# Planning, controlling and execution of high radiological risk activities at CERNAVODA NPP

NUCLEARELECTRICA
Puterea Viitorului

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# INTRODUCTION

ALARA is an important element of the global approach to radiological protection and management commitment to ALARA has been clearly stated by “Radiation Protection Principles, Policy and Regulation”.

Radiation Protection compartments provide technical support, supervision, doses management, data bases.

ALARA process was formalized in 2006 and two ALARA committees have been established.

# INTRODUCTION

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Working groups with significant contribution to collective dose (fuel handling, operation, chemistry, maintenance, NDT group) designated an ALARA coordinator.

Health Physics Department appointed the station ALARA coordinator.

ALARA coordinators gathered in **ALARA Technical Committee**, leaded by Health Physics Senior Superintendent.

**Station ALARA Committee** consists of station board members and station ALARA coordinator.

# INTRODUCTION

ALARA objectives for station and working groups are established every year by the ALARA Technical Committee and approved by ALARA Committee.

ALARA objectives have to be realistic, specific, measurable, reviewed to ensure their relevance.

ALARA performance indicators are reported on a monthly basis and their evolution is yearly analyzed by station ALARA Committee.

# INTRODUCTION

The most important performance indicators are:

- plant collective dose (man mSv / year), total and internal;
- working groups collective doses (man mSv / year);
- maximum individual effective dose (mSv);
- unplanned external individual exposures
- unplanned exposures
- unplanned exposures over 0.1 mSv
- dose rate alarms
- maximum individual internal dose.

# INTRODUCTION

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Collective dose is reported twice a month during normal operation.

During planned outages daily monitoring of collective dose is performed, including a day-by-day comparison between estimated and real exposure.

The other ALARA performance indicators are monitored and reported monthly, and specific targets are established for planned outages.

# INTRODUCTION

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**High radiological risk** activities need a special attention from both radiation protection and working groups. The activity supervision level is established in Radiation Work Permit – RWP.

**High radiological risk activity** criteria are:

- Radiography;
- Working in areas with external dose rate >10 mSv/h and/or an expected individual exposure ≥ 5 mSv;
- Manipulating material removed from reactor core or working in their vicinity;
- Polishing, cutting and welding on alpha contaminated materials or removed from reactor core,
- Working in alpha 1 contamination area;
- Strong probability of PHT / moderator heavy water spill.

# RADIOLOGICAL EVENTS DURING HIGH RADIATION RISK ACTIVITIES

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Before approaching "evaluation of radiological risk", during Cernavoda Unit 1 2012 planned outage, a service maintainer received 0.788 mSv unexpected external dose.

He had to raise a scaffold inside a contaminated area and anchored it to a guard rail and took a plastic foil from inside the Rubber Area to wrap the railing, applied a clamp, tightening the screws to secure the scaffolding to the guard rail.

While handling the plastic foil, the dose rate alarm and the total dose pre-alarm on the maintainer EPD were triggered, and in the next minute the dose limit alarm came in.

On the subsequent verification of the Rubber Area, the maximum dose rate at the contact with the contaminated plastic foil was found to be 600 mSv/h.

# RADIOLOGICAL EVENTS DURING HIGH RADIATION RISK ACTIVITIES

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Unsatisfactory radiation protection work practices were identified:

- Radiological surveys didn't identify the presence of a discrete particle on the plastic foil inside Rubber Area, and that area was not adequately posted.

- The service maintainer did not monitor the foil before touching it.

- EPD alarm worker response was not as required by the procedure.

# RADIOLOGICAL EVENTS DURING HIGH RADIATION RISK ACTIVITIES

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Second type of events with significant individual radiological impact revealed poor learning from internal operating experience.

November 14th, 2012 – radiographers performed the examination of a pipe. The length of the cable inside guiding tube did not allow remote handling of the source. Field configuration required that after each repositioning of the container with the source the remote cable needed to be also repositioned, and it got stressed.

