Personal Dose Monitoring System (Wireless Monitoring System)

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1. Introduction

Personnel working in radiation controlled areas of facilities that utilize radiation, such as at a nuclear power plant or the like, are required to carry a personal dosemeter. Figure 1 shows the configuration of a personal dose monitoring system employed at an area access control gate. An area access control gate is installed at the entrance and exit of the radiation controlled area, and information, such as a worker's ID number and dose data, stored in the memory of a personal dosemeter is transmitted from the personal dosemeter to the area access control gate. In a conventional system, dose data is obtained in a radiation controlled area by verifying the dosage display on a dosemeter, or by sounding an alarm buzzer when a certain dosage warning level has been reached. A drawback of the conventional system, however, is that the controller obtains dose data for each worker only at the entrance and exit of the radiation controlled area several times a day. Therefore, it is desired to continuously monitor a worker's dosage in order to protect against radiation. Especially for work performed in a high dose area, the real-time acquisition of personal dose data is desired.

2. System Overview and System Specifications

Usually, a worker only carries their own personal dosemeter, and a reading system that has been installed at the entrance or exit of a controlled radiation area reads the accumulated data of the dosemeter whenever the worker enters or exits the controlled area. However, dose monitoring of workers that work in a high dose area must be performed in that controlled area within a short amount of time. So as to support this requirement, a wireless attachment is mounted onto the personal dosemeters in use, thereby configuring a system capable of dosage monitoring. In cycles lasting from several seconds to several minutes, this system is able to monitor dose data of a few or several tens of workers in a controlled radiation area. Furthermore, departure orders and other warning information can be transmitted in real-time from the monitoring system to the personal dosemeters. This system is suitable for such applications as: ① monitoring dose data during normal operation (monitoring many workers with a cycle time of several minutes), ② real-time monitoring of the individual data of workers working in a high radiation area (monitoring a few workers with a cycle time of several seconds), and ③ simple area monitoring using personal dosemeters.

As shown in Fig. 2, a personal dose monitoring system is configured from a wireless attachment for personal dosemeters (hereafter referred to a wireless attachment), a personal dosemeter, a relay station and a data processing unit. The wireless attachment, as shown in Fig. 3, consists of an attachment mountable

