



Management of metals resulting from an Italian nuclear facility: techniques for clearance and unconditional release.

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1. INTRODUCTION



- The start of decommissioning of nuclear facility in Italy leads to an appreciable increase in the volume of metal materials that will need to radiological characterization for the unconditional release.
- The nuclear fuel reprocessing facility ITREC, located in Rotondella (MT) in the south of Italy, is currently in safety maintenance. As part of these activities was necessary the replacement of the drainage pipe (approximately 5000 m) that discharges facility's liquid effluents



1. INTRODUZIONE



- The entire pipeline is in treatment within a small Waste Management Facility suitably equipped for the cutting, the separation of the non-metallic residue and decontamination
- 100% of the pipe portions are characterized by measures of gross alpha - beta - gamma total and high resolution gamma spectrometry in order to verify the removal without radiological constraints.



2. REGULATORY FRAMEWORK



- The version of the Basic Safety Standards suggests the levels of exemption (Exemption Level), which are defined in a more restrictive sense in national law.
- The unconditional clearance levels (Clearance Level) are also suggested in the publications Radiation Protection (RP) in particular, the RP 89 offers specific levels of removal (Specific Clearance Level) for metals.
- The RP 122 Part I to par. 5.1 states that the materials removed should not be subjected to further examination, otherwise it would contradict the principle of Unconditional Removal that prescribes instead the release of materials from the regulatory system (Clearance = release from regulatory requirements).
- The Italian legislation on radioprotection (Article 154 paragraph 3 bis of Legislative Decree 230/95 and subsequent modifications and additions) states that "... the removal of installations subject to authorization ... of materials containing radioactive substances intended to be disposed of, recycled or reused is subject to specific requirements to be included in authorization measures... The clearance levels ... take into account the guidelines, recommendations, and technical guidance provided by the European Union"

2. REGULATORY FRAMEWORK



- The Operating License of ITREC Trisaia, issued by the Ministry of Economic Development pursuant to art. 50 of Legislative Decree 230/95, and subsequent modifications and additions, requires compliance with technical and management requirements - issued by the Control Authority (ISPRA - Institute for Environmental Protection and Research), in particular the management prescription 2.9 indicates the surface and mass concentration levels established for the unconditional removal of metal solid materials by ITREC facility.
- An indispensable operative indication about the methods and procedures of radiological control for the purpose of removal is provided by the UNI 11458:2012 ; it outlines strategies for the measurement of low levels of radioactivity in solid materials from nuclear facility.

3. TRATTAMENTO E CARATTERIZZAZIONE



- Over the years of operation of the ITREC (pre- nuclear tests : 1970 ÷ 1975; nuclear tests : 1975 ÷ 1978) , the liquid effluents were made by cooling water of process components, by the drainage of building process premises , by condensation from the monitoring tank, by intermediate layer evaporator condensation and the water drained from the aquifer to ensure water protection of underground rooms (Local HLW , LLW , Storage Pool , Tank 7.1 and Pit 7.2). After the stop of nuclear activities, from the beginning of the eighties to the present, the discharges are made predominantly from groundwater drainage for water protection of underground rooms. These drains are collected in 3 containment tanks , each with a working volume of about 600 cubic meters which, after analysis and verification of their compatibility with the formula of discharge authorized by the control authority, are drained in the Ionian Sea through a special metal pipe.

3.PROCESSING AND CHARACTERIZATION



- The sea drainage discharge has been entirely replaced in 2008 and the old pipe (with a length of about 5400 m) was stored in 12 containers in crops from about 5 m, for a total gross volume of about 140 m³ and a total mass of about 120 tonnes.



