EU-NORM I INTERNATIONAL SYMPOSIUM ON NATURALLY OCCURRING RADIOACTIVE MATERIAL NORM VI

APPLICATION OF CLEARANCE LEVELS TO METALLIC SCRAPS CONTAMINATED WITH NORM

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INTRODUCTION

- ENRESA IS THE SPANISH NATIONAL COMPANY FOR RADIOACTIVE WASTE MANAGEMENT
- IN THE LAST 12 YEARS OF THE ORDER OF 2000 METALLIC SCRAPS PIECES CONTAMINATED WITH NATURAL RADIONUCLIDES HAS BEEN DETECTED IN SCRAP YARDS AND MELTING INSTALLATIONS (NEAR 60% OF THE TOTAL DETECTED PIECES)
- THIS SCRAPS ARE PRODUCED IN THE DECOMMISSIONING OF CONVENTIONAL INDUSTRIES
  - ORE PROCESSING INDUSTRIES (NOT URANIUM/THORIUM)
  - OIL AND GAS PRODUCTION FACILITIES
  - PHOSPHATE INDUSTRIES (FERTILISER PRODUCTION)
  - OTHER INDUSTRIES

•INTRODUCTION

SPANISH PROTOCOL FOR COLLABORATION ON RADIATION MONITORING OF METALLIC MATERIALS

- THE DETECTION OF THESE MATERIALS IS A PART OF A GLOBAL PROGRAMME CALLED “SPANISH PROTOCOL FOR COLLABORATION ON THE RADIATION MONITORING OF METALLIC MATERIALS”
- WIDELY IMPLEMENTED IN SPAIN AFTER THE ACCIDENTAL MELTING OF A Cs-137 SOURCE (1998)
- OBJECT
  - ESTABLISHMENT OF RADIOLOGICAL CONTROL OF METALLIC MATERIALS AND FINAL PRODUCTS TO DETECT THE EXISTENCE OF RADIOACTIVE MATERIALS IN SCRAP YARDS AND MELTING FACILITIES

INTRODUCTION

- THE PROTOCOL WAS SIGNED BY ALL THE PARTIES CONCERNED IN 1999
  - MINISTRY OF INDUSTRY AND ENERGY
  - MINISTRY FOR PUBLIC WORKS
  - THE NUCLEAR SAFETY COUNCIL (CSN)
  - THE SPANISH NATIONAL COMPANY FOR RADIOACTIVE WASTE MANAGEMENT (ENRESA)
  - THE COMPANIES THAT RECOVER, HANDLE AND STORE SCRAP FOR RECYCLING
  - THE METAL RECYCLING COMPANIES
  - THE TRADE UNIONS

INTRODUCTION

THE PROTOCOL IS COMPLEMENTED BY A TRANSFER AUTHORIZATION

- PUBLISHED BY THE MINISTRY OF INDUSTRY AND ENERGY (FEBRUARY 2000)
- IN THAT THE RADIOACTIVITY LEVELS PROPOSED BY THE NUCLEAR SAFETY COUNCIL TO CLASSIFIED THE DETECTED MATERIALS AS RADIOACTIVE WASTES ARE ESTABLISH
- THESE VALUES ARE BASED ON THE RECOMMENDATIONS OF THE EUROPEAN COMMISSION FOR RECYCLING OF METALS FROM THE DISMANTLING OF NUCLEAR INSTALLATIONS (RP-89)
- MATERIALS CLASSIFIED AS RADIOACTIVE WASTE ARE COLLECTED AND DISPOSED BY ENRESA IN SUITABLE INSTALLATIONS
- LOW LEVEL MATERIALS ARE PROCESSED AT THE INSTALLATIONS

