Ministry of Health
National Centre of Radiobiology and Radiation Protection
Sofia - Bulgaria

AREA OF FORMER URANIUM MILLING PLANT "ZVEZDA" ELESHNIVA – BEFORE AND NOW

(an example for assessment of remediation actions)

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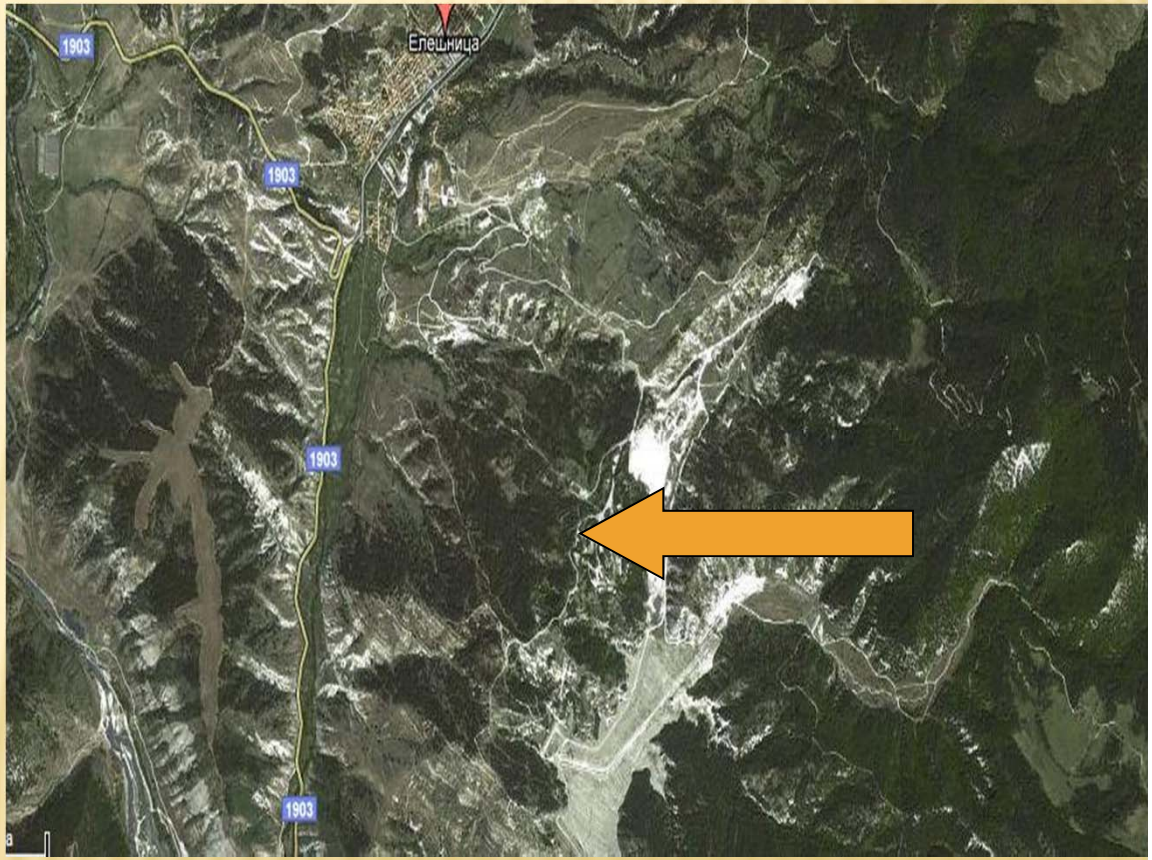
SATE DESCRIPTION

- Uranium Milling plant “Zvezda” is located in Rodopi mountain close to village Eleshnica



OPERATION HISTORY

- 1965 – starting as Milling plant for sulfuric-acid extraction of uranium from uranium ores and regeneration of ion-exchange resins from in situ leaching technology.
- 1992 – was shut down

HISTORICAL DATA

- 2004 - Technical liquidation was completed:
  - Dismantling of machinery, equipment and installations.
  - Removal of metal building structures.
  - Demolition of 4 Buildings (by blasting), because of radioactive contamination.
  - Deposit of radioactive waste in tailing ponds.
  - Radioactivity decontamination (cleaning) of less contaminated equipment.
  - Renovation of not contaminated buildings.

