Improving occupational radiation exposure using ALARA tools: performance indicators

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Puterea Viitorului

Vasile Simionov, Liliana Samson,

Health Physics Department,
CNE Cernavoda, ROMANIA

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CONTENTS

- Introduction
- ALARA Performance Indicators
- New ALARA Performance Indicators
- Trend analysis results
- Conclusions

INTRODUCTION

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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.

RP personnel closely collaborate with working groups and make them aware for being responsible for doses they received.

Radiation workers, ALARA coordinators, first line supervisors, and managers are directly responsible for controlling and reducing radiation doses.

INTRODUCTION

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The actual levels of individual and collective effective doses reveal the effectiveness of implementation of the Radiation Safety Policies and Principles established by the management of the Cernavoda NPP.

Despite the increased number of professionally exposed workers after starting the operation of Unit 2 in 2007, the collective doses did not increased accordingly.

During 20 years of operation, most of the exposures were below the Recording Level and the majority of recordable doses were less than 1 mSv. No legal or administrative individual dose limit has been exceeded.

INTRODUCTION

Collective dose provides indication about plant radiological condition in connection with personnel behavior. Best dose performance is a result of a balanced combination between those two factors. ALARA principle has much qualitative and less quantitative connotations, that's why its implementation is opened to several methods or particular approach.

First level of implementation is using microALARA techniques converted into radiation protection measures for every radiologic risk activity.

INTRODUCTION

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Regarding plant radiological condition, an aggressive policy to reduce individual exposure was applied since 2005, including:

- a strict control of D2O leaks and leaks reduction program
- providing dryers availability
- optimization of personnel access in R/B
- using appropriate RP protective equipment
- hot spot management program
- implementation of RWP system.

INTRODUCTION

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To improve human behavior, we had to find out the near-misses.

Two directions were considered in correcting personnel behavior: define ALARA performance indicators for working groups and elaborate periodically trend analyses for radiation protection deficiencies.

Trend analysis include:

- quarterly value for strategic performance indicators,
- monthly distribution of abnormal condition reports by type of deficiency
- number of deficiencies evolution for the last four quarters.