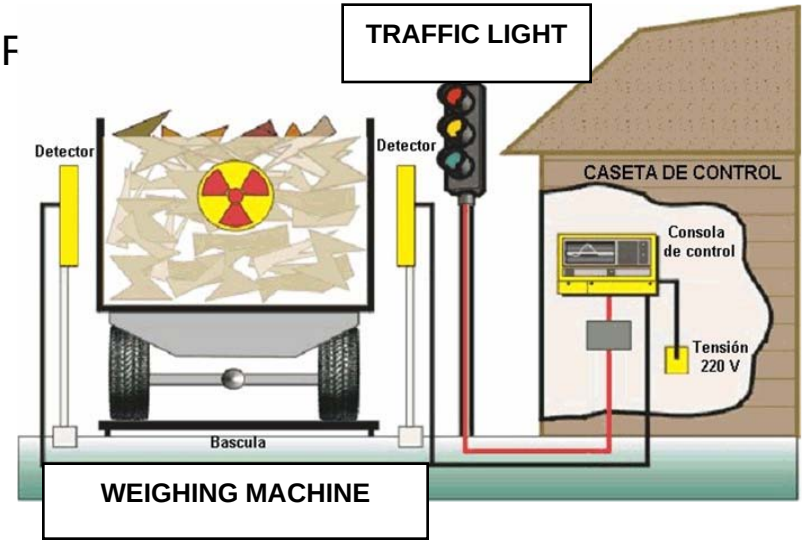
INTRODUCTION

DETECTION OF MATERIALS

- THE INSTALLATIONS HAVE A CONTROL SYSTEM
  - CAPABLE OF DETECTING THE PRESENCE OF RADIOACTIVITY
- MONITORING SYSTEM
  - PORTAL DETECTORS AT THE ENTRANCE OF THE FACILITY
  - PORTABLE EQUIPMENTS
  - AND EQUIPMENTS TO THE CONTROL OF MELTING PRODUCTS AND SLAG AND ON THE OFF-GAS DUST

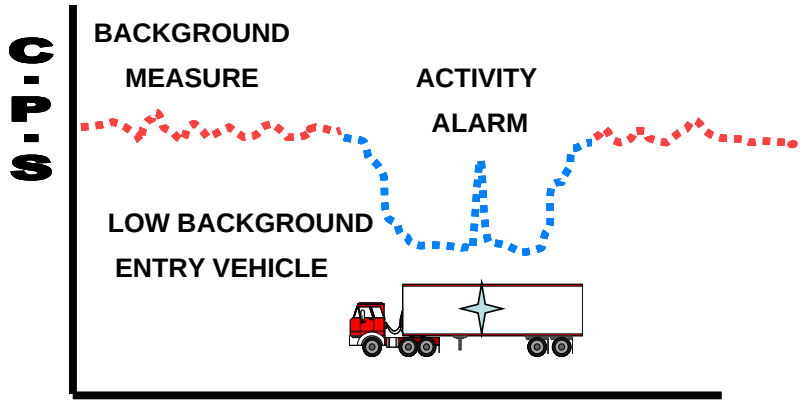
INTRODUCTION

- PORTAL DETECTORS AT THE ENTRANCE OF THE FACILITY INCLUDE
  - TWO DETECTION PANELS WITH ONE OF MORE DETECTORS
  - THE DETECTOR ARE LARGE VOLUME PLASTIC SCINTILLATION DETECTORS
  - THE ASSOCIATED ELECTRONICS
  - SENSORS TO CONTROLLING THE PASSAGE OF VEHICLE
  - SUPPORT AND PROTECTION SYSTEMS
  - EXTERNAL SHIELDING TO MINIMISE BACKGROUND
  - CONTROL AND REGISTRATION UNIT



INTRODUCTION

- MEASURING PROCESS IS THE FOLLOWING:
  - WITHOUT VEHICLE THE PORTAL MEASURES THE BACKGROUND
  - WHEN VEHICLE ENTER THE SENSOR CONTROL ACTIVATES THE MEASURE
  - THE EXIT SENSOR STOPS THE MEASURE
  - THERE IS A SPEED ALARM TO PERFORMANCE MEASURE
  - THE VEHICLE IN MEASUREMENT ZONE DECREASE BACKGROUND
  - THE EQUIPMENT CALCULATES AN ATTENUATED "BACKGROUND LEVEL"
  - ALARM IS SET AT A NUMBER OF STANDARD DEVIATION ABOVE BACKGROUND



INTRODUCTION

ENRESA ACTIVITIES

- KIND OF INTERVENTIONS
  - RADIOLOGICAL SURVEILLANCE REQUIRED BY CSN AFTER INCIDENTS IN MELTING FACILITIES
  - LOCALISATION, SEGREGATION AND COLLECTING OF RADIOACTIVE SOURCES ALSO REQUIRED BY CSN
  - CHARACTERISATION AND CONDITIONING OF RADIOACTIVE MATERIALS (SOURCES, CONSUMER GOODS, CONTAMINATED MATERIALS) BEFORE REMOVAL FOR DISPOSAL OR RETURNING TO SUPPLIERS
- THE ACTIVITIES REQUIRED BY THE CSN AND THE CHARACTERISATION AND CONDITIONING ARE CARRIED OUT BY THE ENRESA RADIATION PROTECTION UNIT (UTPR)

