OSART Good Practices
RADIATION PROTECTION
Radiation work control

Kozloduy 1/4, Bulgaria
Mission Date: 11-28 Jan., 1999

In order to assess the airborne activity in the reactor hall small analytical filters are put on the grate of suction nozzles of the ventilation systems that maintain a negative air pressure in reactor halls. The sampling is to be used preferably in VVER power plants because of the design of the reactor hall ventilation system, although it can be used in other plants with similar arrangements. The nozzles of the ventilation system are easily accessed and filter does not need mechanical means to hold it in place because negative pressure keeps the analytical filter in position. Filters are replaced monthly and more frequently during outages. The results are presented in annual reports. This is very simple and effective way to monitor the condition of the working environment and to determine the main isotopic contributor from the reactor hall to total aerosol discharges.

Lingao, China
Mission Date: 6-23 Aug., 2001

The LNPS RP department has established a radiation work control information system, which is integrated with the work request system. By a simple press on a button within the work request system, all necessary RP-related job information is shown, such as, exposure rates, existing contamination, pictures of equipment with indication of location (e.g. room number), hot spots, and links to experience feedback. Further, this system also contains information on industrial safety risk. Touch screens were installed at the entrance as well as all the main passages in the RCA so that people on-site can research occupational safety risks, cautions and measures regarding their work. Information is also available at every office due to its Intranet web design. This system is called "Occupational Safety Risk Analysis Consultation System" (HPS).
Sta. M. Garona, Spain

Replacement of drainage network in the reactor building. Following an incidence study on the remaining contamination in the reactor building floor drainage network on the dose rate on several levels, this was replaced with a new one, made of stainless steel, which has a better cleaning capacity.

The project started in 1993 as one of the first initiatives that would make up the Dose Reduction Plan. The level of remaining contamination in some parts of the network was a consequence of 22 years of plant operation, together with the material used in the conduits (carbon steel) which limited the effectiveness of the cleaning agents and the existence of isolation siphons which had been systematically installed in each sump. This made it impossible to insert the cleaning jets.

The location of the network (under the floor on each level and not embedded in the floor) had a general effect on the lower floor dose rates (values which could vary around 43µSv/h) and on some drainpipes in zones frequently used by personnel.

First of all the hot points were identified and which of these would have more effect due to their location. A semi-empirical method was developed to assign the specific superficial activities of the different parts of the conduits and to identify the candidate parts.

Initial cleaning tests were carried out with pressurised water. The poor effectiveness in many of the parts was a determining factor in deciding on their replacement, improving their inclination, using stainless steel conduits and implanting cleaning connections at strategic points.

Finally a procedure was written for the measurement and immediate cleaning (if necessary) of the affected parts after a contaminating practice.

As a consequence of the systematic replacement of the drainage network the average dose rate has gone down from 43mSv/h to 22mSv/h. The general incidence has been so great that it has stimulated a "cleaner" behaviour in the use of the drainage network.

Tianwan, China

In order to prevent the contaminated gloves from leaving the fuel storage area, white gloves with red fingers are used. It is very easy to distinguish these from those are used in the clean areas. The team members observed during tour of the fresh fuel building TNPS staff were all using the white gloves with red fingers.
Zaporozhe, Ukraine  
Mission Date; 6-23 Sep., 2004

At the ZNPP a dose planning system for collective effective dose (CED) prognoses and target CED calculation is used. The system is unique for the Ukrainian nuclear power plants and it is focused on equipment. For the methodology, data from 20 years of operation were used. Coding of doses according to equipment and various jobs on the primary and auxiliary system components is used. It enables assessment not only of the total CED but also preset targets of CED for all departments working in the RCA during outage. Dose rate prognoses on the primary system loops are used for the calculation. Work classification is divided into 4 groups according to radiation risk. During the outage the real collective dose and the forecast dose are compared, actions are taken and followed. After the outage, real data are used as feedback to the ALARA system.

Philippsburg, Germany  
Mission Date; 11-28 Oct., 2004

The portal monitors at the exit of the radiation protection area are able to measure simultaneously beta and gamma contamination. The total body surface including hands, head, and feet are measured by 14 beta gas flow proportional counters. Directly behind the beta counters additional two large area gamma plastic-scintillation detectors are positioned in the breast area (left and right side). As they are only gamma sensitive, they are able to detect incorporated gamma activity if any. The detection limit is about 1000 Bq (against Co-60, 3 sigma error) regarding measurement time of 10 seconds. In this way if some internal contamination exists the worker is immediately sent to WBC and the dose assessment is much more accurate.

