THE NATIONAL RADIOACTIVITY MONITORING NETWORK OF THE NETHERLANDS

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INTRODUCTION

In 1988 the Dutch Government decided to integrate the radioactivity monitoring network of the National Institute of Public Health and the Environment (RIVM) managed on behalf of the Ministry of Housing, Spatial Planning and Environment (abbreviated in Dutch: LMR) and a similar network of Ministry of the Interior (BMNI) into the National Radioactivity Monitoring Network (in Dutch: NMR).

After the Chernobyl nuclear power plant accident in 1986, the LMR network was developed within the framework of the National Plan for Nuclear Emergency Planning and Response (EPR) as an early warning and monitoring instrument for future nuclear accidents (1). In March 1990, four years after the Chernobyl reactor accident, the LMR was officially opened. The LMR network consists of 58 stations measuring the natural background γ-radiation level. In 14 of the 58 stations monitors are installed to measure the airborne α/β-radiation level. Because different radioactive nuclides may be released during a nuclear accident the LMR also contains two nuclide-specific monitors which facilitates translation of the measured α-, β- and γ-radiation levels into an effective dose to humans.

The BMNI network is an information system primarily for local management of accidents. This network was designed and built for the Ministry of the Interior by the Netherlands Energy Research Foundation (ECN) in the period 1987-1993. It contains 252 stations measuring the surrounding γ-radiation levels. The network conforms to the management structure of the Ministry of the Interiors Fire Services Department in its hierarchical build-up of four levels: national, provincial, regional and local stations. Measurements are performed at the local level, while the responsibilities for countermeasures during accidents are at the regional level. In February 1993 this network was officially opened.

THE INTEGRATED NETWORK

The integrated network, called the National Radioactivity Monitoring Network, must satisfy the demands of all parties involved. The main objectives of measuring the radiation levels in the Netherlands are to provide:

- early warning against major nuclear accidents
- information on the geographical distribution of radioactive contamination during an accident
- information on the actual radiation doses to the population during an accident
- information on radiation doses to regional, provincial and national authorities
- general information on background levels

The solution was found in maintaining the structures of the existing networks as much as possible and to build an integrating structure, including an overall database at the National Institute of Public Health and the Environment (RIVM) at Bilthoven. In this way the integration is reached by exchange of data, which proved to be much more cost-effective than connecting the different types of monitors and computers using a technical solution.

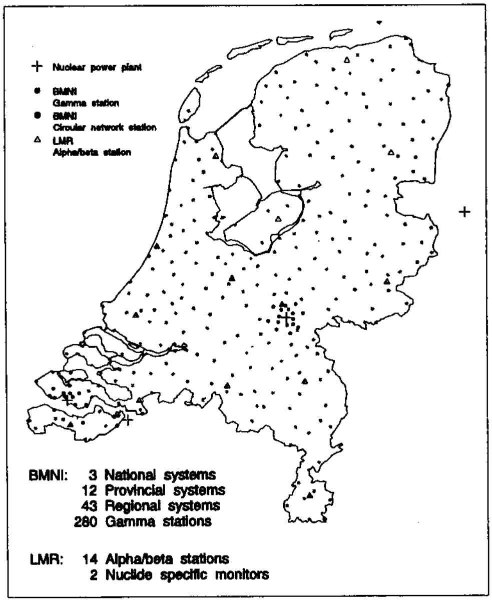

Figure 1. The NMR locations

RADIATION DETECTION

The NMR consists of 280 measuring sites that contain a proportional counter tube (Bitt RS02/1) for the determination of the gamma ambient dose-equivalent rate $H^*(10)$. The distance between sites is typically 15 km. Compared to other European countries, the Netherlands' network, as in Germany and Austria, has a relative high station density (about one station every 150 km^2). A double circular network of monitors has been installed around the two Dutch nuclear power plants: one ring at 5 and one at 10 kilometres from the power plant. These rings immediately provide emission profiles in case of accidents with the nuclear power plants and reduce the necessity for emergency staff to take measurements in highly contaminated areas. Also around the two nearby foreign nuclear power plants some monitors have been installed where the two rings intersect Dutch territory.

An airborne-activity monitor (FAG FHT 59S) determines the aerosol-bound artificial gross-beta activity concentration in air at 14 sites as an indication of inhalation dose. These 14 sites also contain a proportional counter tube to compare artificial gross-beta measurements with gamma radiation levels at the same site. Figure 1 shows all measuring locations of the NMR network.

Two nuclide-specific monitors have been added to the network at RIVM. One, the iodine-monitor, measures the gaseous radioactive iodine concentration in air and the other, the nuclide-specific gamma monitor, identifies the order of contamination of radionuclides by γ-ray spectroscopy.

DATA MANAGEMENT

The special Dutch government emergency telephone network is used for most of the data acquisition. Work stations are set up regionally (sections of provinces, 43 in total at the moment), provincially (12 in total) and nationally (3 in The Hague; a main system, a back-up system and a reserve system in case of malfunctioning of the main system). Acquisition of gamma data takes place once every hour in a hierarchical manner: a regional network calls the sites in its region and collects data, then the provincial work station calls the regional station in its area followed by the national work station, which collects the data from the provincial stations. At the end of a complete upward acquisition cycle, all data are distributed again to the 43 regional work stations. HP9000/340 computer systems, controlled by the regional fire brigades, have been placed in the regional centres. At the National Coordination Centre in The Hague, HP9000/400 computer systems process and store the data. These, as well as the data from the 14 aerosol monitors, are sent to a central database located at RIVM.

