

## QUESTIONNAIRE TO THE REGULATORY BODY MEETING TURKU 2008

### INVITATION

In conjunction with the 2008 ISOE Symposium, 25-27 June 2008, we are preparing a 3<sup>rd</sup> Senior Regulatory Body representatives meeting, to be held 24 June 2008 in Turku (Finland). We hope to encourage your participation in this meeting which follows on from the very successful Regulatory Body representatives meetings in 2004 (Lyon) and 2006 (Essen). The purpose of the meeting is to provide a forum for open exchange and discussion within specialised regulatory audience concerned with occupational radiation protection. For this occasion, the contamination management in NPPs from the occupational point of view has been chosen as the main topic.

### OBJECTIVES OF THE MEETING

The main objectives of the meeting are:

- To meet with regulators from other organisations
  - To exchange information regarding regulatory control on **contamination management in NPPs from the occupational radiation protection perspective** focusing on
    - controlled and supervised areas inside NPP
    - occupational exposure control and assessment due to both external and internal contamination.
- This meeting will not deal with aspects of contamination management other than those related to occupational radiation protection.
- To help to improve national regulatory effectiveness on occupational radiation protection by comparing national reality versus international context

### AGENDA

- Introduction of the different representatives
- Brief presentation on national requirements on contamination management
- Discussion
- Conclusions

### OBJECTIVES OF THE QUESTIONNAIRE

In order to introduce the Regulatory Body representatives meeting it is expected to draw an overview of regulatory control on contamination management in NPPs from an occupational perspective in the different ISOE member countries with their similarities and differences. Therefore we would like you to answer, briefly, to the following questionnaire to stimulate information exchange and discussions. Only one response per country is necessary.

Please do not go into the details, just describe a few "objective data".

**Even in case you will not be able to attend the meeting the information you can provide is precious. If you agree, questionnaires filled in by national authorities will be sent to the regulatory contacts participating in ISOE.**

**Yes, I agree ✓**

**The information can be used only in the RB-meeting**

## COUNTRY AND REPRESENTATIVE IDENTIFICATION

- Country: **Czech Republic**
- Name of the Regulatory Body: **State Office for Nuclear Safety**
- Name and post of the person(s) who fill in the questionnaire: **Libor Urbančík, Radiation protection Department, Radiation Protection of Fuel Cycle Section, Regional Centre Brno**

## REGULATORY CONTROL ON CONTAMINATION MANAGEMENT IN NPP

- Legal framework on contamination control**
  - Does your legal framework have requirements on radioactive contamination control? **YES**  
If so, give a short description of the content of references.
  - 1. **Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll., On Radiation Protection, Section 24, Paragraph 5: Radioactive contamination of body surface, clothes, equipment or constructional elements of the workplaces shall be maintained below the guidance levels for radioactive contamination as set out in Annex 2, Table 1. Shall radioactive contamination exceed the mentioned limits, an effective decontamination shall be performed, while the values stipulated for radioactive contamination of surfaces within the controlled area, occurring as a consequence of anticipated ways of the ionizing radiation source usage, shall only be related to detachable parts.**
  - 2. **Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll., On Radiation Protection, Section 31, Paragraph 1 c): A workplace where radiation activities are to be undertaken shall be designed, constructed and commissioned in such a way as to ensure that a ionizing radiation source will be handled in a safe way during operation, ensuring sufficient radiation protection for any persons at the workplace as well as any persons in the vicinity thereof, while fast and effective personal decontamination shall be possible when needed at workplaces with unsealed radionuclide sources.**
  - 3. **Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll., On Radiation Protection, Annex 2, Table 1 gives clearance levels and guidance levels for radioactive contamination of materials and their surfaces.**
  - 4. **Regulation No. 317/2002 Coll., On Type-Approval of Packaging for Shipment, Storage and Disposal of Nuclear Materials and Radioactive Substances, on Type-Approval of Ionizing Radiation Sources and Shipment of Nuclear Materials and Specified Radioactive Substances, Annex 4, Point 8.:**  
**The non-fixed contamination on the external surfaces of any package shall be kept as low as practicable and, under routine conditions of transport, shall not exceed the following limits:**  
**(a) 4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters, and**  
**(b) 0.4 Bq/cm<sup>2</sup> for all other alpha emitters.**
  - Does your legislation specify reference levels for contamination?  
**YES Reference levels are incorporated into the Czech legislation in terms of “clearance levels and guidance levels” in Annex 2, Table 1 of the Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll., On Radiation Protection.**
- Reference contamination levels on official documents**
  - Does some official document of the licensee specify levels for contamination? **YES**
  - If so specify the document. **Monitoring Programme. This document is approved by the State Office for Nuclear Safety.**
  - Are the reference levels for contamination in NPP the same for all NPPs in your country?  
**YES**

□ **Contamination control in controlled or supervised areas in NPPs.**

How many controlled area categories could exist on NPP site?

