in buffer memory was connected to a dedicated PC as shown in FIG. 1. The radiation dose-rate data acquired every minute by the data acquisition PCs are transferred to the hard disk of a file server through the computer network. A sophisticated software program written under WINDOWS has been used
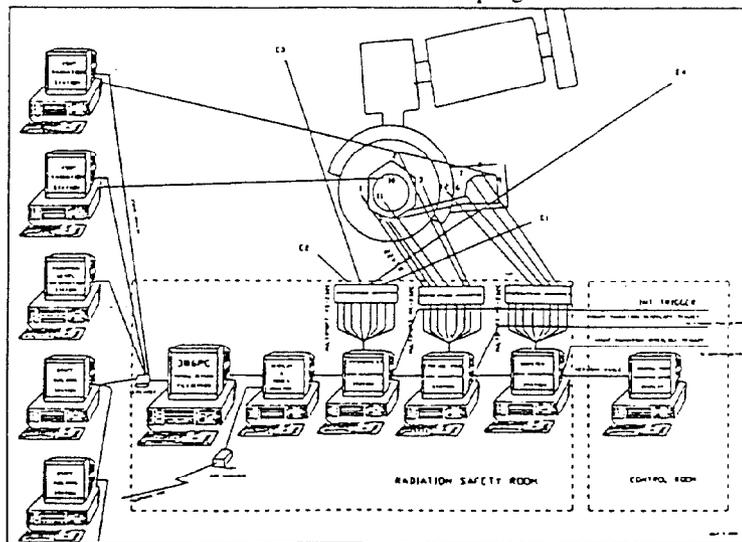
Figure 1. Configuration diagram of real-time radiation monitoring system

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to perform a variety of displays of radiation dose level measured by each of radiation monitors.The information can be retrieved from any one office PC through computer network.
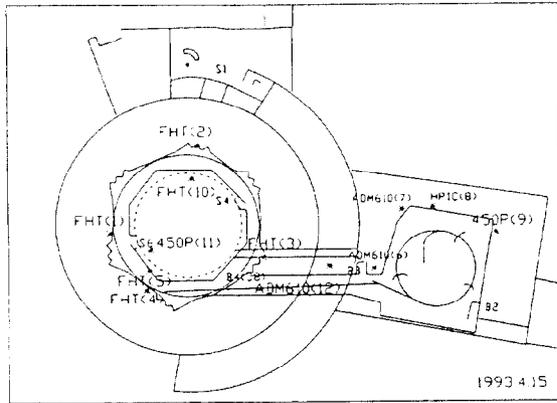
Figure 2. Installation locations of radiation area monitors

2.2 System Function

The real-time radiation monitoring system of SRRC has the following functions. Since it provides real-time display of radiation level, this system can serve as a radiation-level broadcasting system. It can be used to provide trigger signal for interlock devices to shutdown the injection operation when the radiation level exceeds some preset alarm level. Because it keeps record of radiation level history of each radiation monitor, this system can provide on-line radiation level inquiry for in-house staff. Different kinds of information displays can be shown on the screen, such as, radiation level of each monitor shown in bar chart or on installation map with data updated every one minute and radiation level history of each monitor or combination of monitors for selected time period shown in plotted curve or curves.

3.RADIATION LEVELS DURING OPERATION

3.1 Injection and Store

Figure 3 shows gamma-ray radiation-level curves measured by monitors around storage ring on Nov. 8, 1993. It is clear that gamma-ray radiation levels were in one to four orders of magnitude higher during injection than during storage period. Electron loss was most pronounced at injection area (monitor 4 and 5). All radiation monitors, however, recorded high radiation levels. Monitor 4. was installed on the outer wall of the shielding tunnel and was closer to the injection point than monitor 5, which was installed on the roof of the tunnel. Monitor 4 sensed lower

radiation level than monitor 5, it may be due to the fact that monitor 4 lay behind 10-cm thick lead shield mounted on the wall of shielding tunnel.
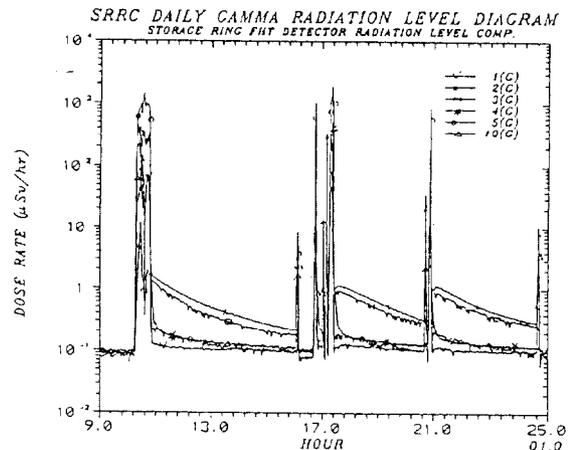
Fig. 3. Gamma -ray radiation levels around stroage ring on Nov. 8, 1993.

