Radioactive metallic waste melting and clearance of ingots into the environment

Andrej Slimák, Alojz Slaninka, Martin Ištjak

Content

1. Introduction
2. Metal melting description
3. Melting of metallic RAW in SR
4. Methodology for clearance of ingots
5. Conclusion

Introduction

- Decommissioning is difficult long-term process
- III. and IV. stage of decommissioning of A1 NPP
- II. stage of decommissioning of V1 NPP
- Large amount of metallic RAW arises during decommissioning
- Suitable decontamination technology increases clearable metals into ENV

Metal melting description

High-temperature technology, scrap metal is heated above its melting temperature

Decontamination factor depends on RN

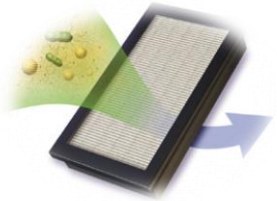
Ingot

^{60}Co, ^{63}Ni

Slag

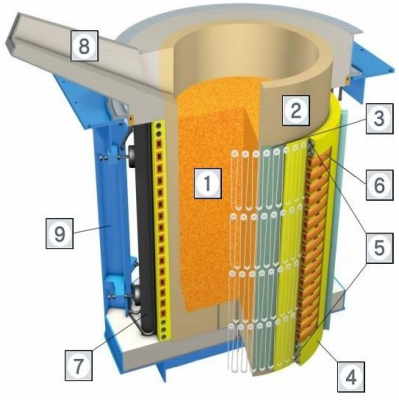
^{90}Sr, ^{137}Cs, ^{241}Am

Dust/fumes



^{137}Cs, ^{129}I

Metal melting description



1 Roztavený kov
2 Keramický téglik
3 Tepelná izolácia
4 Obal so senzorickým káblom
5 Chladiaci okruh
6 Výhrevná indukčná cievka
7 Kotva transformátora
8 Hubica pre odlievanie
9 Oceľový plášť

RN	Ingot [%]	Slag [%]	Dust, fumes [%]
^{60}Co	88	11	1
^{63}Ni	90	10	0
^{90}Sr	1	97	2
^{94}Nb	81	17	2
^{99}Tc	99	0	1
^{125}Sb	95	4	1
^{134,137}Cs	<1	60	40
^{152}Eu	4	95	1
^{239,40}Pu	1	97	2
^{241}Am	1	97	2

Source: QUADE, U., MULLER, W.: *Recycling of radioactively contaminated scrap from the nuclear cycle and spin-off other application,* Revisita de metalurgia, Rev. Metal: Madrid Vol. Extr. (2005), p. 23-28