ALARA PERFORMANCE INDICATORS

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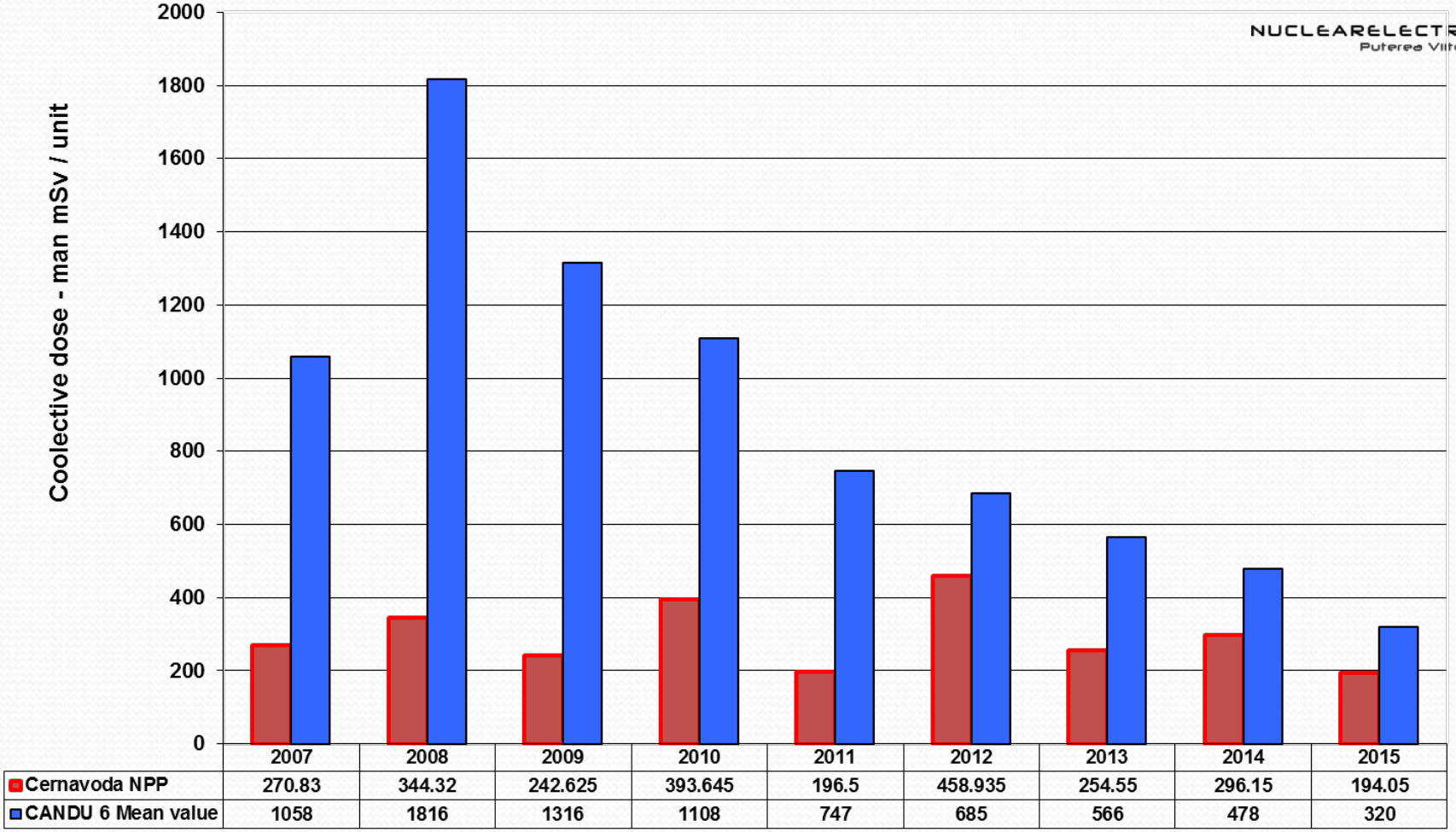
The main indicators are the collective dose and the distribution of individual doses.

The targets for these indicators are based on a generic description of the major radiological jobs to be performed (based on estimated frequency, duration, dose rates and number of workers exposed) correlated with statistical (historical) values.

After implementing ALARA and RWP programs, a continuous station focus on collective radiation exposure reduction resulted in top industry performance for CANDU designed reactors over the last 8 years, reducing station dose from 271 man mSv / unit in 2007 to 194 man mSv / unit in 2015. (fig. 1)

ALARA PERFORMANCE INDICATORS



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cernavoda NPP	270.83	344.32	242.625	393.645	196.5	458.935	254.55	296.15	194.05
CANDU 6 Mean value	1058	1816	1316	1108	747	685	566	478	320

Fig. 1 Annual collective doses - CNE Cernavoda vs. CANDU-6 average

NEW ALARA PERFORMANCE INDICATORS

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Poor performance of both collective and internal doses (2003 – 2006) became triggers for implementing of exposure reducing policy, more interactive and in relationship with working groups. Starting with 2008 besides pre and post job activities evaluation, a set of performance indicators was defined, in order to closely monitor the personnel behavior related with radiation exposure inside working area:

- **Unexpected acute individual external exposures;**
- **Unexpected acute individual internal exposures;**
- **Maximum individual dose;**
- **Internal contaminations with radio-nuclides other than tritium;**
- **Unexpected contamination of surfaces;**
- **Personnel contamination identified at the exit of the RCA.**

NEW ALARA PERFORMANCE INDICATORS

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The awareness of Radiation Protection in the station became a topic in planning meeting agenda. Twice a month, collective dose distribution by working groups is presented to plant management, including senior supervisors of working groups, who can analyze spent dose budget versus monthly target.

First "ALARA Annual Report" has been issued for 2008 to present station ALARA performance, reflecting the exact state of radiation programs efficiency and identifying areas to be improved.