**Three in Dukovany NPP + territory of NPP, two in Temelin NPP + territory of NPP Dukovany NPP during operation:**

- **No-go area as part of containment and sealed compartments + rooms with high dose rate. During outage is no-go area changed into service area. There are areas and activities requiring neither Radiation Work Permit or without necessity of Radiation Work Permit there.**
- **Restricted access area (rooms requiring Radiation Work Permit)**
- **Service area**

**Temelin NPP:**

- **Rooms requiring Radiation Work Permit (hereinafter referred to as the "RWP")**
- **Rooms without requirement of the Radiation Work Permit**

- **What are the maximum contamination levels allowed in the different categories of controlled areas of NPPs for different categories of radionuclides/ types of emissions? If levels are specific for each site, please give an order of magnitude of the range covered for the different reference levels (Registration, Investigation and Intervention).**

**Levels laid down according to the Czech legislation:**

**Surfaces outside of controlled area: 0,3 Bq/cm<sup>2 a)</sup>, 3 Bq/cm<sup>2 b)</sup>, 30 Bq/cm<sup>2 c)</sup>, 300 Bq/cm<sup>2 d)</sup>.**

**Surfaces inside controlled area: 3 Bq/cm<sup>2 a)</sup>, 30 Bq/cm<sup>2 b)</sup>, 300 Bq/cm<sup>2 c)</sup>, 3000 Bq/cm<sup>2 d)</sup>.**

**Levels according to Monitoring Programmes:**

**Dukovany NPP:**

- **Territory of NPP: Registration level: all the measured values  
Investigation level: 0,3 Bq/cm<sup>2</sup>  
1<sup>st</sup> Intervention level: 0,3 Bq/cm<sup>2</sup>  
2<sup>nd</sup> Intervention level: 3 Bq/cm<sup>2</sup>**
- **Service area: Registration level: all the measured values  
Investigation level: 1 Bq/cm<sup>2</sup>  
1<sup>st</sup> Intervention level: 3 Bq/cm<sup>2</sup>  
2<sup>nd</sup> Intervention level: 30 Bq/cm<sup>2</sup>**
- **Restricted access area: Registration level: all the measured values  
Investigation level: 3 Bq/cm<sup>2</sup>  
1<sup>st</sup> Intervention level: 30 Bq/cm<sup>2</sup>  
2<sup>nd</sup> Intervention level: 300 Bq/cm<sup>2</sup>**
- **No-go area: Registration level: all the measured values  
Investigation level: not laid down  
1<sup>st</sup> Intervention level: not laid down  
2<sup>nd</sup> Intervention level: not laid down**

**Temelin NPP:**

- **Territory of NPP: Registration level: all the measured values  
Investigation level: not laid down  
1<sup>st</sup> Intervention level: not laid down  
2<sup>nd</sup> Intervention level: 0,3 Bq/cm<sup>2</sup>**
- **Rooms without necessity of RWP: Registration level: all the measured values  
Investigation level: not laid down**

a) Category of radionuclides 1 (<sup>22</sup>Na, <sup>24</sup>Na, <sup>58</sup>Co, <sup>60</sup>Co, <sup>110m</sup>Ag, <sup>226</sup>Ra, etc.)

b) Category of radionuclides 2 (<sup>7</sup>Be, <sup>76</sup>As, <sup>90</sup>Sr, <sup>144</sup>Ce, <sup>239</sup>Np, etc.)

c) Category of radionuclides 3 (<sup>14</sup>C, <sup>32</sup>P, <sup>99m</sup>Tc, <sup>166</sup>Ho, <sup>241</sup>Pu, etc.)

d) Category of radionuclides 3 (<sup>14</sup>C, <sup>32</sup>P, <sup>99m</sup>Tc, <sup>166</sup>Ho, <sup>241</sup>Pu, etc.)