Penly, France  
Mission Date; 29 Nov.-16 Dec., 2004

The Prevention and Radiation protection Service (SPR) has organized a campaign for systematic eradication of radiological hot spots in order to optimize lower doses.

As part of plant radiological monitoring, the SPR organizes the mandatory monthly radiation survey of dose rates inside buildings. During this activity and based on changes in ambient dose rate, the SPR identifies radiological hot spots on the plant. As a result, hot spots are trended and the effectiveness of corrective actions can be assessed.

Instead of simply shielding, which is the most current practice, preference is given to investigate measures to eradicate the hot spots. The SPR and operations service jointly analyse the hot spots, identify their possible origin and define eradication strategies. This can be the flushing of the systems, clearing of pipes, removing unnecessary pipe sections, installation of permanent shields with integration of seismic resistance and other safety-related concerns.

Recording, monitoring and the results of corrective actions are tracked according the plant
quality assurance system.

Blayais, France  
Mission Date; 2-19 May, 2005

Combined radiological work permit and dose forecast database facilitates detailed ALARA planning. The team calls attention to other plants that the plant’s organization of operational dosimetry and work activities in a readily accessible data base facilitates detailed and efficient ALARA planning. The combined radiological work permit and dosimetry database forms an integral part of the planning process for jobs carried out in radiation exposure conditions. The information needed to describe a job and create a dose optimisation and monitoring document has been determined on the basis of RP reference standards. The radiological work permit issued by the computer programme ensures that all workers-employees and contractors-use a standard document that includes radiological data for all workers, including targets, and limits. It also specifies optimization measures. The database enables access to the list of craft representatives within the area of radiation protection, a direct view of the processing status of the radiological work permits, quick access to specific requests for information on work permit information, access to common job planning databases, and the build-up of RP experience and feedback from activities.

Blayais, France  
Mission Date; 2-19 May, 2005

A central display panel and large, flashing amber light at the plant’s main access entry post informs personnel entering the plant that radiographic shots are in progress and provides notice of their exact locations. This notification practice is formalized in a written procedure and is implemented within a short time of the radiographic shots. The team acknowledged that this is a good practice and should be brought to the attention of other plants. The display of information related to radiography shots at the main access entrance is part of the process for preparing for the shots. This display is a means of providing information and communication used by the site to inform EDF and contractor personnel of the radiography shot schedule and its location, along with prohibited access maps during the shots. A large, flashing amber beacon ensures that attention is called to the notification. This central display accompanied by the flashing beacon ensures:

- That a large number of persons entering the site, but not taking part in the radiography shots are informed. It should be pointed out that the main access post is the only access open during outside of normal working hours—the time when the great majority of radiographic shots are made.
- A rapid association between the presence of the flashing beacon and the ongoing radiographic shot.
- Direct visualization, by marking a map of the shot location and the areas of prohibited access.
- Rapid access to operational information on shots taking place, such as, shot operator pager number, countermeasures applied, radiological characteristics, and starting and finishing times.
Activities requiring a RWP (Radiation Work Permit) are identified through the planning process. Work orders are generated in the plant information system and routed to the ALARA planner for review. Radiological planning is incorporated into the work order task, including an exposure estimate and the assignment of the task to the appropriate RWP. Once the planning is complete, the scheduled activities can be queried by the computer to determine the radiological impact for a given time period. For example, a weekly or project exposure estimate can be generated using values previously captured in work order tasks. These projections are shared with the site work force prior to beginning the work. The actual exposure is tracked against the estimate and discussed with management at the daily morning meeting. The exposure history is useful information in future planning and projections. It is also a good tool for goal setting.

The work schedule is reviewed 10 weeks prior to implementation to ensure that the necessary radiological planning requirements can be implemented prior to performing work. This advanced look allows the RC group to be proactive instead of reactive, for example, in setting up areas for future job support.

The RWP instructs the worker on actions to take if an alarm is received or if radiological conditions change. If an alarm is received the dosimeter is locked until data can be retrieved.

Since October 2000 the whole NPP site (roofs including) has been surveyed annually for radioactive contamination and dose rate. Up to October 2000 this survey was performed at about 35 predetermined positions. The results of the measurements are very well documented in user friendly and illustrative database. Several hot spots with artificial activity and variation of natural background were found. Based on the findings of 2000 and 2001 the working method and procedures with respect to monitoring of contamination of equipment and material leaving the controlled area were improved and extended. In addition the exits and their surroundings, here the equipment is brought out of the RCA, are subjected to quarterly monitoring for radioactive contamination.