Radioactive inventory of the area - 2005

- Gamma dose rate measurements with a portable detector
  - Whole milling plan area - approximately 50 000 m^2

The total contained area was 8 300 m^2

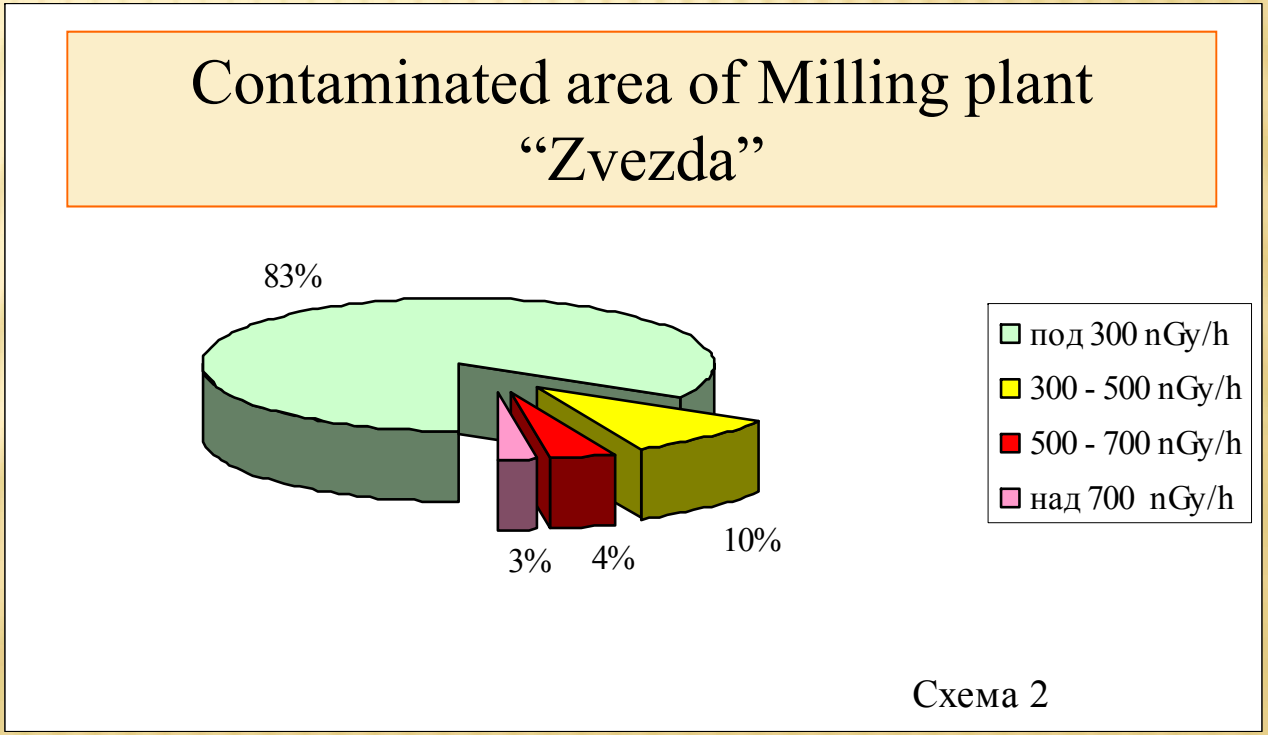


Схема 1 - Мрежа на измерване на мощността на дозата гама-лъчение на терена на завод "Звезда", с. Елешница

Storage of ore
649- 2105 nGy/h.

Main Corpus and waste rock pile – up to 1842 nGy/h.