1<sup>st</sup> Intervention level: 3 Bq/cm<sup>2</sup>  
2<sup>nd</sup> Intervention level: 30 Bq/cm<sup>2</sup>

- **Rooms requiring RWP: Registration level: all the measured values**  
Investigation level: 3 Bq/cm<sup>2</sup>  
1<sup>st</sup> Intervention level: 30 Bq/cm<sup>2</sup>  
2<sup>nd</sup> Intervention level: 300 Bq/cm<sup>2</sup>

- What are the basic technical requirements in NPP to control spread of contamination?

- Delimitation and marking of above stated areas
- Radiological monitoring of the workplaces
- Radiological monitoring of the personal contamination
- Personal protective means applications
- Decontamination of the workplaces and persons when needed
- Control of radiation works by radiation protection officers and qualified persons
- Applications of special monitoring at hygienic points
- Applications of Radiation Protection Programmes as part of technological procedures

Which of them are specified by legal or approved documents and on which the licensee may decide in his own responsibility?

**Legislatively controlled requirements (Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll., hereinafter referred to as the "Decree")**

- Delimitation and marking of above stated areas (Decree: Section 29 and Section 30)
- Radiological monitoring of the workplaces (Decree: Section 76)
- Radiological monitoring of the personal contamination (Decree: Section 30, paragraph 9)
- Personal protective means applications (Decree: Section 34, paragraph 5)
- Decontamination of the workplaces and persons when needed (Decree: Section 24, paragraph 5, Section 31, paragraph 1, letter c)
- Control of radiation works by radiation protection officers and qualified persons (Decree: Section 27)
- Applications of special monitoring at sanitary seals (Decree: Section 24, paragraph 1, letter i)
- Applications of Radiation Protection Programmes as part of technological procedures (Decree: Section 24, paragraph 1, letter b)

**Requirements controlled directly by the licensee**

- Control over suppliers' radiation work and exposed workers
- Debriefing after each radiation work
- Regulation of the radiation worker number entering controlled areas

- Does your legislation or approved documents include requirements about the monitoring program? **YES**. Which document? **Requirements related to the monitoring programmes are incorporated in the Czech Atomic Act (Law No. 18/1997 Coll., in amendments) and in the related delegated legislature (basically in Regulation No. 307/2002 Coll., in amendment No. 499/2005 Coll.)** What kind of requirements (periodicity, certificated instruments, exclusive performed by RP-personal with special education and training, averaging surface (volume, duration), registration and reporting)?

**Legislative requirements include as follows:**

**(1) The monitoring programme, according to the scope and the method of ionizing radiation source and/or radioactive waste management, usually consists of the following parts:**

- a) monitoring of workplace;
- b) personal monitoring;
- c) monitoring of discharges; and

d) environmental monitoring.

(2) The monitoring programme shall involve the monitoring under normal operation, the monitoring for predictable deviations from normal operation as well as the monitoring during radiation incidents and radiation accidents:

a) determination of the quantities to be monitored including the method, scope and frequency of their measurements;

b) instructions for the evaluation of measurement results;

c) reference levels and the overview of appropriate countermeasures if the reference levels are exceeded;

d) specification of the methods of measurement; and

e) specification of the types of gauges used for measurement including other aids and their parameters.

(3) The monitoring programme shall be established in such a way and such a scope as to verify the requirements of exposure limitation during operation of the workplace and to demonstrate the optimization of radiation protection and other requirements for safe operation of workplaces, especially early detection of deviations from normal operation. Depending upon the nature of work, the monitoring shall be established either as routine, that is continuous or periodic, or as operative during a certain activity aimed at evaluating and ensuring the acceptability of this activity from the point of view of the limitation system. If the arrangement of workplace, sources, methods and/or the conditions of ionizing radiation source management and/or monitoring methods are changed, the monitoring programme shall be updated.

These requirements are processed more in detail in current monitoring programme.

□ **Contamination control of personal protective equipment.**

- Does your legislation or approved documents (company instructions) include requirements about contamination of protective personal equipment? **YES** Which document?

**Legislative document: Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll. in Section 30, paragraph 9, and in Annex 2 Table 1. These legal requirements are sequentially processed into monitoring programme of the licensee, which is then approved by the State Office for Nuclear Safety.**

- Which requirements? These requirements are related to conditions as follows:

- Type of personal protective means applications in dependence on Radiation Work Permit, i.e. dependence on type of work, work conditions, work duration etc.
- Allowed contamination of the outer surface of the personal protective means
- Allowed contamination of the inner surface of the personal protective means
- Allowed contamination of the body surface (skin, hair).
- Current and actual personal protective means applications

- What are the reference levels for contamination of protective personal equipment?