NEW ALARA PERFORMANCE INDICATORS

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Lately, based on EPRI and WANO/INPO guides, few more ALARA performance indicators were defined:

- Inadequate response to EPD's dose rate / dose alarms
- Maximum individual internal dose
- Personnel Contamination Events (inside Radiation Controlled Area - RCA)
- Unexpected exposures: external and effective over 0.1 mSv

NEW ALARA PERFORMANCE INDICATORS

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Nowadays, 10 ALARA performance indicators are monthly reported and analyzed with working group ALARA Coordinators (ALARA Technical Committee). They are assessed and reported periodically to reflect the objectives and permanently mark out achievements and breakdowns.

Every year performance indicators are analyzed and they could be redefined or targets readjusted to reflect the efficiency of professional exposure control process.

Radiation protection ALARA personnel record every deficiency and investigate all events which exceed target values. Corrective and preventive actions and recommendations aim both work planning (exposure control) and technical aspects, so that work conditions (especially radiation work) to be improved.

NEW ALARA PERFORMANCE INDICATORS

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Five years dose reduction plan has been developed and approved by senior management to provide oversight and resources for dose reduction initiative.

After 2010, ALARA reports showed a negative trend for "Unexpected acute individual external exposures", measured by personnel response to EPD dose alarm. Event analysis revealed weaknesses in applying EPD dose alarm response, even when worker knew his PAD alarm had been activated.

To improve this performance has been necessary to come closer to the workers, identify steps with radiation protection impact and give them support to avoid unnecessary exposure.

TREND ANALYSIS RESULTS

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Integrated root cause analysis for inappropriate response to EPD dose / dose rate alarms opened our vision to identify all radiation protection deficiencies, group them against causal factors, follow the trend and make conclusions or corrective actions whenever are needed.

Since 2013, quarterly trend analysis are made and discussed with working groups from Production Division during radiation protection and industrial safety meeting.

TREND ANALYSIS RESULTS

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Radiation protection deficiencies included in this analysis are:

1. Heavy water leaks
2. Use of RWP and work planning
3. Contamination control
4. Radioactive material control
5. Radiation protection work practice
6. Inappropriate EPD alarm response
7. Adverse trend for ALARA indicators
8. Protective individual equipment deficiencies
9. Radiological conditions
10. Work practices during high radiological risk activities
11. Personal contamination events
12. RP fundamentals