The NDE operator communicated by signs to those at the bottom of the scaffold. The worker on the scaffold misinterpreted a signal of the person at the bottom.

The worker on the scaffold received a total dose: 0.134 mSv, with maximum dose rate: 163 mSv/h.

# RADIOLOGICAL EVENTS DURING HIGH RADIATION RISK ACTIVITIES

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**May 16th, 2013 - After using the source container remote controller inside exposure area NDT operator's EPD recorded a dose alarm, before leaving the exposure zone.**

**The NDT operator manipulating the source asked his colleague if the film is installed, the other operator said "yes", but he meant the dosimeter, not the film. The source was then manipulated to the exposure zone, where the operator was still there to change the film.**

**The EPD alarmed and he left immediately the area, but received 0.238 mSv total effective dose.**

# RADIOLOGICAL EVENTS DURING HIGH RADIATION RISK ACTIVITIES

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**What was wrong:**

**- NDE personnel did not request the review of the RWP to include the re-evaluation of the radiological conditions.**

**- RP critical steps leading to individual overexposures had not been identified in the radiography procedure.**

**- Radio communication during radiography was not explicitly required nor identified as a "stop work" criteria.**

**- Deficiencies of communication between radiography team members;**

**- Starting the activity without using an area alarming gamma monitor.**

# RADIOLOGICAL EVENTS DURING HIGH RADIATION RISK ACTIVITIES

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## Why all of that happened?

- Human performance and missed opportunities to use operating experience;

- Individual mental implication.

# ACTION PLANS TO PREVENT RECURRENCE OF THIS TYPE OF EVENTS

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A new approach of planning, executing, and controlling high radiological risk activities was established.

Root causes and contributors were analyzed to identify the potential weaknesses which could generate unexpected exposures.

Based on the specific and generic lessons learnt from the experienced events, several improvements of the existing processes have been implemented for planning, controlling and executing high radiological risk activities:

# ACTION PLANS TO PREVENT RECURRENCE OF THIS TYPE OF EVENTS

- RP procedure to control radiography activities - revised for estimating a maximal value of gamma dose rate at working zone fences and critical steps independent verification by NDE and SCR personnel.
- "Radiation Protection Assistant responsibilities" - revised to detail responsibilities during radiological high risk activities.
- Procedure for "Gamma non-destructive tests" - include steps for a better communication between RP technician and NDE operator. Radio communication is mandatory and is also a stop work criteria.
- The criteria to classify the radiological risk for an activity have been revised within the integrated risk assessment procedure.

# ACTION PLANS TO PREVENT RECURRENCE OF THIS TYPE OF EVENTS

- An internal procedure that states “stop work” authority for RP personnel and RP assistant on radiological consideration was issued.
- Outage planning procedure has been revised to include the RP impact analysis during outage activities planning.
- Rubber Area controlling and posting, in particular when discrete radioactive particles could be generated during job performing was improved. Specific training for RP technicians was provided.
- EPD alarm response procedure has been revised to simplify personnel response actions.

# ACTION PLANS TO PREVENT RECURRENCE OF THIS TYPE OF EVENTS

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Training materials to promote the identified improvements and to indoctrinate the personnel:

- "Radiation protection fundamentals" - for all RP qualified personnel.
- "Radiation protection behaviors and skills during maintenance activities".
- "Fundamental radiological controls during high radiation risk activities" - for RP assistants .
- "Defense in depth analysis" – requirements for a RP impact analysis during outage activities planning
- Radiation Protection, Industrial Safety, Human Performance and Radiological Safety fundamentals – for Maintenance supervision personnel.

# ACTION PLANS TO PREVENT RECURRENCE OF THIS TYPE OF EVENTS

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Continuous monitoring is performed - self-assessments, RP deficiencies trend analysis - to assess the effectiveness of the implemented actions.

No deficiencies on planning, controlling and executing high radiological risk activities were recorded since November 2013.