**There are only intervention levels for protective means contamination.**

**Intervention level for outer surfaces of personal protective means inside controlled areas, and at exit from controlled area to the dirty part of main changing room**

**Officially laid down values according to the Czech legislation:**

**3.0 Bq/cm<sup>2 a)</sup>, 30 Bq/cm<sup>2 b)</sup>, 300 Bq/cm<sup>2 c)</sup>, 3000 Bq/cm<sup>2 d)</sup>,**

**According to the Monitoring Programmes:**

**Dukovany NPP: 1<sup>st</sup> intervention level 3.0 Bq/cm<sup>2</sup>**

**2<sup>nd</sup> intervention level 30 Bq/cm<sup>2</sup>**

**Temelin NPP: 1<sup>st</sup> intervention level 0.3 Bq/cm<sup>2</sup>**

**2<sup>nd</sup> intervention level is not laid down**

**According to the Dukovany NPP Safety Standards:**

**Dukovany NPP: Operating intervention level is equal 0.4 Bq/cm<sup>2</sup> for outer**

**surface of protective means at an access to the hygienic point and for dirty part of the changing room.**

Intervention level for inner surfaces of personal protective means

Officially laid down values according to the Czech legislation:

0.3 Bq/cm<sup>2 a)</sup>, 3.0 Bq/cm<sup>2 b)</sup>, 30 Bq/cm<sup>2 c)</sup>, 300 Bq/cm<sup>2 d)</sup>,

According to the Monitoring Programmes:

Dukovany NPP: 1<sup>st</sup> intervention level 0.3 Bq/cm<sup>2</sup>

2<sup>nd</sup> intervention level 3.0 Bq/cm<sup>2</sup>

Temelin NPP: 1<sup>st</sup> intervention level 0.3 Bq/cm<sup>2</sup>

2<sup>nd</sup> intervention level is not laid down

- Is it allowed to enter controlled areas with street clothes? **NO**
- Is it allowed to wear protective clothes outside controlled areas on the NPP site? **NO**

□ **Contamination control of reusable working materials at the exit of controlled areas.**

- Does your legislation or approved documents (company instructions) include requirements about the levels of contamination allowed for reusable working material at the exit of controlled areas? **YES**

- Which document? If affirmative, provide reference levels: **Legislative document: Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll. in Section 30, paragraph 9 and in Annex 2 Table 1. These legal requirements are sequentially processed into monitoring programme of the licensee, which is then approved by the State Office for Nuclear Safety.**

Officially laid down values according to the Czech legislation:

0.3 Bq/cm<sup>2 a)</sup>, 3.0 Bq/cm<sup>2 b)</sup>, 30 Bq/cm<sup>2 c)</sup>, 300 Bq/cm<sup>2 d)</sup>

Approved document is monitoring programme:

Dukovany NPP: intervention level 0.3 Bq/cm<sup>2</sup>

Temelin NPP: intervention level 0.3 Bq/cm<sup>2</sup>

□ **Estimation of effective dose from internal contamination**

- Does your legislation or approved documents include requirements about internal contamination of occupational exposed persons? **YES** Which document? **Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll. in Section 22, paragraph 2, letters a), and b), and Section 84, paragraph 5, letter e), and monitoring programmes of the licensee approved by the State Office for Nuclear Safety.**

Which requirements?

(2) The derived limits for internal exposure per calendar year, except the cases laid down in paragraphs 4 and 5, shall be for radionuclide intake:

a) by ingestion a value of the quotation of 20 mSv and the conversion factor

$h_{ing}$  for intake of a particular radionuclide by ingestion by an exposed worker according to tables in Annex 3; and

b) by inhalation a value of the quotation of 20 mSv and the conversion factor

$h_{inh}$  for intake of a particular radionuclide by inhalation by an exposed worker according to tables in Annex 3.