Map of the site with contamination

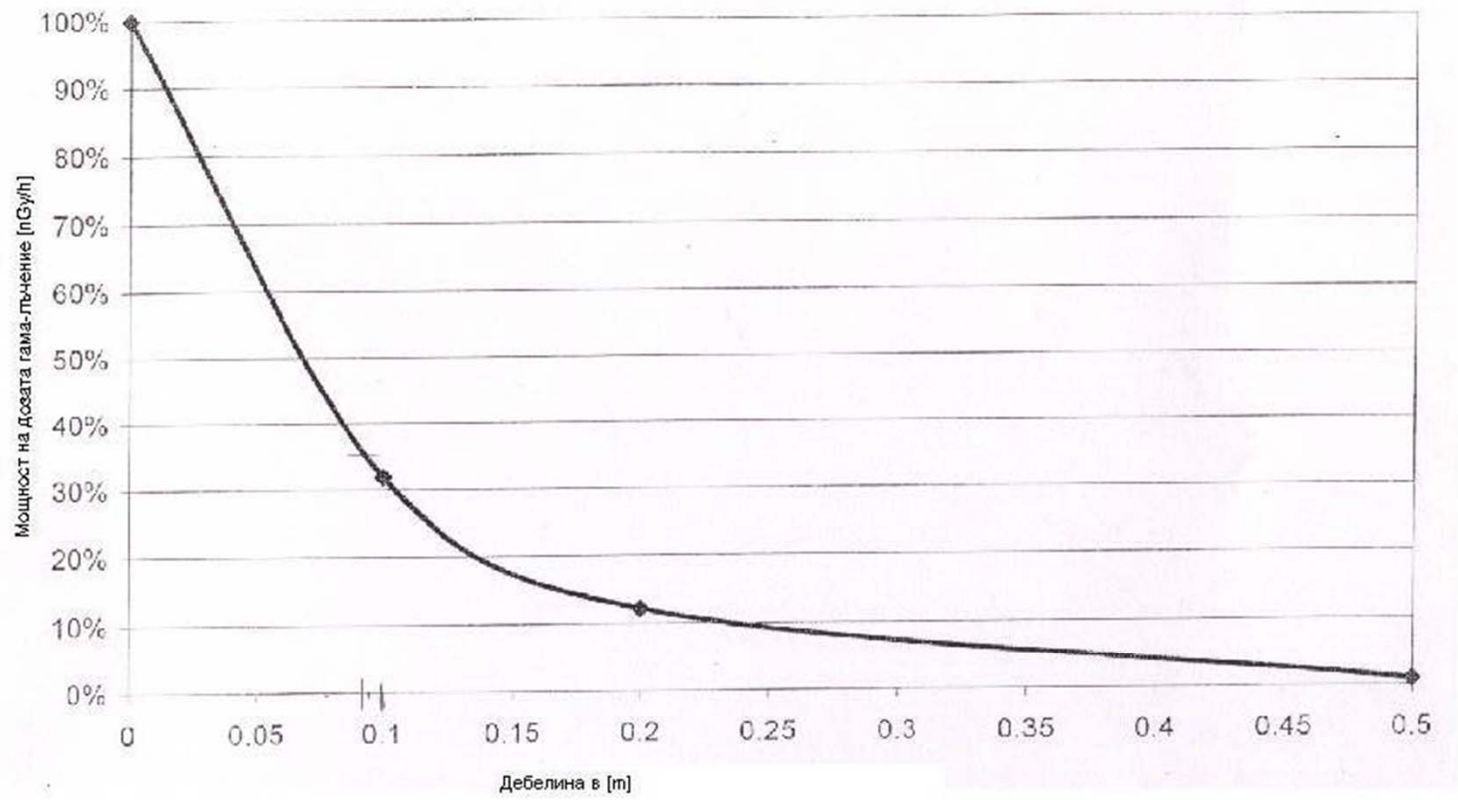
DECOMMISSIONING ACTIVITIES

- Covering with non radioactive soil layer (clay) - measuring of the gamma dose rate and calculating the thickness of the layer, using the equation

$$H=H_0 \cdot \exp(-\mu d)$$

- For validation of results has been used theoretically derived dependence used in German practice to calculate the thickness of the covering layer over similar sites.
- Accepting an insulating layer of clay with 2.2 g/cm^3 density and thickness of 30 cm.