During 2014 planned outage, RP personnel stopped a high radiological risk activity on radiological considerations (gamma dose rate at work zone boundaries exceeded the estimated value).

This good catch shows an effective implementation of the improvements in increasing the oversight of the high radiological risk activities by RP supervisor and first line working group manager.

# CONCERNS TO IMPROVE CONTROL OF HIGH RADIOLOGICAL RISK ACTIVITIES

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**Implementing alpha program - at Cernavoda NPP is in progress.**

**First step was the characterization of gross alpha activity levels in areas where TRU may be present in order to assign a proper area action level: level I areas (high alpha contamination), level II areas (medium alpha contamination) and level III areas (low alpha contamination).**

**CNE Cernavoda finalized areas characterization and identified areas and activities where alpha hazard is present (Table 1)**

# CONCERNS TO IMPROVE CONTROL OF HIGH RADIOLOGICAL RISK ACTIVITIES

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## Implementing alpha program

Specific RWP is issued for activities performed in one of these areas, containing radiation protection measures against alpha hazard.

Continuous Air Monitor and alpha/beta radiometers are already in use and they are able to determine low level alpha activity. We intent to add instrumentation for individual air sampling (PAS), sampling pump “goose neck” and faeces bioassay collecting sampler.

Training material about alpha hazard is already issued and radiation protection personnel is about to be trained. Training material for station personnel is ongoing.

# CONCERNS TO IMPROVE CONTROL OF HIGH RADIOLOGICAL RISK ACTIVITIES

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| Area / System | Equipment / component / activity | Alpha contamination level |
|---|---|---|
| 1(2)R-114, 1(2)R-115, 1(2)R-103, 1(2)R-104 | FH auxiliary ports – 35611 and spent fuel discharge port (charge/discharge FH snout plugs) | 1 |
| 1(2)R-001 | Inspections, maintenance activity, FH auxiliary equipment activities | 2 |
| FH D2O Supply 1(2)R-012 | Ion exchange resin and mechanical filter replacement | 3 |
| FH Shop, 2S-180, 1S-129, 1S-130 | FH maintenance | 2 |
| PHT, 1(2) R-402, R-406 | PHT Purification filters replacement | 1 |
| PHT U1 and U2 | Inspection / maintenance on: Steam Generators PHT side; $D_2O$ feeders; fuel channel assembly; PHT main pumps. | 1 |

**Table 1 Areas and activities with alpha hazard**

# CONCERNS TO IMPROVE CONTROL OF HIGH RADIOLOGICAL RISK ACTIVITIES

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## Hot spot management program

We intend to establish design solution for all active hot spots to reduce the risk of personnel exposure till end of 2015:

- 35 hot spots are identified and periodically surveyed.
- Shielding design solutions for 25 hot spots already elaborated. Part of them are temporary shielded and 5 of them are located in inaccessible areas at full power.
- During outage, more temporary shielding is installed in areas with high gamma dose rates.

# CONCERNS TO IMPROVE CONTROL OF HIGH RADIOLOGICAL RISK ACTIVITIES

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## Hot spot management program

- Work activity assessment takes into consideration experience from previous outages and a specific shield is designed to reduce gamma dose rate around working area.
- It is under development a facility of Hazard Info data base, to allow recording of temporary and permanent shield, also the movement of lead blankets.

# CONCLUSIONS

- CNE Cernavoda didn’t experienced new unexpected exposure events during high radiological risk activities, since 2013.
- Three events regarding RP fundamentals deficiencies occurred during 2014, with no significant impact on individual doses.
- Alpha contamination control program is generally implemented, but alpha dosimetry program needs to be finalized.

# CONCLUSIONS

- Radiation Protection supervision of high radiological risk activities identified few radiological aspects during pre-job briefing, needed to be reinforced to act as stronger barrier. Activities were interrupted to eliminate the deficiencies and were successfully finalized.
- During 2015 no incidents happened during high radiological risk activities.

# Thank you for your attention!

## Questions?