The national radioactivity monitoring network of the Netherlands

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Abstract Since the first activities concerning the monitoring networks of the Netherlands in 1986 a lot of optimalisation and adaptation steps have been made. A good maintenance regime, both for computer systems, software and for measuring stations is the key solution to trust in the early warning function of the network. Starting in 1986 the Nuclear Research and Consultancy Group (NRG) has built up a large expertise in the construction and maintenance of such early warning systems. This is also the benefit of having calibration facilities available on the company area of NRG for the different types of detection systems: calibrations can be performed for systems for gamma radiation, aerosols, iodine and the noble gases. Finally, with the Incident application, NRG can provide for the organisations involved in emergency planning and response a robust, user-friendly PC-application. With this application not only data can be extracted from a local computer system, at this moment tests are done with getting data from an external FTP-server.

Key words calibration • monitoring systems

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Introduction

The National Radioactivity Monitoring Network (NMR) in the Netherlands is the common product of two separate monitoring networks of the Ministry of the Interior and the Ministry of Housing, Spatial Planning and Environment. Both monitoring networks were built after the Chernobyl accident in 1986 but with a different purpose. The network of the Ministry of the Interior, the BMNI-network, was primarily designed for the local management of nuclear incidents, such as the use of nuclear weapons and accidents with nuclear power plants. The main purpose of the network of the Ministry of Housing, Spatial Planning and Environment, the LMR-network, was the detection of nuclear incidents [1, 4].

In 1994 both previously mentioned Ministries ordered integration of the BMNI and LMR networks. In 1996 the integration was finished and the new network was officially opened under the name NMR (National Radioactivity Monitoring Network.) The two original networks are nowadays referred to as the γ-module and the α/β-module of the NMR (Fig. 1). Since 1998 until now the NMR-network is upgraded. In this project called second generation NMR the system components are replaced. Also the data transmission characteristics and presentation facilities have been improved.

Technical design of the γ-module

Monitoring stations

The γ-module originally consisted of 252 monitoring stations. During the integration project with the α/β-module this number increased to 280 stations. The extra stations

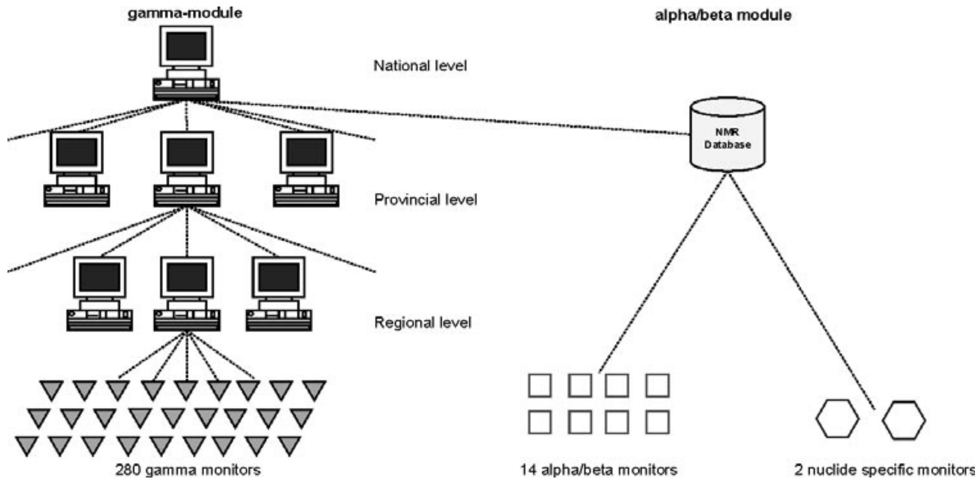

Fig. 1. The integrated NMR network.

were used to create a double circular network around the two Dutch nuclear power plants: one ring at 5 and one at 10 kilometres around each power plant. Also around the two nearby foreign nuclear power plants some monitors have been installed where the two rings intersect Dutch territory.

The grid of the γ-monitoring stations was originally based on the scattering of the former civil defence locations. The small distance between the measuring stations (below 15 km) was primarily chosen to determine the point of detonation of a nuclear weapon and to trace the fallout trajectory. During implementation of the second generation the number of γ-monitoring stations was reduced to 163. This smaller number is justified by the fact that the usage of nuclear weapons became very unlikely.

At the monitoring stations, a small computer is installed (DG14 data logger from Bitt Technology), connected with an underground cable to an external proportional detector (model RS03), measuring every ten minutes the ambient dose equivalent $H^*(10)$. The RS03 detector is placed in a protective casing outside the building, leaving a free radius of at least 20 m. The monitoring stations are NEMP (Nuclear Electro Magnetic Pulse) protected. The NEMP protection has proven to be very useful. In the year 1994 the lightning struck into a monastery in the town of Oosterbeek. All the communication equipment in the monastery (fax, telephone) was burned, because the lightning hit the telephony cable. The measuring station, which is located in the monastery, however was undamaged although the modem was unable to contact the central workstation because of the destruction of the telephone cable. Local read-out however was still possible.