In 2005 no contamination from the NPP was found outside the RCA during the site contamination survey.
Mochovce, Slovak Rep.  
Mission Date; 4-20 Sep., 2006

The plant monitors extensively the effectiveness of the barriers against contamination propagation and statistically analyzes all revealed cases of personal contamination including contamination of protective clothing and tools. Analyzing trends in contamination of individual rooms and corridors, the plant can take effective measures to further improve radiation work control.

Automatic personnel contamination monitors alarm levels are set up on the lowest possible value (0.3 Bq/cm² if possible regarding to dose rate). This creates an effective barrier against contamination spread.

Personal contamination is measured by several types of devices; any discovered contamination is to be reported by a prescribed form to the RPU. Moreover, alarms of the PCM2 devices (personal monitors) and from tool monitors in change rooms are signalled in RP control room and automatically recorded into a database. Workers are not punished when an alarm occurs, but they are obligated to report the circumstances. They are encouraged to notify all cases of contamination. This helps to keep reports as complete as possible and to make the analyses more valuable.

Permanent places for collecting waste are equipped with device for dose rate/contamination monitoring. It helps to keep dose and possible contamination as low as possible.

Floor washing water from corridors and rooms in RCA is sampled and measured on gamma spectrometry in order to analyze contamination spread. This practice is not frequently used in NPPs.

All records are statistically analyzed in order to map contamination sources, keep the contamination in RCA as low as possible, and evaluate the effectiveness of the barriers against contamination propagation and the effectiveness RP measures.

St. Laurent, France  
Mission Date; 27 Nov.-14 Dec., 2006

A laser pointer is used in carrying out radiation and contamination surveys in application of the ALARA principle of optimization of individual radiation exposure. A technician with an audio link indicates the points to be surveyed to another technician doing the survey in a hostile environment such as reactor cavity. Dose saving is reported to be about 30%.
Yongwang, Korea

Mission Date; 17 Apr.-4 May, 2007

YGN 5&6 uses advanced radiation monitoring system which serves for comprehensive and easily accessible information for radiation workers regarding radiation situation, provides complete operations regarding radiation work permit and ensures detailed environmental information to the public.

The RIS (Radiation Information System) is a very advanced system carrying out many functions. The RIS has been made as:

- Radiation information system as a part of the environmental management of knowledge information society.
- Advanced radiation safety control such as a reduction of the exposure of workers inside YGN 5&6 RCA.
- Improvement of credibility and reliability of submitted information from YGN 5&6 under domestic and foreign conditions.

The system provides a unique feature easy access the following:

- Direct access to this information by each worker at the entrance/exit of RCA
- Linking with the operating radiation control system (ERP/RAM)
- Ensuring requirements for workers to access and exit the RCA
- Dose database in break down to every single entry to RCA
- Informing each worker of his dose during a certain month or period
- Informing each worker of the radiation situation inside RCA
- Ensuring that the Radiation Protection Permit contains the latest information so that the workers can work inside the RCA safely by providing latest information on real-time basis
- Maximization of efficiency for the radiation control such as convenience of work service
- Information on the dose rate of total 632 monitoring points.

The system offers as follows:

- Direct data exchange with ERP system at KHNP Headquarters and resulting security of handling speed and safety inside RCA
- Provision of more rapid and stable information by securing mass storage server systems
- Unification of system operation equipment and personnel
- Systematic system integration control (unification of server computers and also information on the personal dose for YGN plants 1, 2 & 3, radiation information by regional groups, homepage of the RP Section)

The Radiation Information System used to support access of and provide doses of radiation workers at YGN 5&6 is a powerful tool which enhances ALARA approach and reducing doses.
Yongwang, Korea

YGN 5&6 uniquely uses a camera system as an additional supervisory tool to follow workers’ actions in order to reduce exposure, optimize working time of radiation workers inside RCA and reduce radioactive waste production.

In addition to the regular monitoring system the so-called CCTV system is managed by the RP Section. The system has been developed as a tool for instant feedback with fast response. The system provides instant real time information regarding people’s movement and behavior inside workplaces where radiation risk activities are expected. The connection between workers and operators is organized by all kinds of connecting links (pager phones or other ways).