- Identification of container and positioning in front of the tunnel overlooking to the equipped cells (WMF Waste Management Facility);
- extraction of some sections of the pipe from the container, control of the exposure rate and positioning in the tunnel entrance of the WMF;
- subdivision of the pipe contained in a specific container in batches made of 4 ÷ 5 sections each;
- transfer of each lot in the cells of treatment;
- detection and identification of each section of pipe;
- carrying out preliminary radiometric checks;
- removal of bitumen and mineral tissue protective coating;
- collection and packaging of removed bituminous material in 380 liter overpack for subsequent characterization;
- cutting into two parts, each of about 2 meters, of each section;
- univocal identification of the pipe's parts produced by cutting;

- inner cleaning of each of the two parts of pipe' section, using appropriate brushes, wire brushes and / or other tools, with simultaneous collection of the powders by dedicated aspirators;
- further cutting into about 50 cm parts, already identified in the section of treated pipe;
- crushing, with press of 60 Mg. of 50 cm parts and longitudinal cutting of each single piece with plasma torch
- controls the total surface contamination and surface contamination controls transferable through two smear tests for each of the two portions of single 50 cm piece, both on the outer and on the inner surface;
- insertion of treated drainage pipe lot in 380 liters Overpack for subsequent characterization by ISOCS system.

Preliminary operations to characterization



- removal of bitumen and mineral tissue protective coating;



- collection and packaging of removed bituminous material in 380 liter overpack for subsequent characterization



Preliminary operations to characterization



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Preliminary operations to characterization



- longitudinal cutting of each single piece in two parts, using plasma torch and crushing with press of 60 Mg the crops of 50 cm



Preliminary operations to characterization



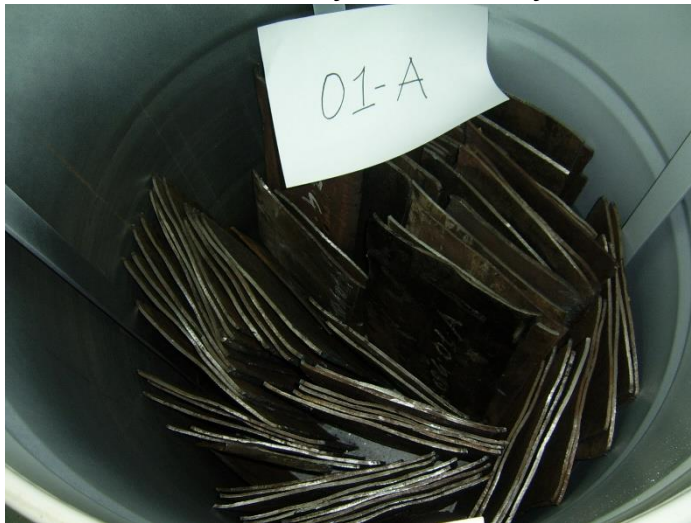
- controls the total surface contamination and surface contamination controls transferable through two smear tests for each of the two portions of single 50 cm piece, both on the outer and on the inner surface;



Preliminary operations to characterization



- insertion of treated drainage pipe lot in 380 liters Overpack for subsequent characterization by ISOCS system



- For the purposes of unconditional release of materials, it was verified that the levels of mass concentration and surface were respected for various radionuclides listed in Table 1 extracted from the document and in particular by the prescription management 2.9

Radionuclide (i)	(C_{li}) Metallic materials		(C_{li}) Concrete materials		(C_{li}) Other materials
	Surface (Bq/cm ²)	Mass (Bq/g)	Surface (Bq/cm ²)	Mass (Bq/g)	Mass (Bq/g)
³ H	10.000	1	10.000	1	0,1
⁵⁵ Fe	1.000	1	10.000	1	0,1
⁶⁰ Co	1	1	1	0,1	0,1
⁵⁹ Ni	1.000	1	10.000	1	0,1
⁶³ Ni	1.000	1	10.000	1	0,1
⁹⁰ Sr	1	1	100	1	0,1
¹³⁴ Cs	1	0,1	1	0,1	0,1
¹³⁷ Cs	10	1	1	1	0,1
¹⁵² Eu	1	1	1	0,1	0,1
¹⁵⁴ Eu	1	1	1	0,1	0,1
α emitters (*)	0,1	0,1	0,1	0,1	0,01

(*) As U and/or Th

Table 1: Levels of unconditional removal

- The condition to be met in the case of multiple radionuclides is the following:

$$\sum_i \frac{C_i}{C_{li}} < 1$$

- In order to have conditions even more conservative was assumed the value 0.8, so the condition to be met will be the following:

$$\sum_i \frac{C_i}{C_{li}} < 0,8$$

- The verification of condition "Surface" recalled in Table 1 was carried out on 100% of the areas to be investigated.