TREND ANALYSIS RESULTS

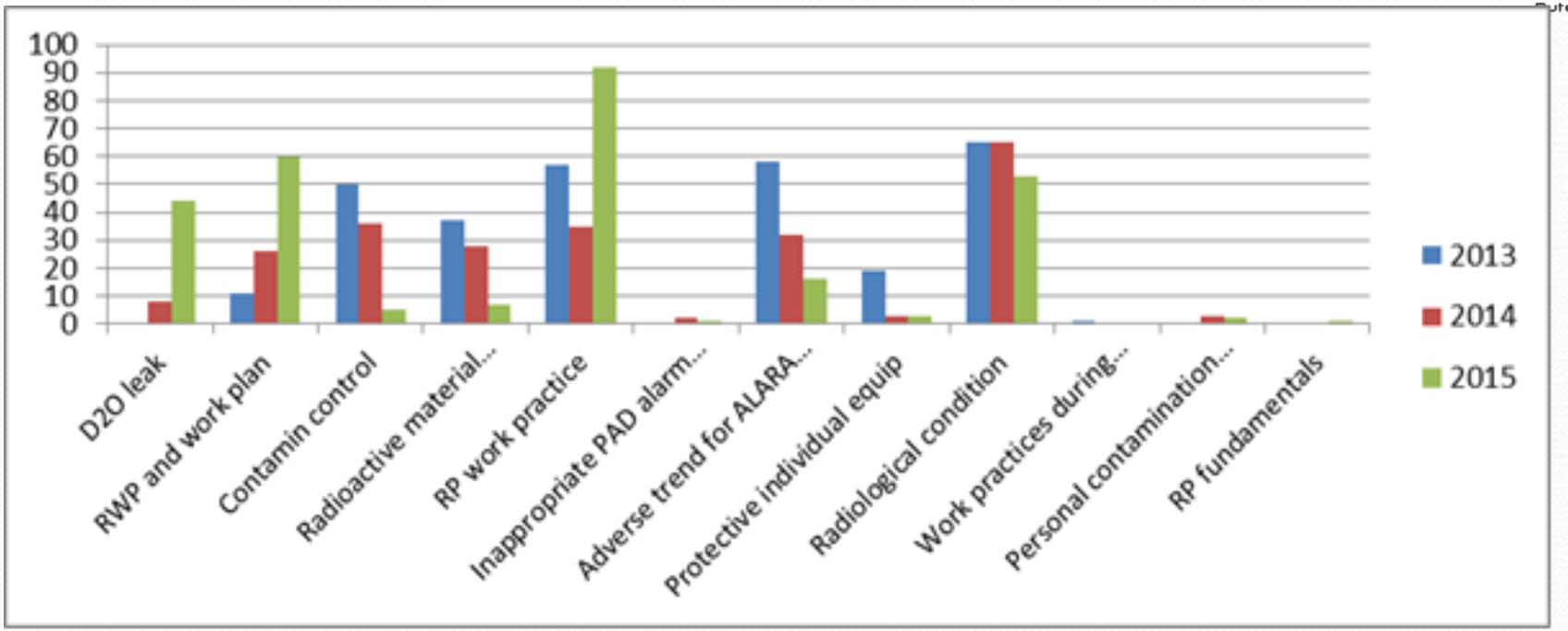

Fig. 2 Evolution of radiation protection deficiencies

A three years picture of radiation protection deficiencies shows improvements in contamination control, radioactive material control, adverse trend for ALARA indicators and radiological condition.

TREND ANALYSIS RESULTS

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"Contamination control" has been a hot issue in 2013 and RP department developed an action plan to reduce number of violations of procedure and this theme is annually analyzed into a focused self-assessment report.

"Radiological conditions" and "Heavy water leaks" accounts for equipment defects generating increased radiation dose rates.

In order to improve radiological conditions, RP Department implemented a program for hot spot management and upgraded tritium in air monitoring system in Unit #1 & 2.

Efforts were made to accelerate implementation of support system with good impact in radiological condition: portable dryers, installing air dehumidifier in reactor building.

TREND ANALYSIS RESULTS

Starting 2015, during monthly meetings, Technical ALARA Committee analyze from radiological point of view every job with a difference higher than 25% between estimated and received doses. This is considered a radiation protection deficiency and, if necessary, corrective actions are established in order to improve the performance.

Three more categories were added as new type of abnormal condition: D2O leaks, personal contamination events and RP fundamentals.

TREND ANALYSIS RESULTS

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To correct personnel behavior it is under implementation a RP fundamentals training course. RP Fundamentals for RP personnel and workers will be reinforced, with special attention to high radiological risk jobs, in particular radiography and high activity materials manipulation.

Radiation protection themes are included in "Subject of the week" training materials of Operation and Maintenance Departments.

The awareness of Radiation Protection in the station and ownership of dose have been increased by placing in key high traffic areas of the plant specific information: charts, bulletin, newsletter on RP stations goals, ALARA initiatives, RP policies and procedures.

CONCLUSIONS

Keeping exposures ALARA is first a way of thinking, rather than a formula.

Since the objective of the optimization of radiological protection is to keep individual and collective doses below the appropriate dose constraints, the most relevant indicator is the dose (collective or individual). Good results for dose are the outcome of good adherence to the radiation protection procedures.

ALARA performance indicators are useful if they are used to identify the low level errors generated by poor radiation protection working practice with exposure consequences.

CONCLUSIONS

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Making periodic trend analysis of RP deficiencies and related corrective action plans could also contribute to performance improvement. This is demonstrated by our improved performance for contamination control (50 deficiencies in 2013, 5 in 2015 and 0 in 1st quarter of 2016) and radioactive material control (37 deficiencies in 2013, 7 in 2015, 2 in 1st quarter 2016).

There is still room for improvement, we must stay focused on "Radiation protection work practices" (57 deficiencies in 2013, 92 in 2015 and 27 in 1st quarter 2016), particularly on: monitoring equipment used in zone 1, RP individual equipment abandoned in the work areas (half masks, gloves), temporary storage of contaminated materials, arrange and working in rubber area.

Thank you for your attention!

Questions?