Melting of metallic RAW in SR

A1 NPP– III. a IV. decom. stage

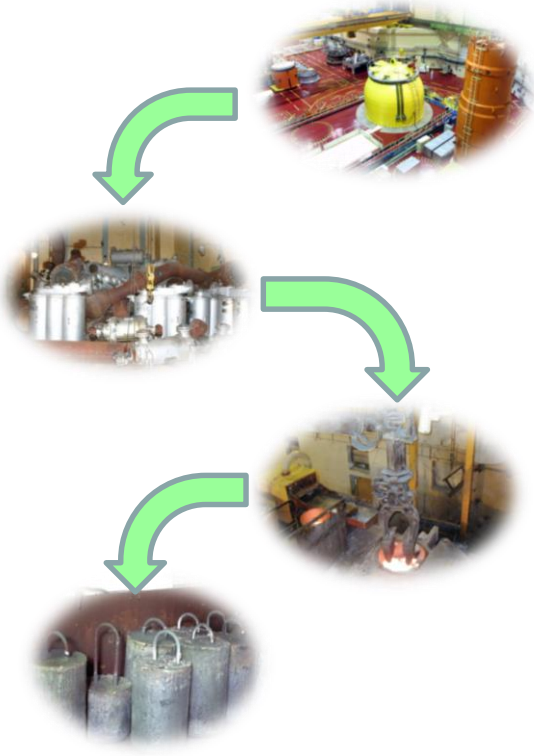
^{137}Cs

^{90}Sr

^{241}Am

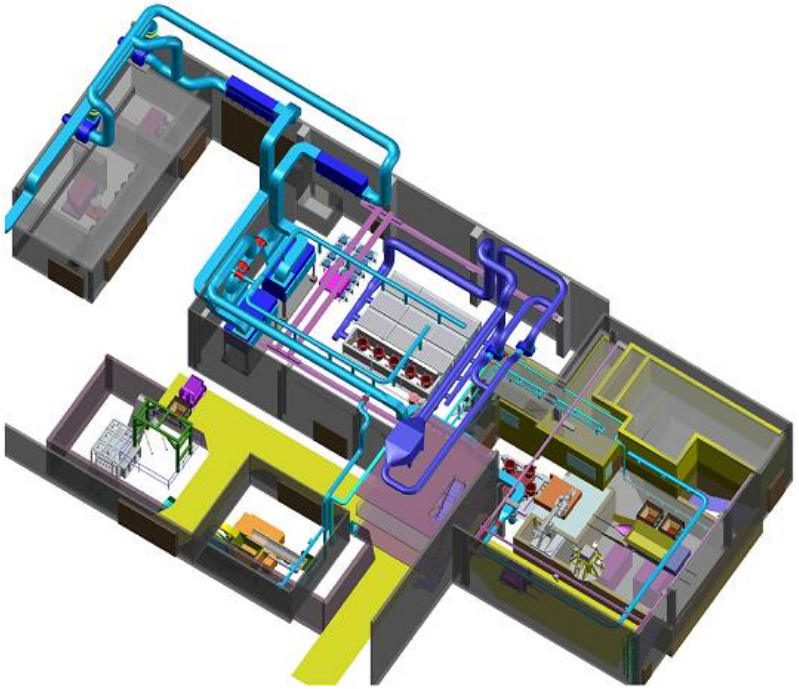
V1 NPP– II. decom. stage

^{60}Co

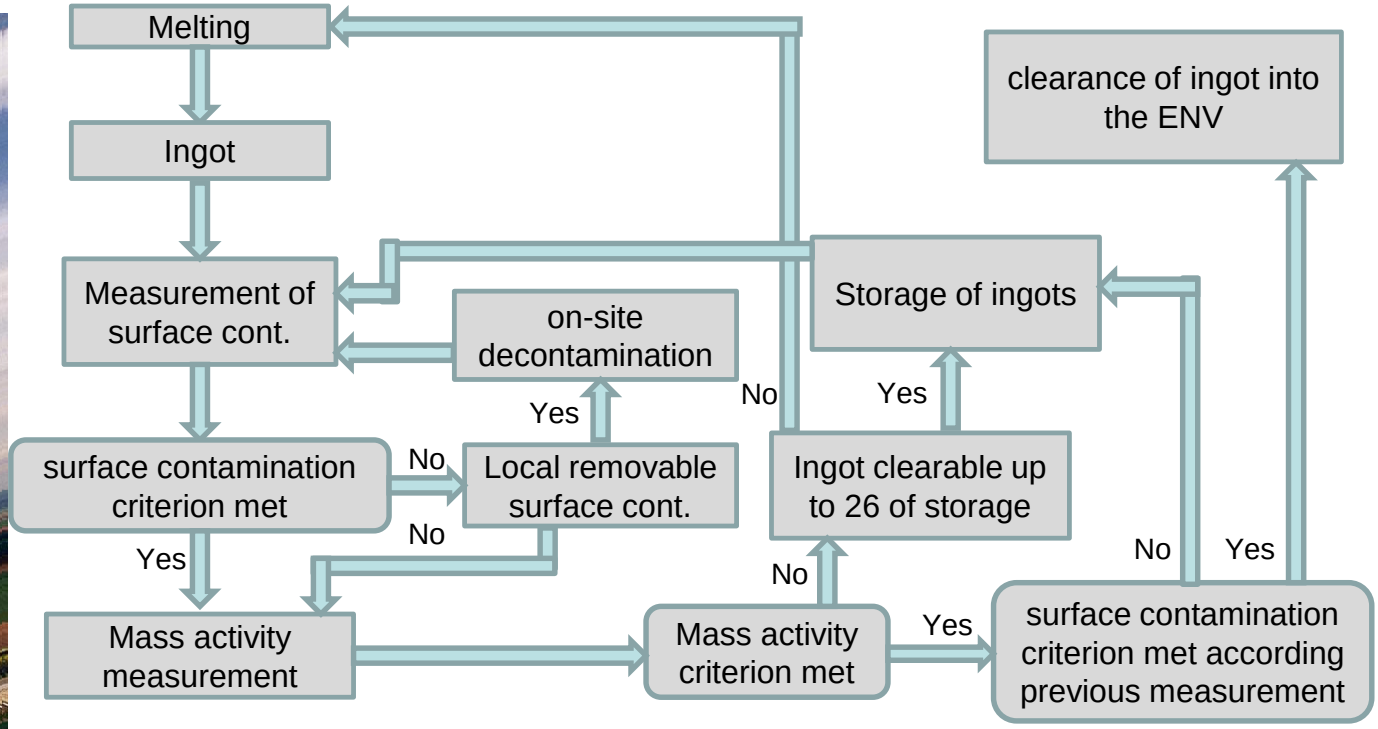


Melting of metallic RAW in SR

- Medium-frequency induction furnace
- Charge size – 2 tones – 5 ingots
- 4 charges daily considered
- Annual melting capacity 1000 tones of scrap metal – 2500 ingots