Fig.1 Dose monitoring system with area access control gate

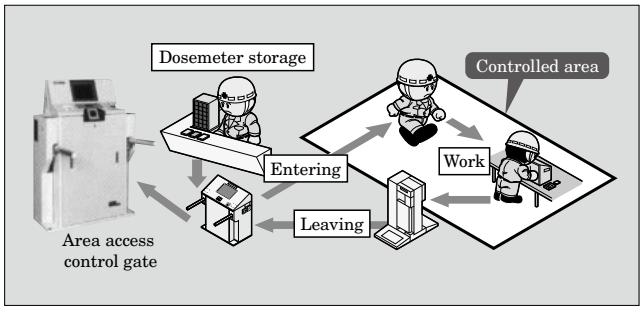


Fig.2 Personal dose monitoring system

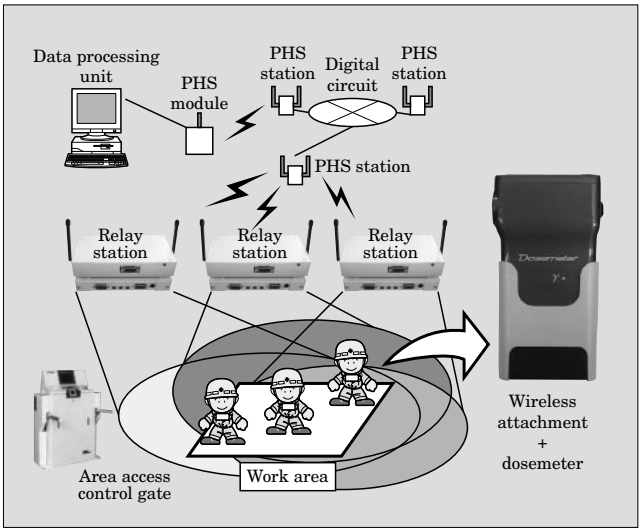


Fig.3 Wireless attachment + dosemeter

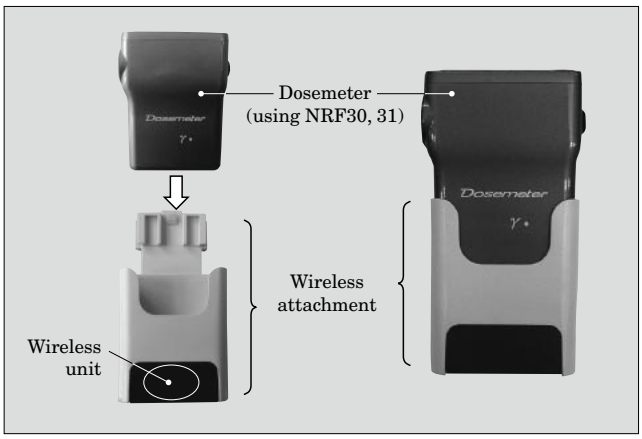
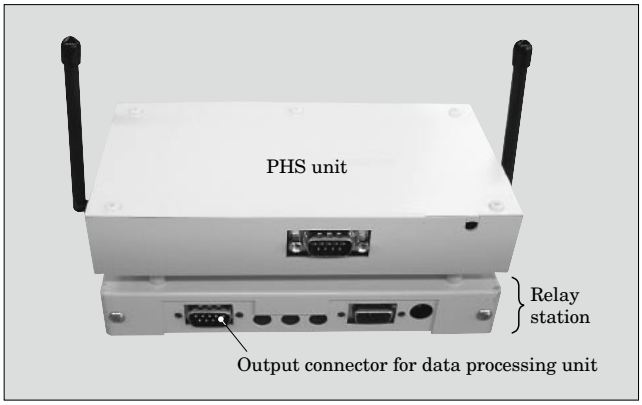


Fig.4 Relay station

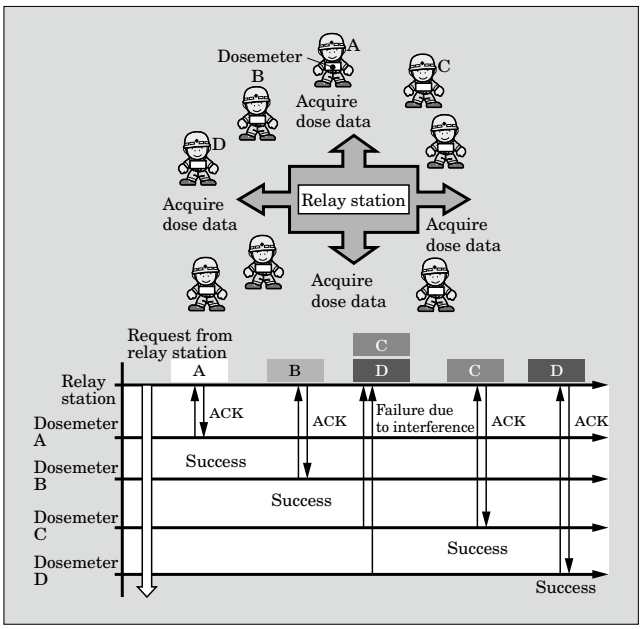


to the personal dosemeter containing a built-in radiation sensor, and a wireless unit for implementing the wireless transmission of dose data from the dosemeter to a relay station. Moreover, the personal dosemeter is also provided with an infrared communication function so as to be able to transmit dose data externally. The wireless attachment is also provided with an infrared communication function which is used to transmit dose data and so on between the personal dosemeter and the wireless unit. The relay station shown in Fig. 4 is provided with a function for temporarily storing dose data from multiple wireless attachments and a mechanism for transmitting data to a data processing unit. The mechanism for transmitting data to the upper-level data processing unit can be selected from among: ① a PHS-based communication method (local area circuit), ② an Ethernet*1-based communication method, or ③ a RS-232C-based communication method (for uploading data directly to a data processing unit). The relay stations shown in Figs. 2 and 4 are an example of a PHS-based communication method.

The operation is described below. Figure 5 depicts the principles of a monitoring operation in the case where an unspecified large number of personal are present in a controlled area and dose data must be

*1: Ethernet is a registered trademark of Xerox Corp., USA.