(3) For simultaneous external and internal exposures over a calendar year, except the cases mentioned in paragraphs 4 and 5, the limits for exposed workers shall not be exceeded if  $H_p(0.07) \leq 500$  mSv and simultaneously  $H_p(10) + \sum h_{j,inh} I_{j,inh} + \sum h_{j,ing} I_{j,ing} \leq 20$  mSv, where  $H_p(0.07)$  and/or  $H_p(10)$  is annual personal dose equivalent in a depth of 0.07 mm and/or 10 mm,  $I_{j,inh}$ , and/or  $I_{j,ing}$  is annual intake of a particular radionuclide by inhalation and/or ingestion, and  $h_{j,inh}$ , and/or  $h_{j,ing}$  is the conversion factor according to tables in Annex 3 for intake of a particular radionuclide by inhalation or ingestion by the exposed worker; for unidentified radionuclides, unidentified chemical forms and properties of aerosol being inhaled, the activity shall be determined for radionuclides, chemical forms and properties of the aerosol with the highest conversion factor for intake by inhalation and/or ingestion according to Annex 3.

- What are the methods and criteria for assessment of internal doses?

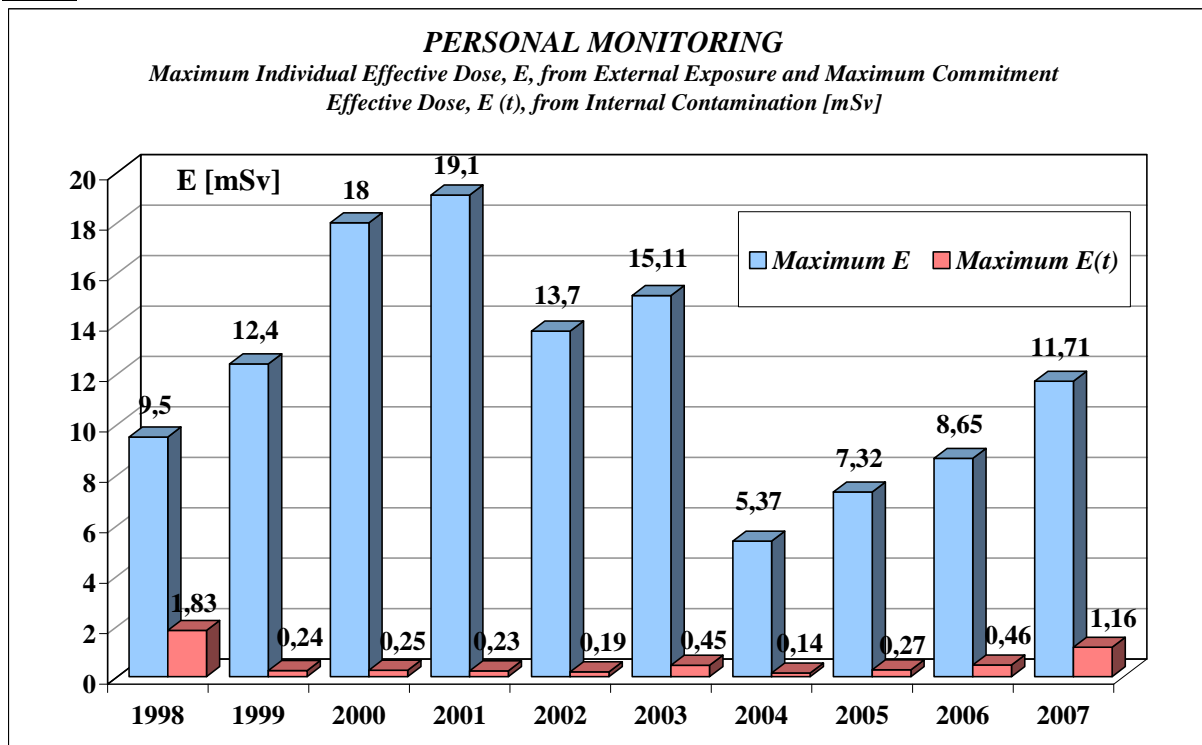
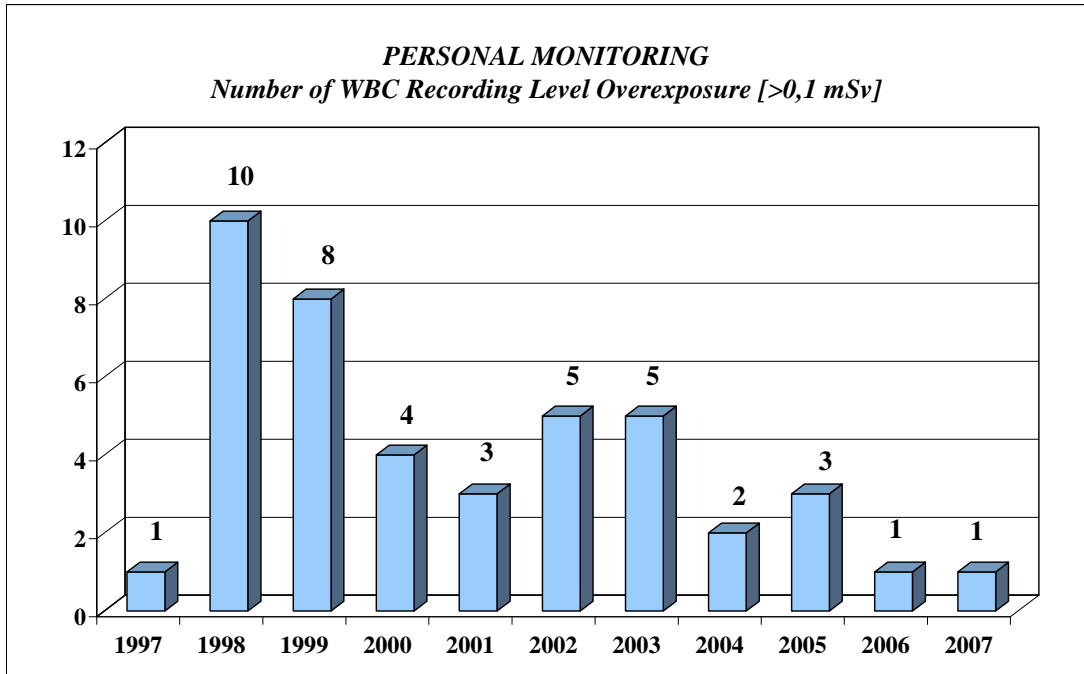
**Methods:**