The system consists of fixed cameras and portable cameras which are located as required to support important or high radiation work. Fixed cameras of CCTV system are located at workplaces and entrances and exits from the RCA, and whole system allows additional control of the efficiency of the radiation works. Operation of the system has brought effective collective dose reduction, reduction of radioactive waste production and reduction in working time. Reduction in working time means reduction of exposures, as well.

The team assessed the contribution of CCTV as very useful tool which significantly enhances radiation protection.

Balakovo 4, Russia

The plant use a computer and portable equipment based radiation survey system which allows easy accessible and retrievable information on radiation situation in every room of the RCA. Survey can be carried out periodically or on demand. During a survey is no need to fill tables or to take notes of values.

The needed software is commercially available and easy to set for plants.

The computer database consists of sketches of all RCA rooms together with main technological components. In selected points of the sketch is possible to show values of radiation characteristic entities as dose rates and contamination values. Data are available to all technical positions on the plant. Access and retrieve ability of the information is via intuitive graphic interface.

Radiation survey is performed by a set of pocket personal computer (PPC) and dose rate/contamination measuring device. During a survey RP technician check visually survey points on screen of the PPC as singular pre-planned tasks (detailed pictures of the room in proportional scale are available) and confirm storing of the measured values to the MPC memory. Time stamp of every particular measurement is automatically added.

Data from PPC are later transferred to the PC net computer. The ORACLE database enables to check tasks of radiation technicians, values of radiation survey, trends of values, graphics etc...

The system enables:
- To reduce time in performing the survey
- To present actual information to the workers, work planners and group leaders on
radiation characteristic in rooms and on equipment
- To improve quality of survey
- To create database of characteristic radiation values
- To create graphic presentation of rooms and equipment with points of measurement

**Ringhals 3/4, Sweden**

Mission Date: 1-18 Mar., 2010

In-situ gamma spectroscopy to determine surface activity concentrations on internal surfaces of plant systems.

The plant has for many years performed a systematic analysis of the deposition of radionuclides on the internal surfaces of primary coolant and auxiliary systems components using a portable high-resolution gamma spectrometer. Furthermore, the plant uses radiation dose rate data from a number of fixed points to calculate a “dose rate index”. This index can be used to evaluate the effectiveness of the source term reduction initiatives and to aid wider understanding of how plant operations affect radiological conditions around the plant. Whereas collective radiation exposure is a function of dose rate and occupancy (i.e. the scope of an outage), the use of an indicator of radiation dose rate on the plant enables an assessment of the effectiveness of the plant chemistry and radiological protection programmes to be made; independent of the outage workload. These tools have yielded information that has assisted in determining the optimal primary coolant chemistry to reduce source term and optimize occupational doses as low as reasonably achievable. As an example, in 2008, increasing deposition of Ag-110m was detected on cool surfaces of the chemical and volume control system (CVCS) indicating a leaking control rod. Conventional sampling of the coolant system was unable to detect this release and deposition. The leaking control rod was replaced before the Ag-110m became a significant contributor to dose rates around the CVCS.

**Doel, Belgium**

Mission Date: 8-25 Mar, 2010

Index cards are available describing radiation protection measures as well as the protective clothing and equipment needed for a variety of activities.

The radiation protection department has developed descriptions of a number of standard maintenance tasks (in the form of index cards). The index cards contain the following:
– A description of the functional location
– A brief description of the work, including whether there are any requirements relating to the task according to Technical Specifications
– Radiation protection measures needed for the task
– Protective clothing and equipment needed for the task
– Measures to be taken by the Maintenance department

Index cards also exist for some generic activities. The index cards are available at the radiation protection counter at the entrance to the radiation controlled area. Whenever work is to be carried out, radiation protection staff follow the instructions on the index card to prepare the radiation protection measures needed at the work site. The index cards are compiled by all radiation protection staff and submitted to review. Periodic review of the index cards is also carried out.
The identified benefits of the index card system are:

– Minimized possibility of errors when preparing radiation protection measures for a work site
– Minimized dose in work site preparation
– Time saved in work planning
– Operational experience of work involving a radiation risk is transferred when index cards are updated.

Evidence of the effectiveness of the system is that the performance indicators for collective work dose at the site are within the best quartile of the industry.

