Cernavoda NPP – Using Dose Constraints as ALARA Instruments

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2010 ISOE INTERNATIONAL SYMPOSIUM
17-19 November 2010, Cambridge, United Kingdom

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INTRODUCTION

Cernavoda NPP is a 2 units plant, CANDU 6 PHWR, 700 MWe each, located in Romania, by the Danube River.

The management of Cernavoda Nuclear Power Plant is committed, as a matter of policy, to keep all radiation exposures As Low As Reasonably Achievable, economic and social factors being taken into account.

Since the effective dose is a risk related quantity, a measure of the detriment on the health, is a conservative attitude to use all the appropriate methods for keeping the doses ALARA.

ICRP APPROACH ON DOSE CONSTRAINTS

The principle of optimization of protection:

the likelihood of incurring exposures, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable, taking into account economic and societal factors.

Optimization is aimed at achieving the best level of protection under the prevailing circumstances through an ongoing, iterative process.

ICRP APPROACH ON DOSE CONSTRAINTS

Optimization involves:

- ✓ evaluation of the exposure situation, including any potential exposures (process framing);
- ✓ selection of an appropriate value for the constraint or reference level;
- ✓ identification of the possible protection options;
- ✓ selection of the best option under the prevailing circumstances;
- ✓ implementation of the selected option.

ICRP APPROACH ON DOSE CONSTRAINTS

The level of protection should be the best under the prevailing circumstances, maximizing the margin of benefit over harm.

Restrictions on the doses or risks to individuals from a particular source (dose or risk constraints and reference levels) are required in order to avoid severely inequitable outcomes of the optimization procedure.

The concepts of dose constraint and reference level are used in conjunction with the optimization of protection to restrict individual doses.

ICRP APPROACH ON DOSE CONSTRAINTS

Dose constraint for planned exposure situations:

A prospective and source-related restriction on the individual dose from a source, which provides a basic level of protection for the most highly exposed individuals from a source, and serves as an upper bound on the dose in optimization of protection for that source.

For occupational exposures, the dose constraint is a value of individual dose used to limit the range of options considered in the process of optimization.

DOSE LIMITS AT CNE CERNAVODA NPP

Dose constraints, and other limiting values are formulated as:

✓"*nobody above X mSv*" or

✓"*special authorization needed if a person would exceed X mSv*"

and used to control and optimize occupational exposure of nuclear workers.

Since first year of operation (1996) Cernavoda NPP implemented dose limit values recommended by ICRP 60 Council of European Union Directive 96/29/EURATOM, for both occupational and public exposure.

DOSE LIMITS AT CNE CERNAVODA NPP

	Dose limit (legal)		Administrative limit	Dose Constraint
	Occupational	Public	Occupational	Public
Effective dose	20 mSv/ year	1 mSv/year	18 mSv/year	0.1 mSv/(year unit)
Equivalent dose in the lens of the eye	150 mSv/year	15 mSv/year		
Equivalent dose in the skin	500 mSv/year	50 mSv/year		
Equivalent dose in the hands and feet	500 mSv/year	-		

DOSE LIMITS AT CNE CERNAVODA NPP

- ICRP limits were adopted by the Romanian laws in 2000; the annual limit for effective dose is more restrictive since the possibility of “20 mSv/year, averaged over defined period of 5 years” for normal exposures was eliminated from the national regulations.

- For special authorized exposures, regulatory body (CNCAN) may approves the exceeding of 20 mSv effective dose limit but without exceeding any equivalent dose limit and provided that average over 5 years does not exceed 20 mSv/year.

DOSE LIMITS AT CNE CERNAVODA NPP

Pregnant women

- Once pregnancy has been declared the fetus is protected by requiring an equivalent dose limit to the surface of the woman's abdomen of 1 mSv for the remainder time of the pregnancy.

Emergency exposure

- For the emergency situations limits presented before are replaced with emergency dose limits provided in the emergency plans and approved by the regulatory body. For special cases (life threatening dangers) emergency limits can be exceeded.