INTRODUCTION

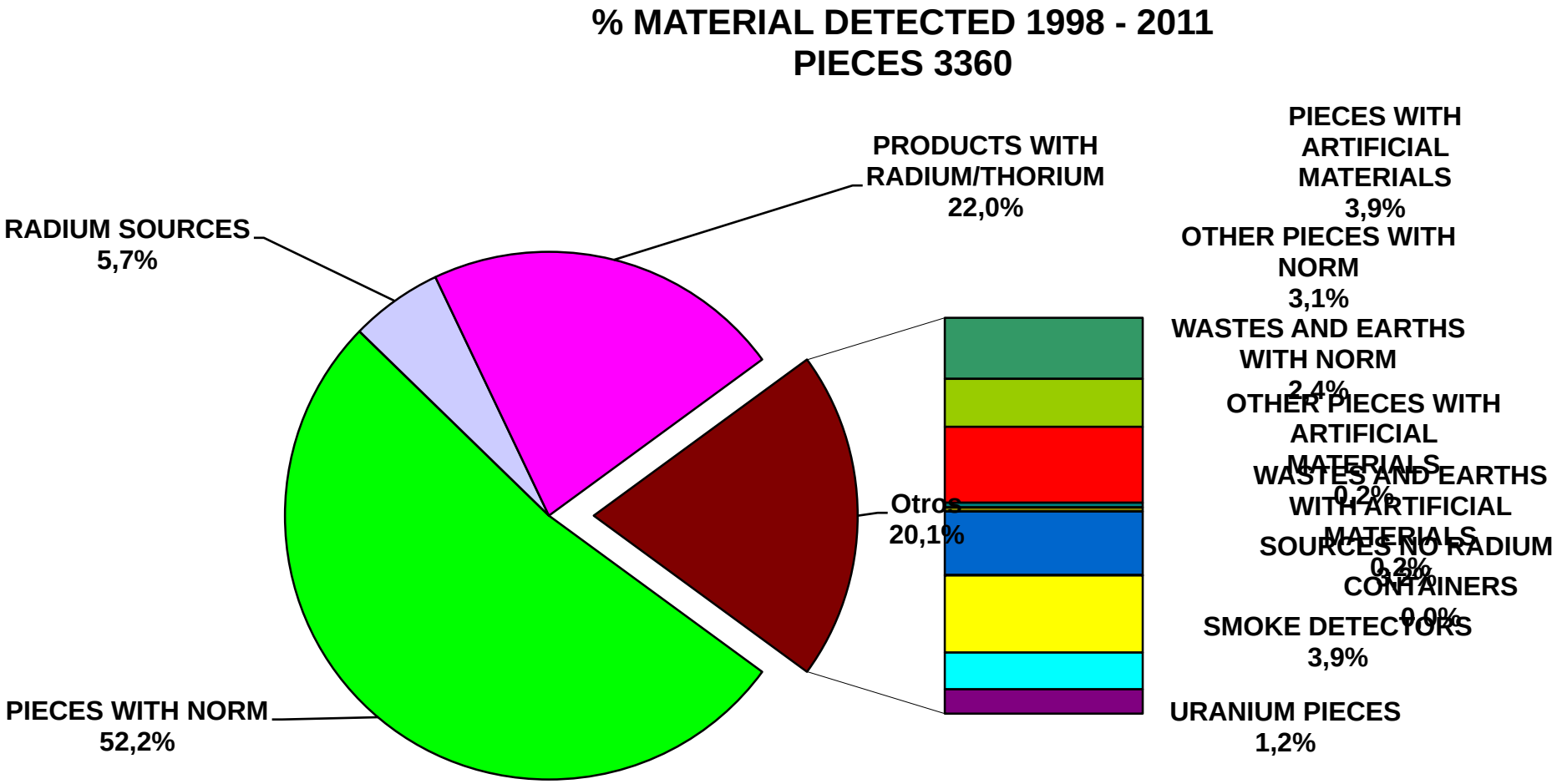
ENRESA ACTIVITIES

- NUMBER OF INTERVENTIONS (1998 – 2011)
  - INTERVENTIONS IN INCIDENTS 5
  - INTERVENTIONS FOR CHARACTERIZATION AND CONDITIONING 353
  - COLLECTING/TRANSPORT 247
- INSTALLATIONS
  - MELTING FACILITIES 24
  - SCRAP RECOVERING INSTALLATIONS 37