Relation between percent of gamma dose rate decrease and thickness of the layer

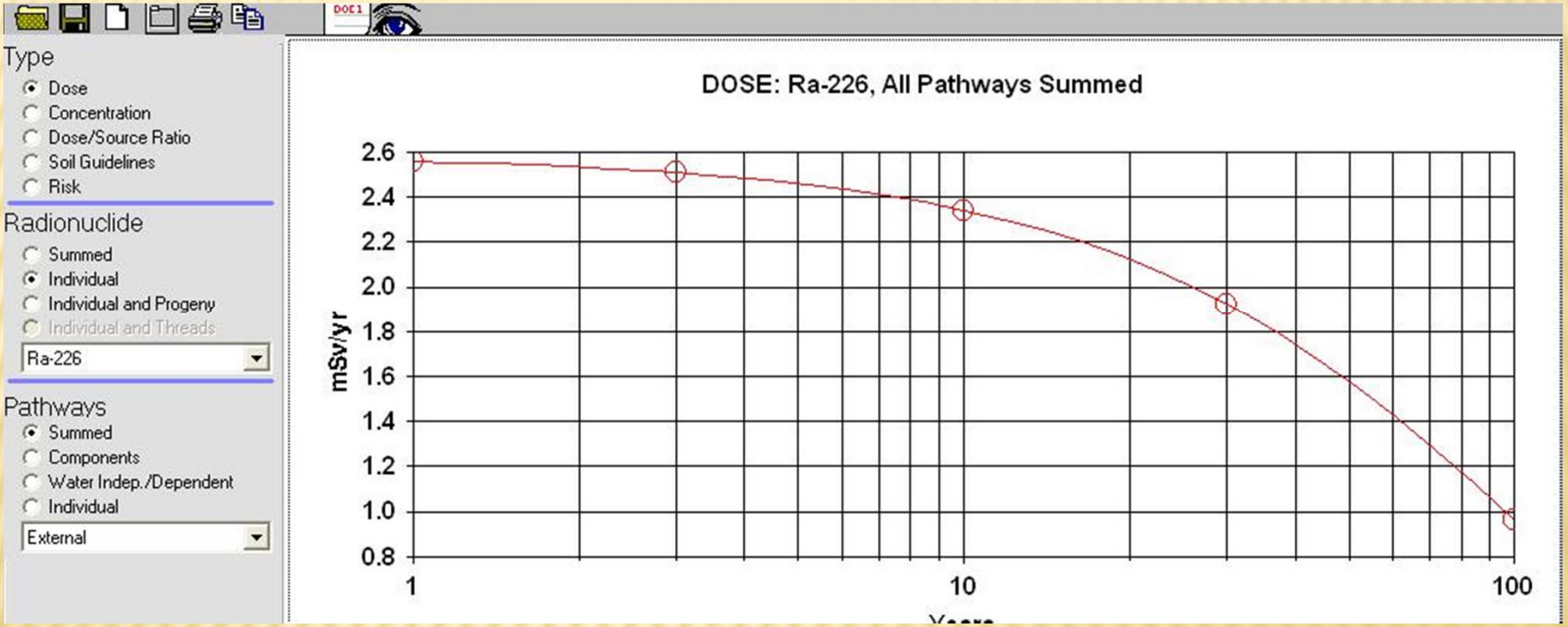


Фиг.1
(към радиационната програма)

