Radiological Work Management at CNE Cernavoda NPP: Radiation Monitoring System (RMS)

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2009 ISOE INTERNATIONAL ALARA SYMPOSIUM

VIENNA, AUSTRIA, OCTOBER 13-15, 2009

CNE Cernavoda management is committed to continuously improve the safety standards in order to protect environment, population and personnel.

INTRODUCTION

Cernavoda Nuclear Power Station is a two-unit plant with pressurized heavy water reactors, CANDU 6 type designed by AECL Canada, 700 MW electrical each.

The main mission of the company is the industrial production of electricity and heat, by using nuclear power, in terms of maximum safety, reliability and respect towards the environment.

Commercial operation of Unit #1 started in December 1996.

Unit 2 commercial operation started in November 2007 therefore CNE Cernavoda now generates about 17 – 18% of the overall electricity production of Romania.

INTRODUCTION

A new system - Radiation Monitoring System (RMS) has been implemented at Cernavoda U2, with commercial operation in the fall of 2007.

The purpose of this improvement is to connect the on-line radiation monitoring equipment to a computerized interface system that allows remote monitoring, limited remote control capability and maintaining integrated short and long-term database.

Thus the collective dose of the operating personnel will decrease (by avoiding the entrance in high radiation hazard areas) and a better radiation hazard control will be improved for the normal operation of the plant (where real time radiation hazard information will be available).

THE RADIATION MONITORING SYSTEMS NETWORK (RMS)

- **The RMS integrates all fixed and portable radiation monitoring equipment, a local area network and dedicated components and software to control the field equipment, store and display the measured or processed data, trends.**
- **RMS interface with the following systems: Fixed Gamma Area Monitoring, Fixed Contamination Monitoring, Portable Radiation Monitors, Fixed Tritium in Air Monitoring, Liquid Effluent Monitor, Gaseous Effluent Monitor and Post Accident Air Sampling and Monitoring.**
- **Information is transferred in real time using standard communication protocols and commercial computers.**

THE RADIATION MONITORING SYSTEMS NETWORK (RMS)

The RMS functions are:

- **Monitoring – allows operator to survey the radiation hazards;**
- **Control – to establish the set-up parameters for the automatic operation of the channel;**
- **Maintainability – equipment and system failures are annunciate in RCS and MCR rooms;**
- **Data storage – every event is stored in a data file that can be read and backed up or printed;**
- **Operator interface – provide customer reports, detailed display of historical events, remote interactive control functions for the field radiation monitoring equipment.**

RMS Portable Area Monitors

RMS portable equipments interface consists of 26 junction boxes wired to a special designed network, where portable monitors can be connected.

Portable radiation monitors can be placed in different locations in Reactor Building and Service Building which are not covered by other fixed monitors or, they can be used as back-up solutions in case of failure of fixed monitors measuring loops.

Portable equipment that can be use in this way is:

- Semi-portable area alarming gamma monitors;
- Continuous air (radioactive particulate) monitors.

Fixed Area Gamma Monitors System (FAGM)

The system consists of 34 loops connected to a Central panel through redundant network line.

Extension with one loop and improvement (replacement of silicium detectors with ionization chamber) is in progress at both units. At the end of this program there will be 35 operational loops per unit.

During Unit 2, planned outage in 2009 four loops were improved and one loop has been improved in running.

During Unit 1 planned outage in 2010, the last 3 loops will be improved.

Fixed Area Gamma Monitors System (FAGM)

The system is designed to accomplish the following functions:

- **Monitor the level of gamma radiation in those areas of the station where high radiation fields are expected.**
- **Provide a continuous and centralized display of the radiation level.**
- **Provide a visual and audible alarm.**
- **Allows to the control room operator to check at any time the radiation level and alarm conditions.**

Fixed Contamination Monitors System (FCM)

The movement of personnel is controlled by establishing traffic routes and fixed monitoring stations at the transitions boundaries and at the exit from the RCA. The radiological zone is divided into three zones according to the potential contamination in each area.

Control of personnel contamination is achieved by placing monitors at the transition boundaries, thus individuals passing between zones can monitor hands, feet and clothes.

Fixed Contamination Monitors System (FCM)

Zone 1 contains radioactive systems, equipment and materials that may be source of contamination or significant radiation exposure.

- **Two Full Body Pre-monitors and one Exit Tools Monitor are provided for the persons leaving the Reactor Building through equipment airlock.**
- **Hand, foot and clothes monitors are placed in the Service Building (S/B) at the exits point from those rooms considered Zone 1.**

Fixed Contamination Monitors System (FCM)

Zone 2 contains no radioactive systems, normally free of contamination but is subject to infrequent cross-contamination as a result of people and equipment traffic.

- **There are 43 contamination monitors all connected to the Radiation Monitoring System, to indicate high radiation alarms and monitor failures.**

Fixed Contamination Monitors System (FCM)

Zone 3 A clean zone where absolutely no contamination is permitted. (Turbine Building).

- Four Full Body Monitors are located at the main exit from the RCA, personnel leaving this area must make a final check at this point. Two Exit Tool Monitors (Small Article Monitors – SAMs) are provided in the same location to check the tools and small personal objects. At Unit 2, these monitors are connected to Radiation Monitoring System, to remotely indicate high radiation alarms and monitor failures.
- Due to the fixed contamination monitors obsoleteness at Unit 1, 65% of the monitors were replaced starting from 2003 and the program will be finalised in 2012.