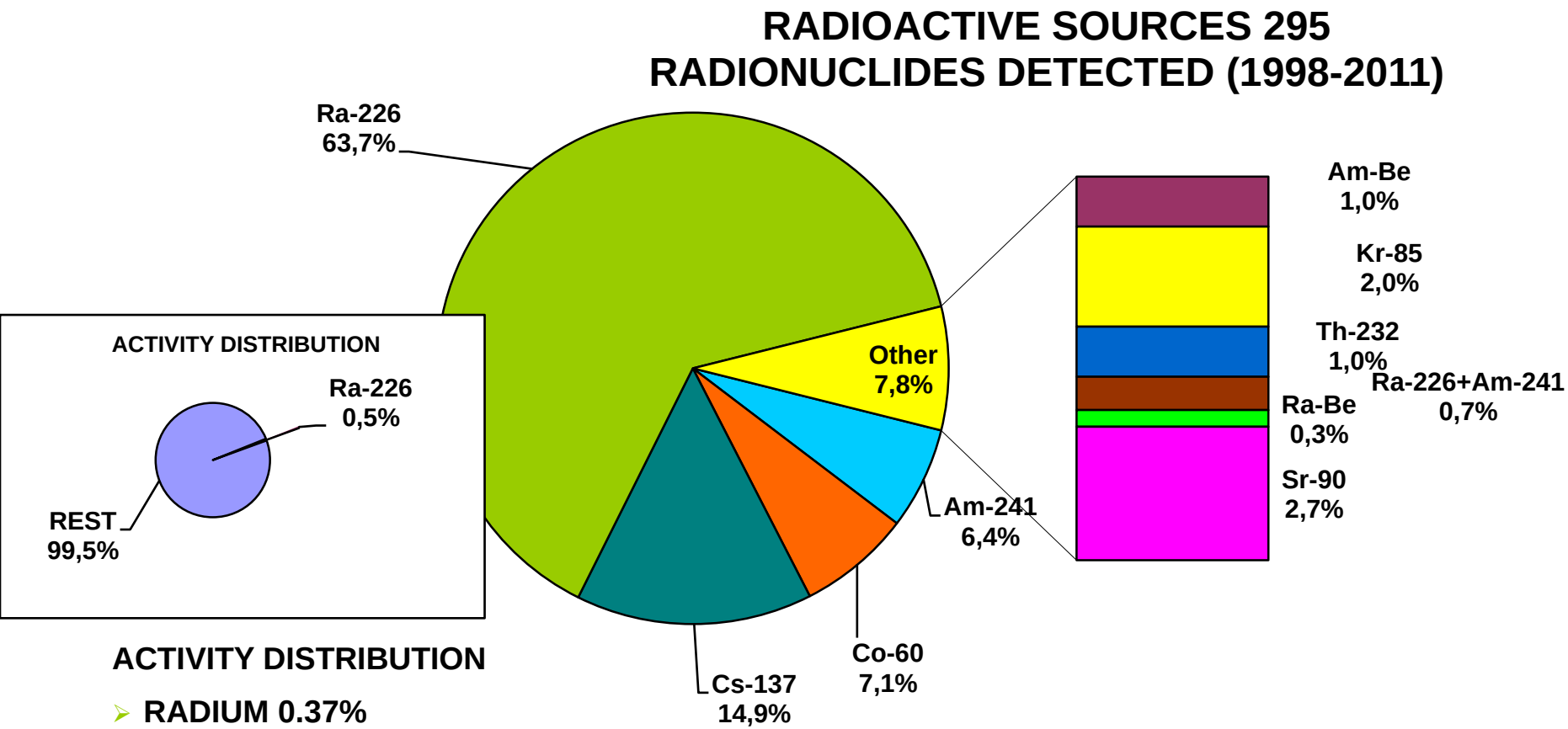
CHARACTERISTICS OF DETECTED MATERIALS

- MORE THAN 1000 DETECTIONS (1998- 2011)
  - IN MANY CASES MORE THAN ONE RADIOACTIVE MATERIAL IS DETECTED (TOTAL 3360)
  - DIFFERENT MATERIALS DETECTED
    - *RADIOACTIVE SOURCES WITH OR WITHOUT SHIELDING 9 %*
    - *CONSUMER PRODUCTS (SMOKE DETECTOR, LIGHTNING RODS, ALLOYS WITH THORIUM, ARTICLES WITH LUMINOUS PAINT WITH RADIUM) 28 %*
    - *METALLIC PIECES WITH NORM 57%*
    - *METALLIC PIECES WITH ARTIFICIAL RADIO NUCLIDES 4 %*
    - *PIECES OF DEPLETED URANIUM 1 %*
    - *WITHOUT RADIOACTIVE MATERIAL 1 %*