NETWORK ALERT

Twenty-four hours a day, every ten minutes, radiation levels are measured at nearly 300 sites in the Netherlands. When the network level is exceeded at one of the sites, the station processor automatically calls the NMR computer at RIVM, which in turn activates a pager carried by specially trained RIVM staff members. The most recent data are sent with the alarm message to the personal computer of the staff member on duty. Ten-minute values of the previous four hours can be examined using NMR presentation software running on personal computers stationed at the homes of RIVM staff. When the alarm level of one of the gamma counters is exceeded, it is followed by an automatic validation procedure: an alarm signal is sent out to the pager (via the NMR computer) only when at least two monitors within an area of 40x40 km^2 have their alarm levels exceeded. The chances of a false alarm due to monitor failure are greatly reduced by this measure.

In 1995 the NMR network performance was tested against the specifications for an adequate alarm response: signalizing an enhanced radioactivity level within 1.5 hours to the central database at RIVM. The tests were performed by simulating a radioactive cloud passing by over the Netherlands. With the help of the regional fire brigades' staff nearly half of the total amount of measuring stations was alarmed during those days. Because of the positive test results the NMR network was declared operational December 1, 1995. It will be officially opened early in 1996.

ACCURACY OF MEASUREMENTS

There are some specific scientific aspects related to the integration of the networks. The reproducibility of the γ-radiation measurements is high (within 3%). As a result, the data can be analyzed to determine and discriminate between the variations in the natural background γ-radiation levels (between 60 and 100 nSv/h) (2). Two γ-radiation measuring stations, one (old station) belonging to the LMR network and one to the BMNI network, are situated at a distance of about 50 metres apart in Bilthoven. The monitors of the LMR are positioned at 3.5 metres height (on top of the measuring station), while the monitors of the BMNI are positioned at 1 metre height (at ground level). Since the monitors are identical, an intercomparison of the measurements is now in progress, which may provide a possibility to separate the different contributions of cosmic radiation, terrestrial radiation, airborne and deposited radioactivity to the total γ-radiation level. Typical day/night variations in the natural γ-radiation levels were observed for some stations (*Figure 2*). Inspection of the location where the variation was observed showed that for the upper curve (station 01w501 in Kaatsheuvel) the detector was located in the direct vicinity of a shopping centre. During the day a lower γ-radiation level was seen due to the parked cars shielding the emission of γ-radiation from the used building materials in the car park.

For the lower curve (station 22w502 in Heerhugowaard), where an opposite variation in the γ-radiation level was seen, the detector was also located near a car park. However, in this particular case the car park was in front of a block of flats. Assuming the residents to be at home during the night, the γ-radiation level in this period was lower as a result of the shielding by the parked cars. This is confirmed by the measurements in the weekend. The absence of cars in the weekend resulted in a γ-radiation level for station 01w501 without dips in that period. Assuming that the residents in the block of flats also spend some time elsewhere in the weekend, the day/night variations should continue, which was indeed observed.

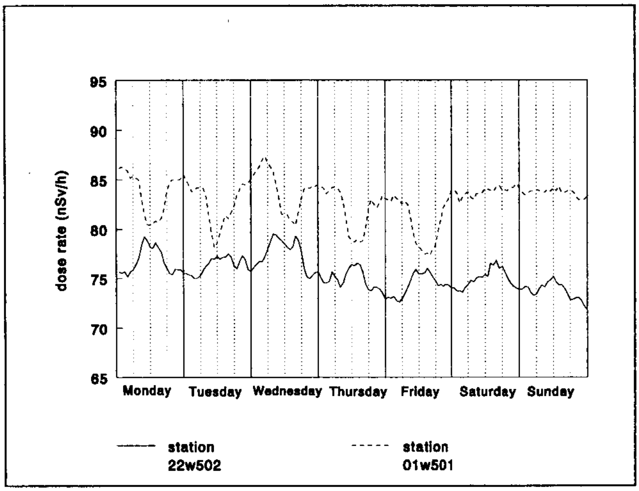

Figure 2. γ-dose rates for a week at two stations in the Netherlands.

These fluctuations and other variations in monitoring levels, with no relationship to an actual accident, can be ascribed to variations in natural environmental conditions. This illustrates that proper scientific judgement should be applied in every activation of alarm levels. RIVM provides this expertise to the EPR organisation.

NETWORK MANAGEMENT

The nuclear emergency response organisation operates on the assumption that nuclear accidents are by definition unpredictable, but do require immediate response. Therefore the network must be permanently maintained. RIVM manages the National Radioactivity Monitoring Network, providing quality assurance, developing and adjusting standard procedures for daily control, providing training of RIVM staff and financial management. ECN is subcontracted to maintain all gamma counters and the work stations. For this purpose a separate maintenance work station is operational at ECN. It is this combined network management that makes the NMR a reliable early warning network for nuclear accidents.

REFERENCES

1. Ministry of Housing, Spatial Planning and Environment, *National Plan for Nuclear Emergency Planning and Response (EPR)* (in Dutch), Tweede Kamer, 1988-1989, 21015, nr. 3, VROM 9044/2-89 1174/26, The Hague (1989).
2. R.C.G.M. Smetsers and R.O. Blaauboer, Time resolved Monitoring of Outdoor Radiation Levels in the Netherlands. *Radiation Protection Dosimetry*, 55 (3) pp. 173-181 (1994).