Fixed Tritium in Air Monitoring System (TAM)

CANDU reactors are both moderated and cooled by heavy water (D2O). Tritium is produced by neutron reactions with deuterium, boron, and lithium and by ternary fission. Most of the tritium present in CANDU reactors is in the form of tritiated heavy water – DTO.

Fixed Tritium in Air Monitoring System (TAM)

Before the commercial operation, in Unit 2 the "Tritium in Air Monitoring" was operational and integrated in the Radiation Monitoring System.

By detecting tritiated vapour, the monitoring system serves the following purposes:

- **detects heavy water leakages;**
- **indicates levels of tritium in radiological area;**
- **Decreases the exposure of plant personnel by preventing the entrance in those areas where tritium dose rates unexpectedly increased and reducing time spent by radiation control staff for air sampling.**

Fixed Tritium in Air Monitoring System (TAM)

The Tritium in Air Monitoring System contains 8 fixed Local Monitoring Units (LMU). Each LMU is sampling air from 4 locations with a potential tritium hazard.

A similar Tritium in Air Monitoring System has been installed at Unit 1, system which contains 4 fixed Local Monitoring Units.

Each LMU is sampling air from a specific area (5 to 11 separate locations).

In order to improve the system efficiency, will be implemented one supplementary Local Monitoring Unit, so the system will contain 5 Local Monitoring Units.

Liquid Effluent Monitor (LEM)

The national regulatory body, CNCAN, established the maximum allowable radiation dose to be received annually by a member of the general public at the site boundary.

To facilitate the provision of acceptable release levels, all the crucial released radionuclides are limited to specific maximum concentrations (in air and water) called "Derived Emission Limits" (DELs).

Liquid Effluent Monitor (LEM)

The role of the Liquid Effluent Monitor (LEM) system is to:

- **continuously monitor any liquid waste as it is being discharged;**
- **provides a permanent record of the concentration of radioactivity in the discharge;**
- **provides the daily and monthly total activity released.**

Liquid Effluent Monitor (LEM)

At the end of 2007, at Unit 1 was finalised the improvement of the LEM system, which consist in installation of two redundant subsystems: LEM OLM and LEM OFM.

- **The On-Line Leak Monitor (LEM OLM) is designed to measure the gamma volumetric activity of a leak stream in a pipe.**
- **In order to control their released activities, an OFF-LINE Monitor (LEM OFM) is used to take a sample from this pipe to a bucket located on the top of a NaI scintillation detector. The samples collected are taken to the station Health Physics laboratory for detailed analysis. The results constitute the official release results for the station.**

Gaseous Effluent Monitor (Stack Monitor - GEM)

To ensure that the limits of permissible release of radioactive gases and particulates are not exceeded, a stack monitor, called Gaseous Effluent Monitor (GEM) is used to measure particulate, iodine and noble gases activity and to alarm when these release levels are exceeded.

Gaseous Effluent Monitor (Stack Monitor - GEM)

The alarms signals which are displayed on a monitor in the Main Control Room are:

- **stack air flow unbalanced (high or low);**
- **high activity alarm for cumulative releases and instant release rates for each monitor;**
- **equipment test;**
- **Equipments failure (measurement system and sampling pump failure).**

Gaseous Effluent Monitor (Stack Monitor - GEM)

In order to solve the "components obsoleteness" problems of the GEM's system at Unit 1, at the end of 2008 were finalised the first two steps of improvement, so it were installed a redundant particulate, iodine and noble gases loop and two passive collectors (tritium and 14C samplers) similar with the new equipments installed at Unit 2.

The third step is to install a new noble gases spectrometric loop by the end of 2009, in order to evaluate the individual radioactive isotopes releases.

The GEM spectrometric noble gases project will be extended in the next year at Unit 2.

Post Accident Air Sampling and Monitor System (PAASM)

At Unit 2, a new Post-Accident Air Sampling and Monitoring (PAASM) system

- **obtains samples of air from the Reactor Building (R/B),**
- **detects and quantifies iodine, noble gases activity and tritium expected to be present in the Reactor Building atmosphere under accident conditions.**

Post Accident Air Sampling and Monitor System (PAASM)

Post Accident Air Sampling and Monitoring system and Gaseous Effluent Monitors proved their efficiency soon after commercial operation of Unit 2 started, during the discharges of defective fuel bundles, and doses to the public were considerably reduced (reactor building containment isolation due to the high level of air contamination).

MODERNIZATION OF RADIATION MONITORING SYSTEMS IN UNIT 1

The project of Radiation Monitoring System chosen for Cernavoda Unit 2 was intended to prevent the problems encountered in Unit 1 with similar equipment, most of them due to their obsoleteness, and so far it was proved to be a right decision.

MODERNIZATION OF RADIATION MONITORING SYSTEMS IN UNIT 1

At Cernavoda Unit 1, in the next years it's intended to install a new Post-Accident Air Sampling and Monitoring (PAASM) system similar with Unit 2 design and extension of the RMS network from Unit 2 to Unit 1, in order to integrate the radiation monitoring systems: Fixed Gamma Area Monitoring, Fixed Contamination Monitoring, Portable Radiation Monitors, Fixed Tritium in Air Monitoring, Liquid Effluent Monitor and Gaseous Effluent Monitor under a common network Unit 1 and Unit 2.

Thank you for your attention!

Questions?