CHARACTERISTICS OF DETECTED MATERIALS



CHARACTERISTICS OF DETECTED MATERIALS



ACTIVITY DISTRIBUTION

- **RADIUM 0.37%**
- **OTHER 99.63%**

EXAMPLES OF DETECTED MATERIALS

LUMINOUS PAINT

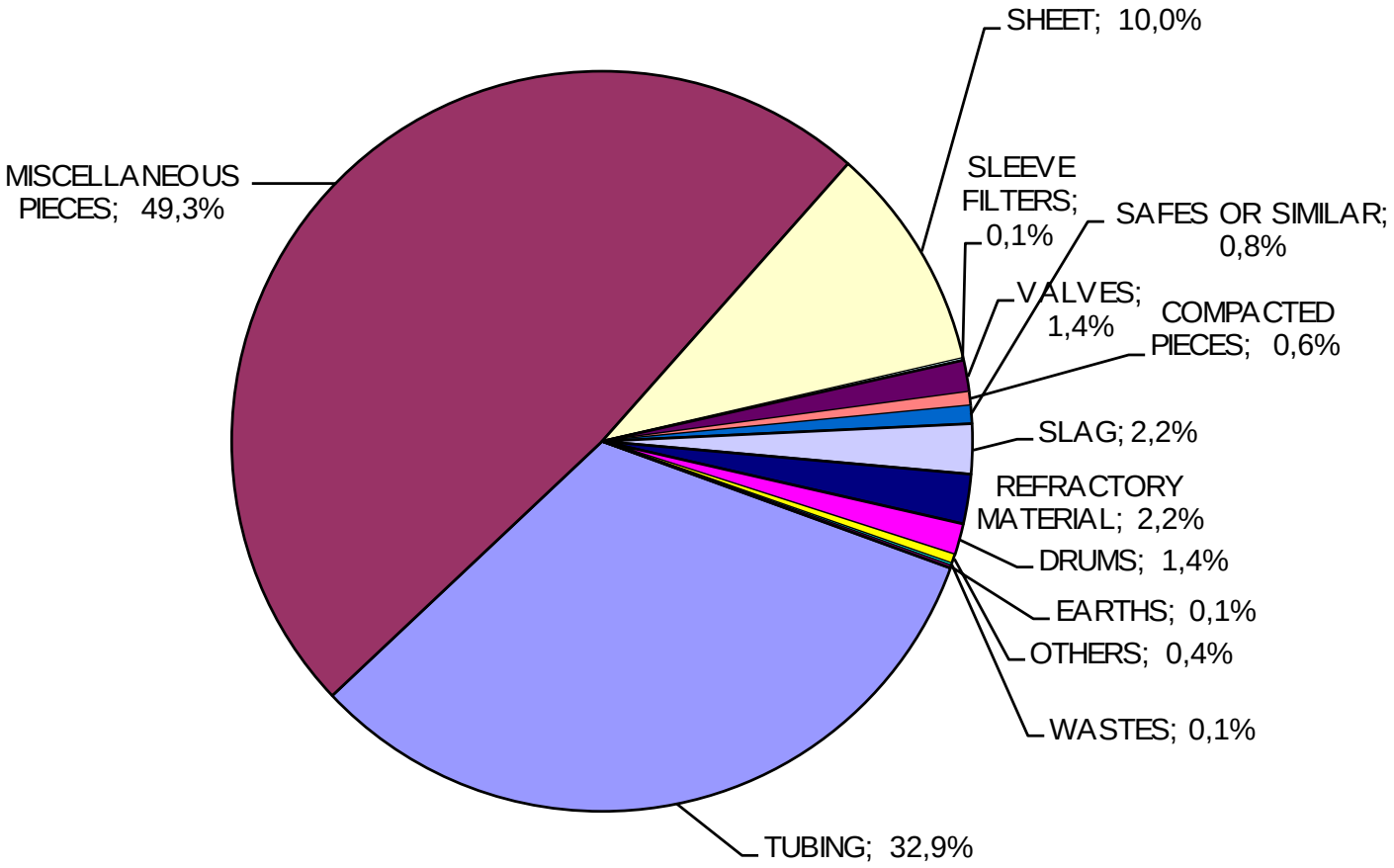
LIGHTNING ROD

PIECE WITH ARTIFICIAL RADIOACTIVITY

RADIOACTIVE SOURCES

CHARACTERISTICS OF DETECTED MATERIALS

TYPE OF PIECES WITH NORM



CHARACTERISTICS OF DETECTED MATERIALS

BIG PIECES WITH NORM

TUBING WITH NORM

EARTHS WITH NORM

PLATING WITH NORM

VALVE WITH NORM

SAFE BOX WITH CONCRETE

CHARACTERISTICS OF DETECTED MATERIALS

SEVERAL PIECES WITH NORM

TUBING WITH NORM

PIECES WITH REFRACTORY MATERIAL

CHARACTERISTICS OF DETECTED MATERIALS

- DIMENSIONS
  - TUBING:
    - *LENGTH FEW CENTIMETRES – 1 OR 2 METERS*
    - *THICKNESS: 0.2 – 0.5 CENTIMETRES*
    - *DIAMETER: 5 – 30 CENTIMETRES*
    - *WEIGHT: TENS OF KILOGRAMS*
  - SHEET
    - *LENGTH: 10 – 30 CENTIMETRES*
    - *WIDTH: 10 – 50 CENTIMETRES*
    - *WEIGHT: TENS OF KILOGRAMS*