Data management

In the second generation of NMR project, the central data collection stations are equipped with modern HP-Unix workstations. The 163 γ-radiation monitoring stations will be equipped with upgraded γ-detectors and data logging equipment. Finally, the aerosol monitors of the α/β-module, giving calculated artificial beta concentrations every ten minutes [3], will be replaced in the year 2001. For this purpose NRG has performed laboratory tests to examine the candidates for the replacement equipment. As an indication of the test possibilities at the company area of NRG the characteristics of a recently tested aerosol monitor are presented in Fig. 2.

The special Dutch government emergency telephony network is used for most of the data acquisition. Workstations are set up regionally (sections of provinces, 39 at the moment), provincially (12 in total) and nationally (in the Hague). The regional workstations are located at the various operational centres of the regional fire brigades. Acquisition of γ-data takes place every hour in a hierarchical manner: a regional workstation calls the measuring stations in its region and collects data, then the national workstation calls all the regional stations. At the end of the upward acquisition cycle, all data are distributed to all 39 regional workstations, 12 provincial workstations and the workstations located at NRG and RIVM. From the RIVM workstation the γ-radiation data is sent to a central database of the NMR network.

The data from the 14 aerosol monitors are also sent to this central database After approximately one hour all measuring data is available at all workstations and at the central database.

As it is imperative that the system remains operational under all circumstances, ample consideration is devoted to redundancy. In the case a workstation fails, all functions will be taken over by a neighbouring station. Two redundant computers back up the important main national workstation. The three national workstations are mutually connected through fast LAN network connections. In case of break down of the main national workstation, one of the redundant workstation will gain control immediately.

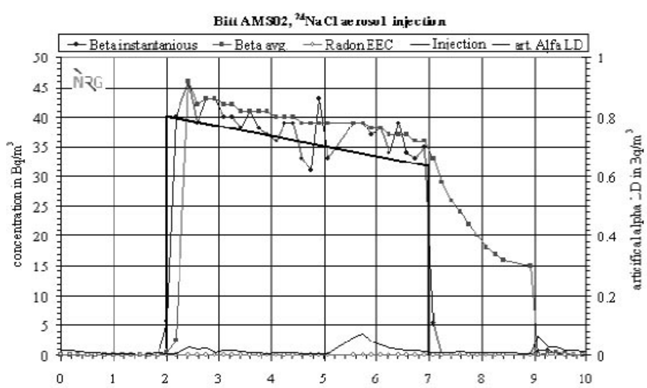

Fig. 2. Response of the Bitt AMS02 monitor to ^{24}NaCI aerosol injection as observed during laboratory tests.

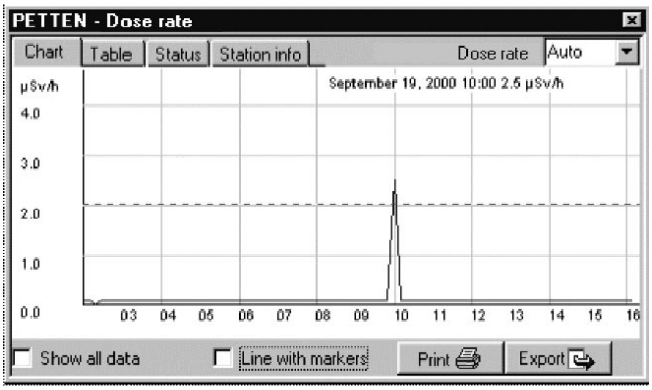

Fig. 3. Increases due to transport of radioactive materials do not cause an alarm because of the validation algorithm.

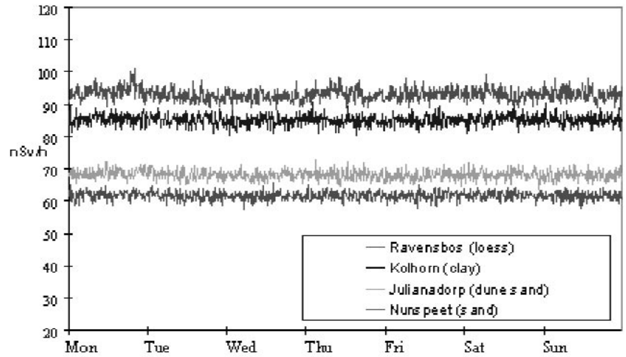

Fig. 4. Influence of different soil types on the γ-radiation level.