- Whole Body Counter (hereinafter referred to as the “WBC”) for routine monitoring.
- Walk-in Counter FASTSCAN for operational determination of the gamma radionuclides activities – internal contamination.
- Special measuring method of the iodine 131 in thyroid: activity of the radionuclide iodine 131 in thyroid.
- Bio-assays in special cases (bodily contamination is likely).

**Criteria:**

- Internal dose controls must be carried out for classified group of workers during outages in routine way and also in case of suspicion on likely internal contamination
  - Whenever an intake is suspected.
- What are the reference levels for internal doses (please give examples for typical nuclides, allowed averaging volume or surface or ...)? **See as examples in Table No. 1. and No. 2.**
- **Estimation of effective dose from external contamination. Skin doses**
- Does your legislation or approved documents (company instructions) include requirements about contamination of skin? **YES.** Which document? **Legislative document: Regulation No. 307/2002 Coll., Amendment No. 499/2005 Coll. in Section 24, paragraph 5, and in Annex 2 Table 1. These legal requirements are sequentially processed into monitoring programme of the licensee, which is then approved by the State Office for Nuclear Safety.**
- Which requirements?  
**According to the Monitoring Programmes from the territory of the NPP to the environment:**
- |                      |  |
|----------------------|--|
| <b>Dukovany NPP:</b> | <b>1<sup>st</sup> intervention level 0.3 Bq/cm<sup>2</sup></b> |
|                      | <b>2<sup>nd</sup> intervention level 3.0 Bq/cm<sup>2</sup></b> |
| <b>Temelin NPP:</b>  | <b>1<sup>st</sup> intervention level 0.3 Bq/cm<sup>2</sup></b> |
|                      | <b>2<sup>nd</sup> intervention level is not laid down</b>      |
- What is the triggering level of contamination to carry out an assessment of skin dose?  
**0.3 Bq/cm<sup>2</sup>**
- What is the maximum level allowed for personal contamination at the exit of the controlled area?  
**< 0.3 Bq/cm<sup>2</sup>**
- How contamination is measured in 1 cm<sup>2</sup>? For discussion in plenary session.  
**Measurement of the surface contamination is not a matter of the legislation it is completely matter of operating procedures of the licensee. Measuring techniques include following process:**
- 1. Direct method**
  - 2. Abrasion method**
- Direct method is preferable. This method is normal process used in general according to the operating instructions of the contamination measurement devices providers/producers.**
- **External risk versus internal risk perception**
- External risk versus internal risk perception and practice in your country? How and why do you weight the risks different? What is the practice in your country? What are the experiences? For discussion.  
**Licensee as well as regulatory body are involved in an achievement of excellent radiation protection results expressed in term of ALARA (as low risks as reasonably achievable). Internal contamination is perceived as a very serious issue. From this**

point of view is essential to devote maximum heed to this problem. Therefore we operate an indicator dedicated to that issue in the Czech Republic: Number of individuals exceeding recording level 0.1 mSv. The investigation and/or intervention levels have been never exceeded during the whole monitored period. Figure No. 1 brings results of the whole body counter recording level exceeding number at Dukovany NPP. Temelin NPP has had no such a case for whole operating period, up to now.