Clearance monitoring concept



Surface activity measurement

- In accordance with Radiation protection act no. 87/2018 coll, annex no.5

$$\sum \alpha_{max}\ 0{,}1\ Bq/cm^2$$

$$\sum \beta_{max}\ 1{,}0\ Bq/cm^2$$

$$\frac{\sum \alpha[Bq/cm^2]}{0{,}1 Bq/cm^2} + \frac{\sum \beta[Bq/cm^2]}{1 Bq/cm^2} < 1$$

- Ingot surface 8000 cm^2
- Clearance monitoring at 100% of surface with hand-held device

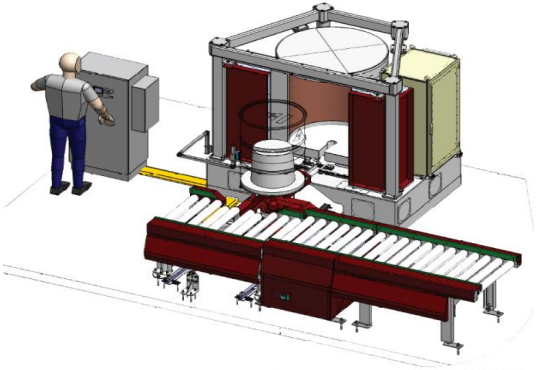
MDA Σα 0,02 Bq/cm^2
Σβ 0,07 Bq/cm^2
background 0,1 μSv/h, 60s background measurement, survey mode with 10s time constant

MDA Σβ 0,13 Bq/cm^2
background 0,1 μSv/h, 60s background measurement, survey mode with 10s time constant

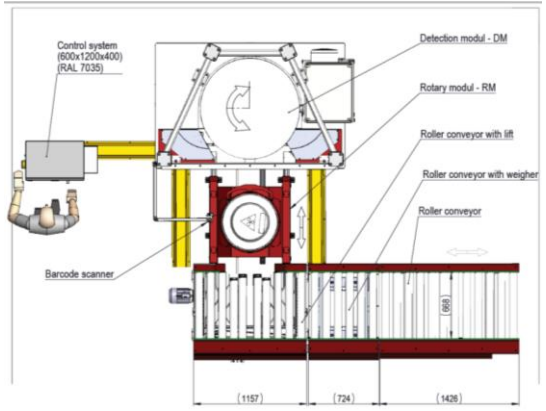
Mass activity measurement

- In accordance with Radiation protection act no. 87/2018 coll, annex no.5
- Mass activity measurement using gammascaner with 3 HPGe detectors
- Summation formula

$$\sum_{i=1}^{n} \frac{A_i}{A_{ui}} < 1$$



Segment gamma scanner WS3100



Mass activity measurement

Determination of relevant RN a clearance levels

- Scrap metal from A1, V1 NPP
- Relevant RNs and CL for **A1 metals** adopted from decision of PHA SR No. **OOZPŽ/7119/2011**
- Relevant RNs and CL for **V1 metals** based on **radiological characterization** and Radiation protection act no. **87/2018**

RN for A1 NPP	Clearance level [Bq/kg]	Half-life [y]
^{60}Co	**100**	**5.27**
^{134}Cs	**100**	**2.06**
^{137}Cs	**100**	**30**
^{152}Eu	**100**	**13.3**
^{63}Ni	100 000	96
^{90}Sr	1 000	29.1
^{99}Tc	1 000	213 000
^{239,240}Pu	100	24 100
^{241}Am	100	432

RN for V1 NPP	Clearance level [Bq/kg]	Half-life [y]
^{60}Co	**100**	**5.27**
^{137}Cs	**100**	**30**
^{63}Ni	100 000	96
^{94}Nb	100	20 300
^{125}Sb	100	2.77
^{241}Am	100	432

Conclusion

- Suitable decontamination technology – DF depends on metal contamination (RN)
- Possibility to significant reduce metallic RAW
- Melting facility under construction at present
- Suitable for metal contaminated with fission products and transuraniums

THANK YOU FOR YOUR ATTENTION!