Network Alert

The network alert can be divided in an alert for environmental purposes and alerts for emergency purposes. When an aerosol monitor detects an increase in the calculated artificial beta concentration (above 3 Bq/m^3), then it automatically calls the NMR computer at RIVM.

When alarm thresholds are exceeded at a measuring station of the γ-module then the matching regional workstation is called automatically by the measuring station. The regional workstation performs an automatic validation procedure. This procedure implies the calling of all neighbouring stations to check if the neighbouring stations also show an increase in γ-dose rate. This method is based on the assumption that a large scale incident influences at least 2 or more neighbouring stations. The validation procedure checks all measuring stations in an area of 25 km by 25 km around the alarm reporting station. The changes of false alarm due to monitor failure or transport of radioactive materials are greatly reduced by this procedure (Fig. 3).

The γ-radiation monitoring stations have three alarm thresholds, also expressed in $H^*(10)$: the lowest at 200 nSv/h, the warning level 2 µSv/h and the alarm level at 20 µSv/h. The first alarm threshold of 200 nSv/h is only processed by the NMR computer at RIVM. This computer activates a pager carried by RIVM staff. The second and third thresholds are processed on the workstations of the γ-module. The emergency officers of the regional fire brigades will be alarmed by means of the activation of a visual and an acoustic alarm which is connected to the workstation.

Accuracy of measurements

As a result of the yearly maintenance of all monitoring stations not only a very high operationality of the network is obtained, also the accuracy of measurements is high. This accuracy, which is within 3%, can only by obtained by a calibration interval of the gamma-counters of three years. The calibration interval can only be this long period when combined with a yearly maintenance interval at the location, during which the response of the monitor is tested. When the monitor does not respond within the specifications the monitor is replaced.

With the resulting accuracy, the influence of the soil type of the location on the radiation level at a particular location can be seen (Fig. 4) [2].

Developments

Satellite communications

In 1996 NRG investigated the possibility of using satellite communication for the data link between the measuring stations and central data collection stations. A successful experiment has shown that the Inmarsat-C satellites provide a reliable way of transmitting radiation data in case of the absence of public telephony lines or a cellular network.

Next generation early warning network

As mentioned before, the γ-module of the Dutch nuclear early warning system (NMR) is build up from about 57 Unix

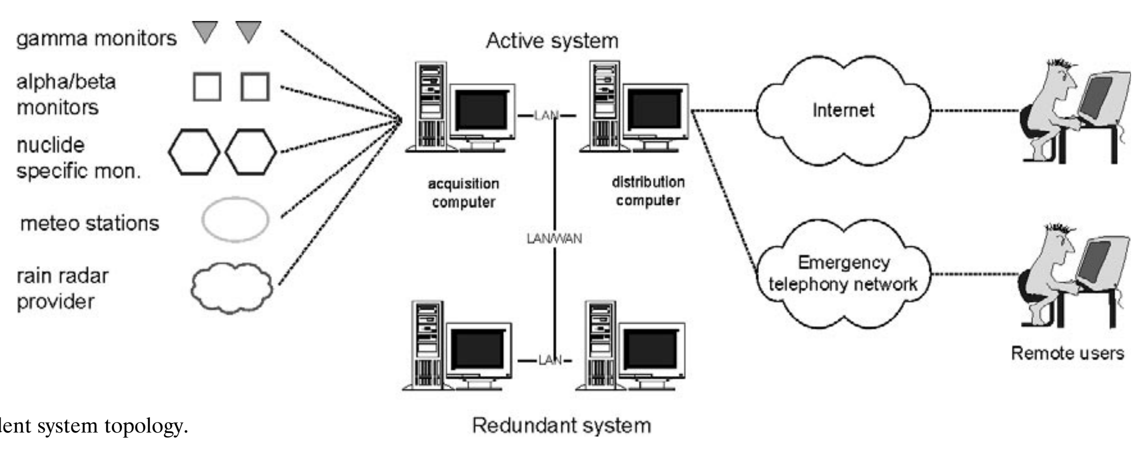

Fig. 5. Incident system topology.

