NETWORK OF RADIATION MONITORS (NORM) AT KEK AND ITS PRESENT STATUS

Mitsuhiro Miyajima, Shinichi Sasaki, Kenichi Hozumi
and Kazuaki Katoh
National Laboratory for High Energy Physics (KEK)
Uehara 1-1, Oho, Tsukuba, Ibaraki, 305 JAPAN

INTRODUCTION

The NORM, Network of Radiation Monitors, had firstly constructed in 1980 with a center, 3 sub-stations and 48 radiation monitors. The basic conditions for the construction of the NORM were as follows: the first is to ensure the large extension of the number of both the sub-station and the radiation monitor, the second to invest the selection of radiation detectors with the large flexibility so as to allow stepwise development of those, the third to unify the assemblage of radiation detectors and electronic circuits, and the fourth to simplify the connection between a sub-station and a radiation monitor. The NORM has largely expanded for 7 years. Here we describe the NORM system in detail.

ROLES OF NORM AT KEK

In KEK the laboratory site is divided into 7 radiation areas. The radiation monitors are mainly installed at representative places to monitor the level of radiations and radioactivities in air or dust in such areas. The important role of the radiation monitors is to raise an audible alarm with a flashing light when the level of radiations or radioactive contaminations exceeds the assigned one. There are some radiation monitors which are installed near the border between the radiation area and the residential area and also on the site boundary. The crucial role of the radiation monitors on the border is to stop the machine operation as soon as the radiation level exceeds the assigned one. The radiation monitors on the site-boundary always verify the background level of radiations. The sub-station is located in each local control room of its facility. During the machine operation, operators sometimes need informations on the radiation monitors and on the generations of radiation alarms and interlocks in order to feed those back to the operation of their facilities. The sub-station also make the book-keeping of a short period (a week), and display the dose rates at all monitoring points and messages about the radiation interlocks. The center is located in the radiation control office and all the sub-stations are connected to this center. The center receives the status and the radiation levels of all the monitors from 7 stations. The book-keeping of all the data about the radiation monitors are also made at the center.

THE SYSTEM OF NORM

The NORM is at present composed of three different systems, a

central mini-computer (CENTER), 7 sub-stations (STATION) and 192 stand-alone radiation monitors (SARM). Each STATION is star-likely connected to the CENTER with two pairs of local telephone lines. Each SARM is also star-likely connected to one of the STATIONs with a coaxial cable through a module in a CAMAC system which is dedicated to the STATION. At each monitoring point, two SARMs are normally installed with a detector for gamma-rays and one for neutrons. In order to monitor activities, a detector for gamma-rays is used. The detectors presently used in KEK are shown in table 1.

Two types of the radiation monitor are developed. One is a table-top radiation monitor and is composed of a radiation detector with a preamplifier, a main amplifier with a discriminator, a presetable scaler with a comparison logic circuit and a 100 mA cable driver. All the circuits except the preamplifier are contained in a monitor frame with a high voltage and a biasing power supplies as shown in Fig.1. A detector can be set on the frame or separately on a wall. The other is a wall-mount radiation monitor, which is furnished with just doubled circuits of the table-top one in its frame. The detectors are separately mounted on a wall. The dose equivalent rate due to gamma-rays and also due to neutrons are separately calculated from each counting rate. The dose equivalent rate summed up every 10 sec is displayed with LED on the front panel of monitor frame. The signal, which is correspond to each count, is sent to the STATION through the 100 mA cable driver. The termination of the 100 mA current driver is made at the input of a CAMAC module with a resistor of 50 ohm. It keeps the dc level of the input 5 volt and a narrow negative going pulse correspond to each count as a signal. The dc level of 5 volt is used to detect a power failure at the SARM. In order to use the ionization chamber for the SARM, a circuit, which is used to quantize the output dc signal from a charge integrator of the chamber, is incorporated instead of the amplifier system.

The STATION is composed of a micro-computer (NOVA MP/100) with a down-line loader, a CAMAC system and a graphical display unit (Apple II) as shown in Fig.2. In the CAMAC crate, a timer module is used to generate a LAM signal every 10 sec to the computer to force it read the data in all modules. Modules used in the NORM are mainly 4-channel 24-bit scalers and interlock drivers. Each scaler registers the signals from a SARM and also watches the dc level of the input. If the dc level is zero, it outputs a special bit pattern to the CAMAC dataway. If not, it sends out the number of counts for 10 sec to the dataway. An interlock driver receives the same signals as a scaler and looks for the case that all counts in eight short successive periods exceed the counts which correspond to a level of radiation interlock. If the case is found, a signal is sent to the operator's console and the operation of accelerator is automatically stopped. The computer of the STATION reads all the data from modules in the crate every 10 sec, and sorts and puts those data in its memory. Also, it sends the data to the CRT display. It interrupts the center computer and sends the status of the SARM if it finds the SARM which generate alarms or interlock signals. Furthermore, it sends the data to the CENTER, whenever it receives a request from the CENTER. The data of hourly dose from

all the SARMs are sent to the CENTER once a day.

The CENTER is a mini-computer (NOVA 4/X) system equipped with a disk with large capacity which is shown in Fig.3. The computer is operated under the real time disk operating system which has two grounds. An on-line program, which is used for communication between the CENTER and the STATIONs, is always running at the Background. The analysis and the book-keeping of the data from all the SARMs are made at the Foreground. Furthermore, programs running at the STATION are written at the Foreground and are sent through the down-line-loader to each STATION. A main task of the on-line program is to collect all the data which are sent from all the STATIONs once a day. In the disk, recent two years data are kept in the form of hourly dose for all the monitoring points and are served to analyze the data and to make the book-keepings of those. The current data in the forms of every 6 min, hourly, and daily dose for a past week are always available at the STATION with the request of the CENTER.