Koeberg, South Africa

Mission Date; 22 Aug.-8 Sep., 2011

Provision of portable radiation monitors to non-Radiation Protection personnel to allow them to confirm the radiological conditions in their work area and assist in dose reduction. The RAD-EYE monitor was first used in August 2010 where it was introduced as a dose reduction initiative in the outage. The function of the RAD-EYE is to provide radworkers with a hand held device that can be used to better identify the dose rate gradients in their work area, and on transit to the work area, as a supplement to survey signposting at room entrances. The dose rate readings from the RAD-EYE are for information only, with RP surveys and signposting serving as the official survey data for all control zone areas. The RAD-EYE is mainly to be used by supervisors at the job site in the controlled zone. The use of the RAD-EYE has steadily improved with radworkers themselves seeing the benefit of the instrument. The RAD-EYE is used by on-job supervisors for insulation installation and removal teams, where lay down areas are identified and higher dose rate areas can be avoided or time in the area minimized as work progresses throughout the controlled zone. Scaffolders can identify areas for staging that represents the lowest practical dose rate in the work area, and can change access routes to the job site based on the lowest dose rate path. Maintenance individuals can better understand the use of time and distance when performing work on valves and pumps. For all groups, the RAD-EYE is used for the radworker to better identify the dose rate characteristics of the work area, where even a few µSv/h can make a substantial difference to the job collective dose when the task proceeds for more than a few hours.

Additional benefits of the RAD-EYE are radworkers awareness of changes in dose rates in work areas and a reduction in EPD alarms. The RAD-EYE has resulted in real line group accountability for dose, where the radworker now has the independent ability to better appreciate the radiation gradients in the area. The RAD-EYE plays a role in the many initiatives to reduce CRE at Koeberg.

Examples of dose savings:

1) Work was performed at 2RCP001BA The workers did a survey and discovered that they were in an elevated general area dose rate zone. By avoiding the localized area they made a substantial saving.

2) During outage 218 when scaffolding was erected at the RCP pumps, the supervisor performed a pre job survey and realised that the higher the scaffold was erected the more dose they would have incurred. In discussion with RP they applied shielding and also achieved a considerable saving on the job. Similar conditions existed at all three pumps.”
Rajasthan, India

Mission Date: 29 Oct.-15 Nov., 2012

To ensure timely dissemination of radiation protection information, the Health Physics Unit (HPU) has developed a unique display system consisting of a TV-screen and White Board outside of the HPU shift office, which results in rapid and accurate information to all staff on radiological and other related data. This is well visible to all personnel prior to entry into the inner controlled areas. Unique numbering is attached to jobs performed in controlled area. On the TV-screen are displayed:

- The photos and names of shift health physicists and technicians;
- Information on accessible and non-accessible areas of the reactor building and other relevant rooms;
- The dose rates, contamination levels and air concentration of tritium in various rooms and areas.

On dedicated white boards are displayed:

- Information on the relevant “hot spots” in the station;
- The collective dose targets and the incurred doses for the present year and for some years back.

The data is regularly updated after the surveillance performed during each shift and as new dose data becomes available. It enables both the HPU staff and the other personnel who work in the station to get quick and accurate information about the prevailing radiological conditions, accessible areas and the performance of the radiation protection programme of the station.

Furthermore, a unique numbering scheme is used for different jobs in the controlled area. This enables detailed tracking of dose and trending for repeated activities.

Chooz, France

Mission Date: 17 Jun.-7 Jul., 2013

Enhancements to standard identification of orange zones.

Orange zones are areas of elevated dose rates that require specific authorization for people to enter. In order to prevent inadvertant access without the appropriate authorization the plant has established enhanced warnings at the entry to all orange zones.

Where an orange zone is accessed through a door, as well as the standard warnings posted on the door, the plant have placed fixed extendable barriers at chest height.
Where there is a partial orange zone (term used when only part of the room is classified as an orange zone) the plant apply the standard barrier tape which is supplemented with a visible and audible sign that has motion sensors that activate the flashing lights and audible warning.

Since the implementation of both practices in 2009, the plant has not had a significant reportable event of persons entering and orange area without appropriate authorization.
Stickers for radiation protection work areas
In the past, access conditions for RP work areas were listed in written form on sheets, parts of which had to be completed by hand depending on the area's classification. These sheets have been replaced by stickers, which correspond to the different types of predefined working conditions: the sticker is affixed to the worksite identification sign and stipulates prerequisite conditions for entering the work area.

Clearly legible stickers provide a simple illustration of the equipment to be worn for entering the area (PPE + other appropriate equipment). This stand-alone worksite identification sign eliminates potential errors and omissions associated with handwritten information. It also promotes consistent work practices.