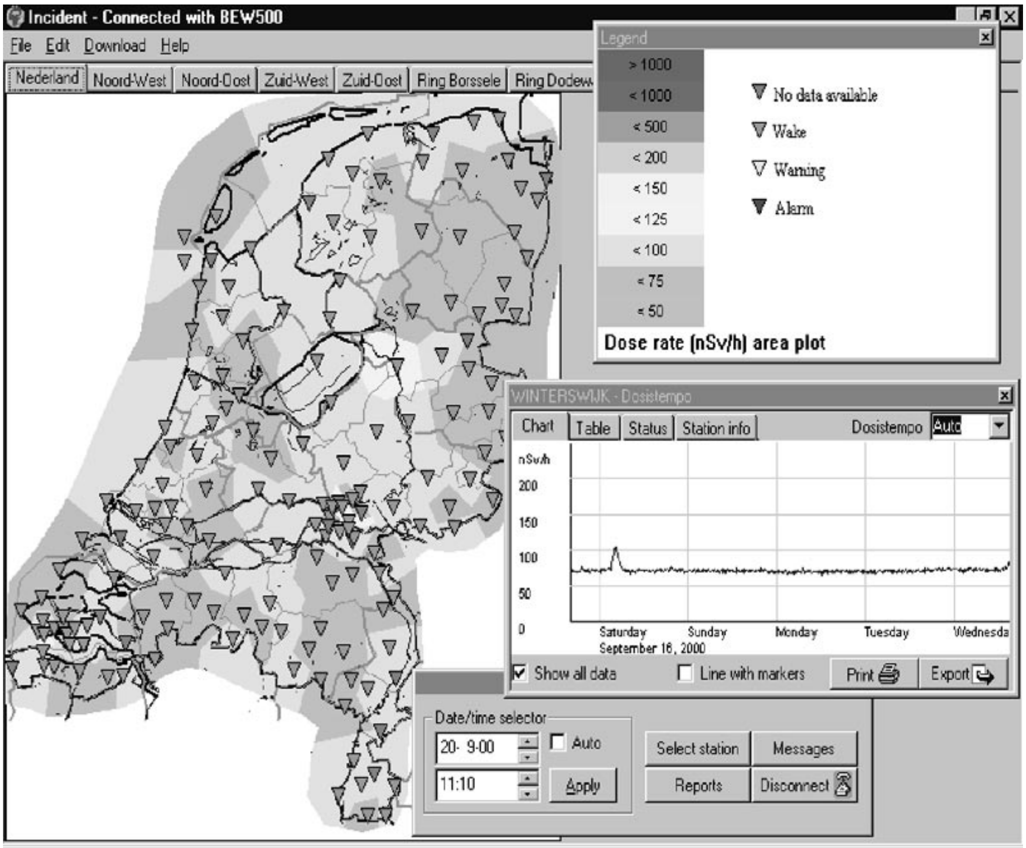

Fig. 6. The user interface of the Incident system.

servers, each covering a part (region) of the Netherlands. This approach of many Unix servers continuously exchanging data works fine and is robust because when one system fails another system takes over the tasks of the malfunctioning system. The disadvantage is that the purchase of 57 Unix servers with peripheral equipment is expensive and the cost of maintenance is high.

Ongoing technical development enables a new approach to the nation wide monitoring of radiation data. NRG has developed a new generation early warning network, which carries the name "Incident system". The Incident system is a high performance data acquisition and distribution system for radiological and meteorological quantities. The heart of the system is build up from 1 or 2 Windows NT servers, which can be backed-up by a set of redundant computers (see Fig. 5). The users connect to the servers with their own personal computers using the Internet or Intranet. The system can also be accessed trough public telephony lines or by cellular phone (GSM). The servers periodically read out all measuring stations and store the data in a database. A remote user has specialised user interface software that queries- and visualises the data.

The Incident system is primarily designed to be used as an early warning system covering a geographic area, such as a country. The system, however, is also capable of monitoring and visualising the radiological components inside or around a nuclear facility. In the Incident system a region (for example a country or a nuclear power plant) can be divided in other regions (for example provinces or buildings). Each region can be divided in other regions, so a province can be divided in one ore more subregions. If for a station the current radiological level exceeds one of the two predefined alarm levels, then the Incident system will validate the alarm. Validation is done to make sure that a malfunctioning station cannot cause an alarm. When the alarm turned out to be valid, then the regions in which the station is contained are set to alarm state. The responsible officers will be informed by e-mail and all the pagers for the affected regions will be activated. The region officers can consult the user interface software to get more detailed information about the incident so they can take appropriate counter measures.

For visualising the measurement data an advanced user interface has been developed (see Fig. 6). The data is well organised displayed by means of projection on a geographic map (vector or bitmap.) The user can choose how to use the level indication mode. In level indication mode the map is filled with colours that correspond with the measured dose rate. The program uses Thiessen polygons for this purpose. The different radiation levels can also be displayed using the contour plot. The data of the last week is directly viewable in graph or table format. The user interface enables the user to send and receive e-mail messages to/from other users.

With this application not only data can be extracted from the local computer system, NRG is investigating the possibilities of getting data from an external supplier of data. At the moment tests are performed with the public telephone net, the Internet and the special Dutch government emergency telephony network. The most promising means for regular situations is probably the data supply from an external FTP-server.

Combining the Incident application with the described data transmission possibilities results in a very promising tool for the organisations involved in emergency planning and response.

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