Fig.5 Principles of monitoring operation



acquired. At prescribed cycle times, the relay station requests dose data from the wireless attachments carried by the workers. The dose data request signal received by a wireless attachment is converted from an electrical signal to an infrared optical signal and transmitted to the personal dosemeter. In response to the request for data, the personal dosemeter uses a built-in infrared communication function to transmit dose data as an optical signal to the wireless attachment. The wireless attachment receives the dose data and then transmits the dose data to the relay station at a random timing so there is little risk of interfering with a wireless signal from a wireless attachment carried by another worker. If there is no interference, the dose date is transmitted to the relay station and the wireless attachment receives an ACK signal from the relay station acknowledging that reception was successful to complete the communication. If there is interference, however, an ACK signal is not received from the relay station and the transmission will be attempted again at a random timing to avoid interference. By repeating this type of communication at prescribed cycle times, this communication method achieves a success rate of nearly 100 %.

The dose data from multiple wireless attachments is first stored in a memory inside the relay station. Then, at predetermined cycles, in response to data requests from the data processing unit that reads signals, the relay station transmits the dose data stored in the memory to the data processing unit. The data communication method used at this time may be any of the three methods described above. The main system specifications are listed below.

(1) Monitoring cycles: 15 s to 1 min
(2) Wireless attachments to be monitored: 10 to 50 units

Table 1 Wireless attachment specifications

Item	Details
Wireless specification	Specified low power wireless communication (Japanese standards)
Wireless frequency	429.500 MHz (tunable to other frequency bands)
Transmit power	0.01 W
Transmission rate	4,800 bps
Continuous operation time	Approx. 30 h (When communicating once per minute)
Current consumption	Approx. 17 mA

(3) Monitoring area: Several tens of meters (The area differs according the environment, and in the case of 50 units, is 10 × 10 m or less)

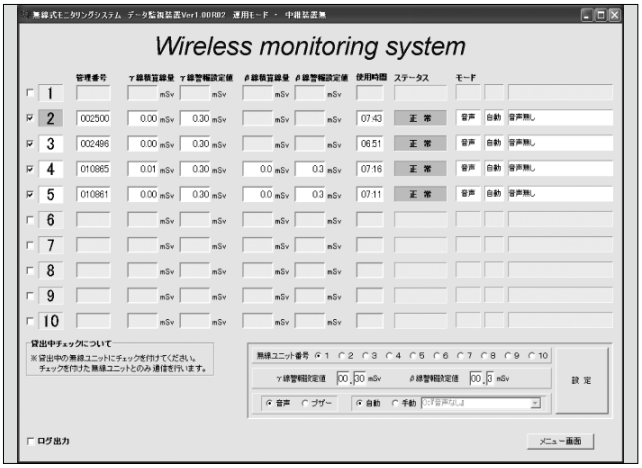
The monitoring interval can be set to approximately 15 seconds for a small number of people, or to approximately 1 minute for a large number of people. As an example, in the case where there are 50 wireless attachments to be sampled, the sampling interval will be approximately 1 minute.

3. Device Features and Specifications

3.1 Wireless attachment

The wireless attachment is provided with an attachment function capable of encapsulating the personal dosemeter (and is suitable for use with NRF30 and NRF31 dosemeters. Refer to the next chapter.) The wireless attachment is also provided with a function for converting the infrared optical signal from the personal dosemeter into an electrical signal. The wireless communication between relay stations is implemented using a type of specified low power wireless communication, and the frequency of this specified low power wireless communication can be changed to a setting that enables use overseas. Since the wireless attachment and the personal dosemeter are electrically isolated, the wireless attachment is equipped with a rechargeable AAA-size battery (nickel hydride). At the bottom of the wireless attachment is provided a terminal for connecting a charging device, and the battery can be recharged via this terminal. Or, a commercially available ordinary AAA battery may also be used. The main specifications of the wireless attachment are listed in Table 1.

Fig.6 Example display screen of data processing unit



3.2 Relay station

The relay station acquires dose data via wireless transmissions from multiple wireless attachments, and temporarily stores the dose data received. The relay station can be connected via a D-SUB connector to a PHS, to an Ethernet or to a data processing unit, and uses these communication methods to transmit the dose data to the data processing unit.

3.3 Data processing unit

The data processing unit is capable of displaying the cumulative dose value of the personal dosemeters and also displaying the status of the wireless attachment. Figure 6 shows an example of the operating mode screen for the case in which ten wireless attachments are used.

4. Postscript

The use of this system to monitor radiation dosages in controlled radiation areas such as at a nuclear power plant and the like will enable the real-time monitoring of personal dose levels, thereby helping to reduce exposure and streamline the task of worker monitoring. In the future, Fuji Electric intends to deploy this system both domestically and abroad, and to continue to supply technologically advanced and highly reliable products.