During store period radiation level around storage ring was low. radiation levels at locations of monitors 2 and 3 were significantly higher than at other locations. The reason for this is that monitors 2 and 3 lay at the end of straight sections, where higher radiation level came from gas bremsstrahlung. From the decay curves of these gas-bremsstrahlung radiation levels information about beam life time may be derived. Neutron radiation levels measured by monitors around storage ring on the same day are shown in Fig. 4.
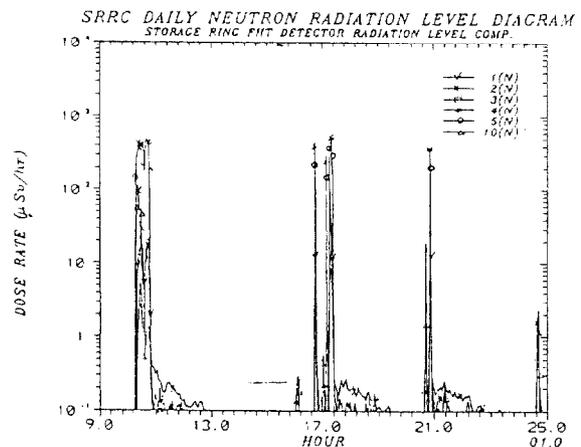
Fig. 4. Neutron radiation levels around storage ring on Nov. 8, 1993.

It can be seen from Fig. 4 that during injection neutron dose levels were proportional to gamma-ray dose levels in a ratio of about 1/3 except for that measured by monitor 4 which was even higher than gamma-ray dose level. Since monitor 4 lay behind 10-cm thick lead, more neutrons would

be produced as high-energy bremsstrahlung passing through lead. During storage period neutron dose levels were very low and hardly to be detected by the monitors. Figure 5 shows gamma-ray radiation levels around storage ring on Nov. 23, 1993. Similarly during storage radiation level at monitor 2 and 3 were due to gas bremsstrahlung. The perceivable radiation levels at monitors 4 and 5 were due to residual activity at injection point, where great amount of radiation activity was produced during injection.
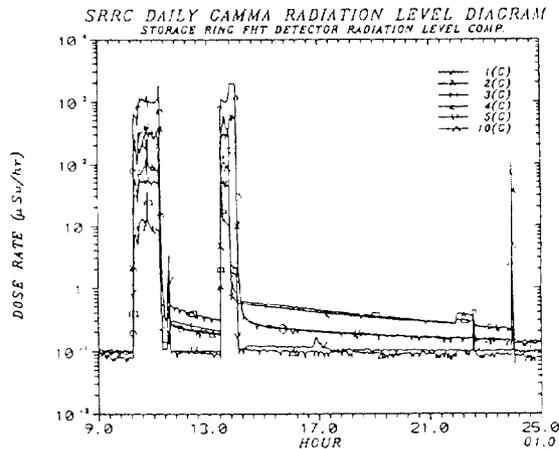
Fig. 5. Gamma-ray radiation levels around storage ring on Nov. 23, 1993.

3.2 Trip/Dump

As shown in Fig. 3 at about 16:00 stored beam was dumped. High radiation levels were only sensed by monitor 5, 4, and 1 because have beam was dumped by kickers. Beam dump at 23:30 as shown in Fig. 5 was caused by RF. Therefore, only monitors 2 and 10 which lay just at upstream of RF devices sensed high radiation levels.

4.CONCLUSIONS

A real-time radiation monitoring system consisting of area monitors, environmental monitors, personal computers, and computer network has been established and put into commission successfully in SRRC. From the inspection of the radiation-level curve of each radiation monitor, variety of valuable information can be extracted including operation conditions (injection, store, and beam trip/dump), beam life time, electron loss pattern, neutron-to-gamma-ray dose ratio, and residual activity. The information delivered by this real-time radiation monitoring system is of great benefit not only for radiation protection and control but also for the machine study and operation.

5.REFERENCES

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