DECOMMISSIONING ACTIVITIES

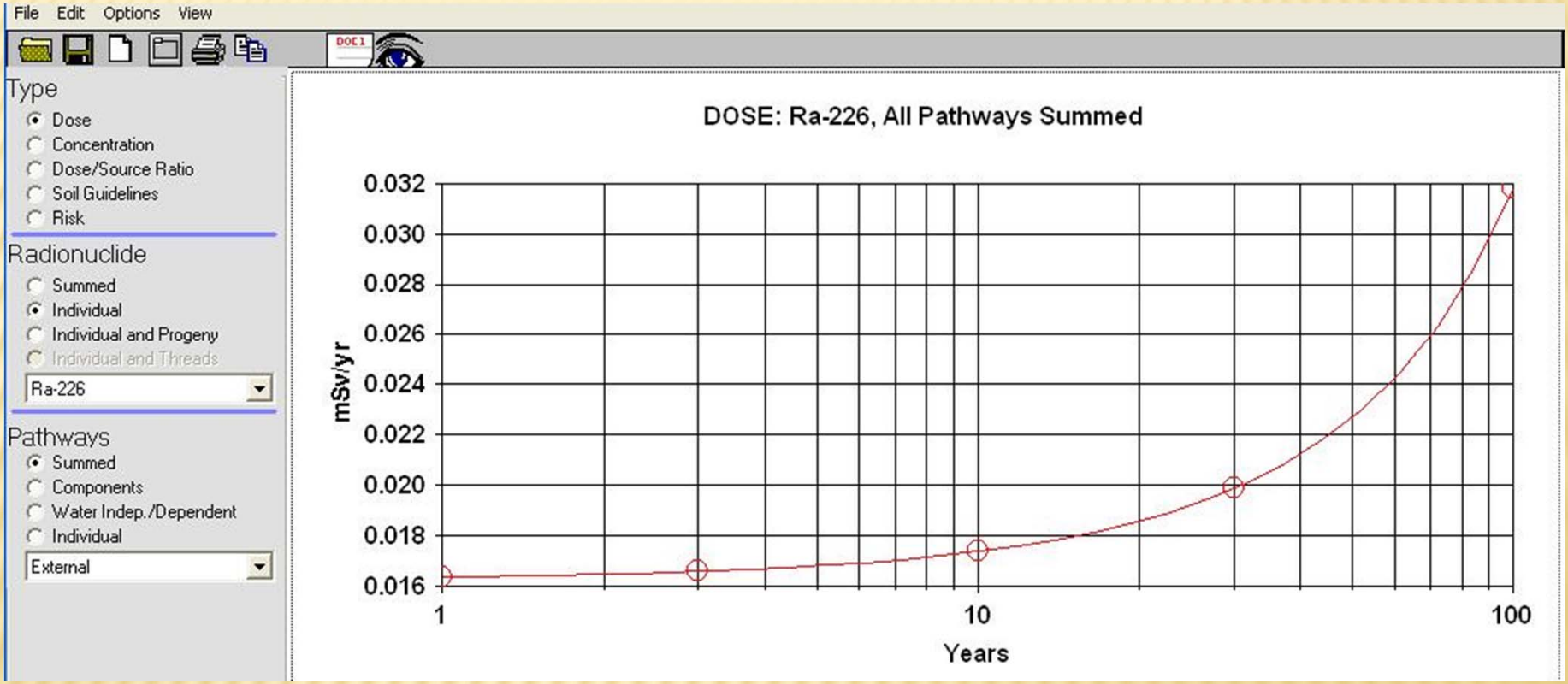
- Placing topsoil
- Removing surface water drainage measures
- Assessment of the buildings and equipment condition
- Remediation area certification

RESRAD 6.3 without remediation



Maximum concentration of Ra-226 in soil 1560 Bq/kg

RESRAD 6.3 with remediation



ReCLAIM with remediation

Exposure Pathway	Parameter	Default Scenario	Default	Parameters Changed	Basis
Inh Dust	Time spent indoors (h y-1)	0	7100	7100	
Inh Dust	Time spent manually digging (h y-1)	0	20	20	
Inh Dust	Time spent mechanically digging (h y-1)	0	79	79	
Inh Dust	Time spent outdoors when the ground is not	0	689	689	
Inh Dust	Time spent outdoors with soil on skin (h y-1)	0	79	79	
Inh Dust	Nonambient Inhalation Rate (m3 h-1)	0	1.69	1.69	
Inh Dust	Ambient Inhalation Rate (m3 h-1)	0	0.92	0.92	
Inh Dust	Enhanced Dust Loading in air (g m-3)	0	0.0005	0.0005	
Inh Dust	Ambient Dust Loading in air (g m-3)	0	0.00005	0.00005	
Inh Dust	Enrichment Factor	0	1	1	
Ing Soil	Time spent outdoors with soil on skin (h y-	0	79	79	
Ing Soil	Soil Ingestion Rate (g h-1)	0	0.005	0.005	
Skin Dose	Time spent outdoors with soil on skin (h y-	0	79	80	
Skin Dose	Enrichment Factor	0	1	1	
Ext dose buried	Time spent at Buried Geometry 1 (h y-1)	0	7100		
Ext dose buried	Thickness of Cover Material 1 (m)	0	deep burial (m)	0.3	
Ext dose buried	Thickness of Buried Contamination 1 (m)	0	0	0.2	
Ext dose buried	Density of Cover Material 1 (g cm-3)	0	0	2.2	
Ext dose buried	Density of Buried Contamination 1 (g cm-3)	0	0	1.5	
Ext dose buried	Time spent at Buried Geometry 2 (h y-1)	0		1500	
Ext dose buried	Thickness of Cover Material 2 (m)	0		0.3	
Ext dose buried	Thickness of Buried Contamination 2 (m)	0	0	0.2	
Ext dose buried	Density of Cover Material 2 (g cm-3)	0	0	2.2	
Ext dose buried	Density of Buried Contamination 2 (g cm-3)	0	0	1.5	