PRESENT STATUS

The NORM is composed of 7 STATIONs and 192 radiation monitors at present and have grown from the composition of 3 STATIONs and 48 radiation monitors at the beginning as mentioned above. There now exist two STATIONs which have no space for adding modules further, but a mini-CAMAC system, which is connected through a register module instead of a scaler one in the STATION, is now used to install more SARMs. The computer of the STATION have a only 64 kiro-bytes memory and the program size are limited. However, we still afford to add a STATION in the NORM. About 20 monitors are always ready for installation at present. Whenever troubles at the SARM are found, it is completely replaced with a same type of SARM as soon as possible. If there are found any troubles with three boards in the MP/100, a processor, a memory and an interface one, those are easily replaceable with their alternatives. The periodical examination of all the STATIONs and SARMs is made once a year and the whole system of CENTER is examined twice a year.

DISCUSSION

This NORM system had been planned and designed about 10 years before. In this period we saw outstandingly rapid growth of mini-computers and micro-computers. However, the computers used in the NORM are still convinced to be the best choice at those times. The star-like network of the computers is still powerful in our laboratory because the local power failure or cut only gives rise to the loss of one or two STATIONs. In the case of the radiation monitor, which had been designed as the SARM at those days, we had a lots of benefit for maintenance, replacement, movement, installation and enlargement. Furthermore, the unification of communication signal makes the whole system reliable and especially the 100 mA current driver makes the connection of a monitor to the STATION easy and is free from the contamination of noise in signals.

Neutron	BF_3-Counter with 6.5cm polyethylene	15cmϕ x 180cm 2"ϕ x 14" 1"ϕ x 10" 1"ϕ x 4"
Gamma-ray (x-ray)	side window GM counter	5/8" x 8.58"
	air filled ionization chamber	10 ℓ
Gamma-ray (Activities)	NaI (Tℓ) scintillator	2"ϕ x 2"

Table 1 Radiation monitors

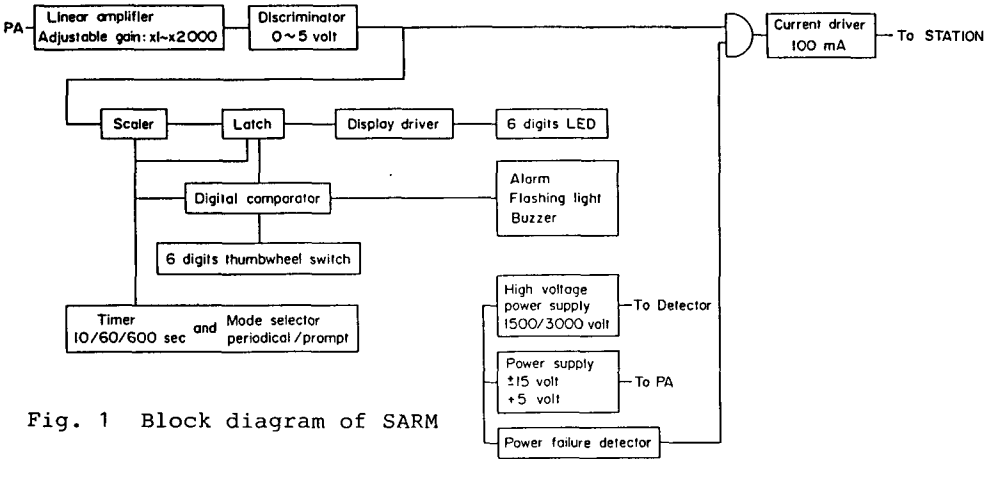

Fig. 1 Block diagram of SARM

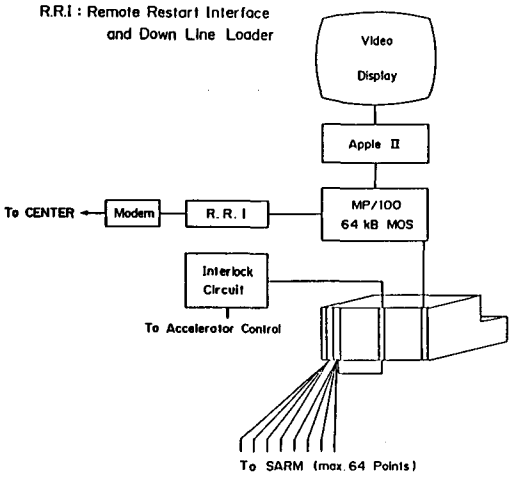

Fig. 2 Block diagram of STATION

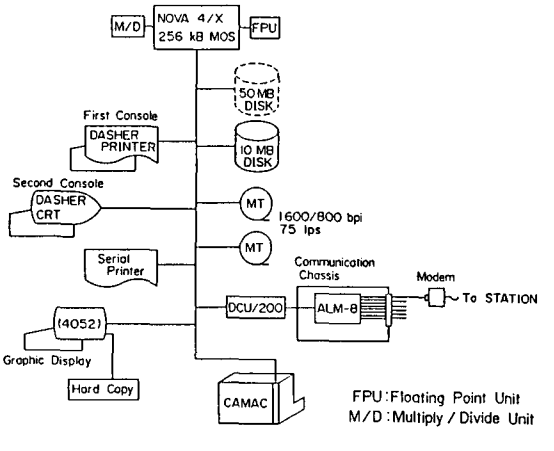

Fig. 3 Block diagram of CENTER