- For the determination of the scaling factors between radionuclides easily detectable (Easy To Measure ETM) and hard to detect radionuclides (Hard To Measure HTM) the analyzed material has been considered, for quantity and radiological spectrum, as belonging to the facility section pertaining to “Liquids Waste Tanks” (LLW and HLW) or to “Process Cells Laboratories”.

$$\frac{{}^{235}\text{U}}{{}^{137}\text{Cs}} = 3.64 \times 10^{-6}$$

$$\frac{{}^{233}\text{U}}{{}^{137}\text{Cs}} = 1.28 \times 10^{-4}$$

$$\frac{{}^{238}\text{U}}{{}^{137}\text{Cs}} = 5.16 \times 10^{-8}$$

$$\frac{{}^{90}\text{Sr}}{{}^{137}\text{Cs}} = 1$$

$$\frac{{}^{232}\text{Th}}{{}^{137}\text{Cs}} = 6.18 \times 10^{-6}$$

$$\frac{{}^3\text{H}}{{}^{137}\text{Cs}} = 1.08 \times 10^{-3}$$

$$\frac{{}^{55}\text{Fe}}{{}^{60}\text{Co}} = 1.7 \times 10^{-3}$$

$$\frac{{}^{59}\text{Ni}}{{}^{60}\text{Co}} = 1.67 \times 10^{-1}$$

$$\frac{{}^{63}\text{Ni}}{{}^{60}\text{Co}} = 19$$

4. RESULTS AND CONCLUSIONS



- At the end of the decontamination and characterization process, has been verified that 90% of the processed material is releasable without radiological constraints.
- below is a sample of data analysis collection form for determination of surface contamination of alpha and beta - gamma emitters radionuclides

SCHEDA IDENTIFICATIVA TRATTO TUBAZIONE CONDOTTA A MARE (dopo pulizia interna)																					
TRATTO N° <u>4.02.A</u>																					
Spezzone n°	CSR (Bq/cm ²) (superficie Esterna parte a e b spezzone)								CSR (Bq/cm ²) (superficie Interna parte a e b spezzone)								CST (Bq/cm ²) Parte a		CST (Bq/cm ²) Parte b		NOTE
	1 a Est		2 a Est		1 b Est		2 b Est		1 a Int		2 a Int		1 b Int		2 b Int		β/y	α	β/y	α	
	β/y	α	β/y	α	β/y	α	β/y	α	β/y	α	β/y	α	β/y	α	β/y	α					
1	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
3	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
6	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
8	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
9	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	
10	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	NR (α) ≤ 3,42·10 ⁻⁴
11	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	NR (β/y) ≤ 2,48·10 ⁻³
12	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1,80E-01	-1,25E-02	-1,80E-01	-1,25E-02	

4. RESULTS AND CONCLUSIONS



- a copy of the final report on high-resolution gamma spectrometry in ISOCS configuration

Radionuclide (i)	C _i Massa (Bq/g)	C _{li} Massa (Bq/g)
³ H	1,21E-06	1
⁵⁵ Fe	1,09E-06	1
⁶⁰ Co	6,39E-04	1
⁵⁹ Ni	1,07E-04	1
⁶³ Ni	1,21E-02	1
⁹⁰ Sr	1,12E-03	1
¹³⁴ Cs	1,02E-03	0,1
¹³⁷ Cs	1,12E-03	1
¹⁵² Eu	3,12E-03	1
¹⁵⁴ Eu	2,01E-03	1
²³³ U	1,43E-07	0,1
²³⁵ U	4,08E-09	0,1
²³⁸ U	5,78E-11	0,1
²³² Th	6,92E-09	0,1
Σ(C_i/C_{li}) Massa = 3,05E-02		

4. RESULTS AND CONCLUSIONS



- At the end of the activities of radiological characterization, the releasable metal parts will be launched in fusion with the constraint on the mixing ratio of 1 to 10 with metallic material from different origin.
 - Activities , subject to the Control Authority, allow to remove unconditionally metallic materials originated from the removal of the sea discharge pipe of liquid effluents from nuclear fuel reprocessing plant ITREC managed by Sogin S.p.A. The methodology described provides a good example of management, treatment and decontamination of metallic materials for unconditional removal.
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- THANKS FOR YOUR ATTENTION
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