DOSE LIMITS AT CNE CERNAVODA NPP

Nevertheless, since the beginning we established an administrative individual annual limit of 18 mSv, 2 mSv lower than the legal limit, supported by:

- ✓Dose Control Point (DCP);
- ✓2 mSv investigation level for unexpected external single exposure;
- ✓1 mSv committed dose, investigation and removal level for internal acute exposure (single intake);
- ✓0.3 mSv follow-up level for internal acute exposure.

DOSE LIMITS AT CNE CERNAVODA NPP

Dose Control Point (DCP) is a very useful tool for control, limitation, and evenly distribute the individual doses.

It represents half of the effective dose available until administrative limit of 18 mSv/year is reached:

- at the beginning of a dosimetric year the DCP is 9 mSv, and it lowers with every dose recorded in the database (external doses measured with TLDs and EPDs, neutron doses, internal doses due to intakes of tritium and other internal contaminants).

This limit cannot be exceeded (in single exposure) without Station Health Physicist approval.

DOSE LIMITS AT CNE CERNAVODA NPP

Gamma radiation external doses, Hp(10), equal or higher than 2 mSv, in a single exposure, are investigated. Also, we usually investigate individual external gamma doses equals or higher than 1 mSv, in single exposure, measured with EPD.

External individual doses equal or higher than 2 mSv, in single exposure, due to neutrons, as they are measured with integrating portable neutrons monitor, they are also investigated.

DOSE LIMITS AT CNE CERNAVODA NPP

Based on conclusions in the investigation reports are established corrective and / or preventive actions.

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.

DOSE LIMITS AT CNE CERNAVODA NPP

Operating experience to date of CANDU reactors has indicated that the major contributor to the internal dose of professionally exposed workers is the tritiated heavy water (DTO).

Other administrative controls are implemented in order to optimize the internal doses due to the intake of tritiated heavy water:

- ✓ investigation and removal limit of 1 mSv tritium committed dose
- ✓ follow-up level of internal exposure to tritium of 0.3 mSv
- ✓ the threshold for mandatory use of respiratory protection equipment was lowered to 0.03 mSv.

OTHER METHODS FOR LIMITING INDIVIDUAL DOSES

Radiation Work Permit (RWP) are required for both routine (generic RWP) and non rutine jobs (specific RWP).

Dose rate and time limits based on the radiological conditions where radiation work will be performed are established in every RWP. If the EPD alarms the worker must leave immediately the area and report to the radiation control technician.

Individual (total, internal and external) and collective dose limits are established for a specific jobs in the RWP.

If these limits are exceeded before finishing the job the RWP is re-evaluated and approved by Station Health Physicist.

OTHER METHODS FOR LIMITING INDIVIDUAL DOSES

Since 2007 more individual and collective dose objectives were established as ALARA performance indicators:

a) maximum individual dose at the end of the year – 9 mSv for 2008, 8 mSv for 2009, lowered to 7.5 mSv for 2010 (planned exposures)

b) maximum individual internal dose due to tritium intake at the end of the year – 5 mSv – established for 2010 (planned exposures)

c) Unexpected acute individual internal exposures – any intake leading to an unforeseen committed dose higher than investigation / removal level of 1 mSv.

OTHER METHODS FOR LIMITING INDIVIDUAL DOSES

d) Unexpected acute individual external exposures – every inappropriate response at the EPD alarm and exceeding the dose that has been set for a particular job;

e) Number of workers with internal contamination with other nuclides than tritium.

ALARA Performance indicators

	2008		2009		2010	
	Target	Achieved	Target	Achieved	Target	Achieved (end of September)
Acute internal exposures	0	6	0	0	0	0
Acute external exposures	0	3	0	7	0	1
Internal contaminations	5	27	5	45	10	18

CONCLUSIONS

- No significant variations of annual individual average dose were observed since commercial operation of the plant started.
- Maximum annual individual doses were well below the national limit of 20 mSv.
- No legal or administrative individual dose limit has been exceeded.
- Individual and collective effective doses revealed the effectiveness of implementation of the Radiation Safety Policies established by the management of the Cernavoda NPP.

Thank you for your attention!

Questions?