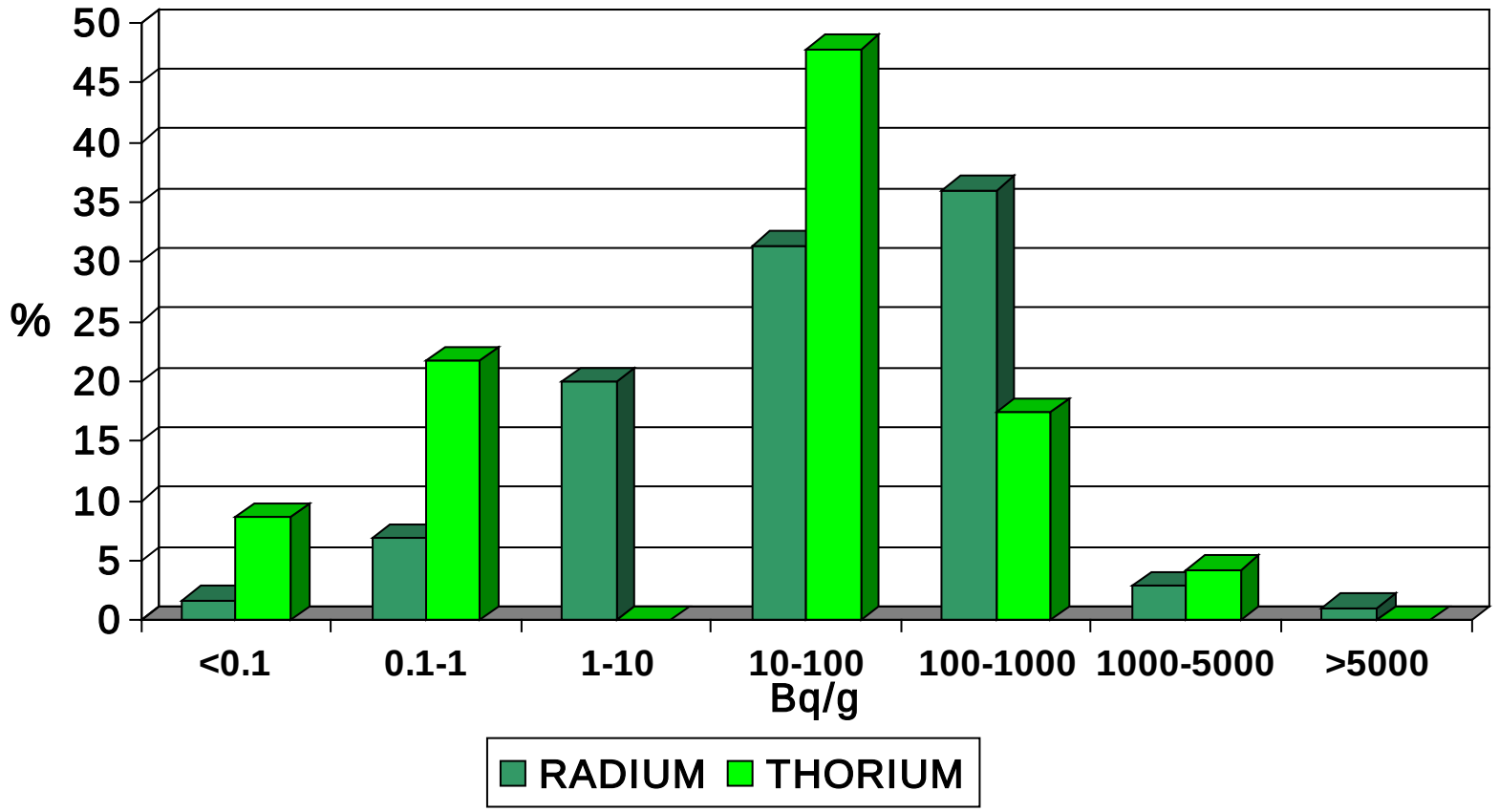
BIGGER PIECES WITH MORE THAN 100 KILOGRAMS HAS ALSO BEEN DETECTED

CHARACTERISTICS OF DETECTED MATERIALS

- RADIOLOGICAL DATA
  - DOSE RATE:
    - *PIECES:*
      - MEDIUM: 0.3 – 1 OR 2 microSv/h
      - MAXIMUM: 20 – 30 microSv/h
    - *EARTHS: 8 – 30 microSv/h*
  - ACTIVITY CONCENTRATION IN PIECES
    - *RADIONUCLIDES: RADIUM SOME TIMES THORIUM*
    - *DETERMINATION THROUGH GAMMA SPECTROMETRY*
      - RADIUM: Ra-226, Pb-214, Bi-214
      - THORIUM: Ac-228, Pb-212, Tl-208
    - *USUALLY IN EQUILIBRIUM WITH DAUGHTERS*
    - *USUALLY BELOW REFERENCE LEVEL (1 Bq/g)*
  - ACTIVITY CONCENTRATION IN EARTHS
    - *USUALLY ABOVE 10 Bq/g*

CHARACTERISTICS OF DETECTED MATERIALS

ACTIVITY CONCENTRATION IN SAMPLES



CHARACTERISTICS OF DETECTED MATERIALS

- PIECES WITH CONCENTRATION ABOVE REFERENCE LEVELS ARE MANAGED AS RADIOACTIVE WASTES