Output Summary

Model Selected	USER-defined scenario
Dose Target (mSv y^{-1})	3.00E-01
Total Dose from Assessment (mSv y^{-1})	1.90E-02
Selected Nuclide	
Most limiting Scenario	USER Specified
Assessment Type	DOSE
Most limiting nuclide	Ra+226

Select model to report

d-Mod1

Total Dose : Dose Target
0.06
PASS

Calculate depth at which model = PASS

VIEW MOST LIMITING SCENARIO OVERVIEW >>>

HIDE ACTIVE PATHWAYS FOR MOST LIMITING SCENARIO

2008 - after remediation activities

2003- before remediation activities

CRITERIA FOR REMEDIATION ACTIVITIES

- Regulation of limits for radiation protection and safety during liquidation of consequences from uranium industry in Bulgaria (St.G. No 1 of 1999)

This limits of radiation protection and safety ensure observation of the limit on effective dose for any member of the public – 1 mSv/y

LIMITS FOR RE-USE OF AREA

Way of using	dose rate nGy/h	Ra-226 Bg/kg
Without restriction	to 300	to 200
For green area without an open-air kindergarten	to 300	to 200
For woodland	to 700	to 1000
For agricultural purposes	to 500	to 600
Competent authorities decision for each case	above 700	above 1000

LIMITS FOR RE-USE OF BUILDING

Way of using	dose rate nGy/h	Ra-226 in soil Bq/kg	Rn-222 inside Bq/m^3
New building	to 300	to 200	to 200
Re-use without restriction	to 300	to 200	to 400
For store	to 500	to 600	to 600
Competent authorities decision for each case	above 500	above 600	above 600

LIMITS FOR RE-USE OF METAL AND PLASTIC WASTE

Way of using	Surface contamination Bq/cm^2	
	Alpha	Beta
Without restriction#	0.05	0.50
For smelting	0.50	5.00
Storage in control aria	0.50 - 2.50	5.00 - 25.00
Competent authorities decision for each case	above 2.50	above 25.00

#with the exception of food industry and drinking water supplies

LIMITS OF BUILDING MATERIAL

Way of deposit	Ra-226 [Bq/kg]
Use or deposit in storage without restriction	200
Storage in control aria	200 - 1000
Competent authorities decision for each case	above 1000

LIMITS FOR RE-USE OF VEHICLES AND EQUIPMENTS

Way of using	Surface contamination Bq/cm^2	
	Alpha	Beta
Without restriction	0.50	5.00

The NCRRP certificates (statement of conformity) the use of above mentioned items.

RADIOLOGICAL SURVEY IN 2010

- Measurements of environmental radiation parameters:
  - Gama dose rate - grid method 10 m × 10 m
  - Outdoors Radon concentration in air

Gama dose rate, min – max [nGy/h]	Radon concentration [Bq/m^3]
300 - 500	30 ± 4

- Criteria for restricted use of woodlands are introduced;
- Decommissioning activities for recultivation of the site will be approved by state commission untill end of 2011;
- Further monitoring and control of the site is needed.

THANK YOU FOR ATTENTION