Do you have some additional topics, which you would like to discuss during the RB meeting:

1. Experience with duration of wet contamination holding on surfaces inside controlled area; commercial and safety approach.
2. Experience with prevention measures of internal contaminations.

Annex No. 1

Example No. 1 Recording, investigation, and intervention levels for activities of particular gamma radionuclides for intake by inhalation and monthly monitoring period at Dukovany NPP.

Radionuclide	Recording level [Bq]	Investigation level [Bq]	1 <sup>st</sup> Intervention level [Bq]	2 <sup>nd</sup> Intervention level [Bq]
Co-58	30	M; 55 500	M; 277 500	M; 1.11E6
		S; 41 670	S; 208 350	S; 8.33E5
Co-60	46	M; 8 680	M; 43 400	M; 1.74E5
		S; 2 870	S; 14 350	S; 5.74E4
Mn-54	44	F; 95 780	F; 478 900	F; 1.92E6
		M; 55 550	M; 277 750	M; 1.11E6
Ag-110m	45	F; 15 150	F; 75 750	F; 3.03E5
		M; 11 570	M; 57 850	M; 2.31E5
		S; 6 940	S; 34 700	S; 1.39E5
Cs- 137	77	F; 17 360	F; 86 800	F; 3.47E5
Cs-134	56	F; 12 250	F; 61 250	F; 2.45E5
Sb-124	50	F; 64 100	F; 320 500	F; 1.28E6
		M; 13 660	M; 68 300	M; 2.73E5
Nb-95	47	M; 59 520	M; 297 600	M; 1.19E6
		S; 52 000	S; 260 000	S; 1.04E6
Zr-95	73	F; 33 330	F; 166 500	F; 6.67E5
		M; 18 520	M; 92 600	M; 3.70E5
		S; 15 150	S; 75 750	S; 3.03E5
Fe-59	51	F; 37 880	F; 189 400	F; 7.58E5
		M; 23 800	M; 119 000	M; 4.76E5
Cr-51	60	F; 3 968 000	F; 19 840 000	F; 7.94E7
		M; 2 688 000	M; 13 440 000	M; 5.38E7
		S; 2 315 000	S; 11 575 000	S; 4.63E7

F, M, S – type of absorption, F - fast, M – medium, S - slow.

**Example No. 2 Recording, investigation, and intervention levels for activities of particular gamma radionuclides for intake by ingestion and monthly monitoring period at Dukovany NPP.**

Radionuclide	Recording level [Bq]	Investigation level [Bq]	1 <sup>st</sup> Intervention level [Bq]	2 <sup>nd</sup> Intervention level [Bq]
Co-58	30	M; 112 000	M; 560 000	M; 2.24E6
		S; 119 000	S; 595 000	S; 2.38E6
Co-60	46	M; 24 500	M; 122 500	M; 4.90E5
		S; 33 300	S; 166 500	S; 6.66E5
Mn-54	44	F; 117 400	F; 587 000	F; 2.35E6
Ag-110m	45	F; 29 800	F; 149 000	F; 5.96E5
Cs-137	77	F; 6 410	F; 32 000	F; 1.28E5
Cs-134	56	F; 4 400	F; 22 000	F; 8.80E4
Sb-124	50	F; 33 330	F; 166 650	F; 6.66E5
Nb-95	47	M; 143 700	M; 718 500	M; 2.87E6
Zr-95	73	F; 94 700	F; 473 500	F; 1.89E6
Fe-59	51	F; 46 300	F; 213 500	F; 8.54E5
Cr-51	60	F; 2 193 000	F; 10 965 000	F; 4.39E7
		M; 2 252 000	M; 11 260 000	M; 4.50E7

F, M, S – type of absorption, F - fast, M – medium, S - slow.