- WHEN IS POSSIBLE THE RADIOACTIVE MATERIAL ADHERED TO THE METAL PART IS REMOVED
- THE METAL PART CAN BE INCORPORATED INTO THE PROCESS

EXAMPLE OF CONDITIONING

- **PIECE WITH MATERIAL INSIDE**
- **CUTTING PIECE**
- **REMOVAL EARTH**
- **METALLIC PIECE TO BE MELTED**
- **RADIUM ACTIVITY: 1,97E-1 MBq – 51.8 Bq/g**

EXAMPLE OF CONDITIONING

- **DOSE RATE: 2 - 7 microSv/h**
- **CUTTING PIECE IN 4 PARTS**
- **NOT POSSIBLE TO REMOVE THE MATERIAL**
- **TOTAL RADIUM ACTIVITY: 1.22 MBq**
- **RADIUM CONCENTRATION:**
  - **MATERIAL: 45 Bq/g**
  - **PIECE: 32.27 Bq/g**

REFERENCE LEVELS

- IAEA SAFETY GUIDE RS-G-1.7
  - CLARIFY APPLICATION OF THE CONCEPTS OF EXCLUSION, EXEMPTION AND CLEARANCE
  - EXCLUSION APPLIES TO ANY EXPOSURE TO NATURAL RADIATION FROM UNMODIFIED CONCENTRATIONS BUT PRODUCTS AND WASTES CAN HAVE HIGHER CONCENTRATIONS AND CAN NOT BE EXCLUDED FROM REGULATORY CONTROL.
  - THE VALUES ESTABLISHED IS FOR BULK QUANTITIES HIGHER THAN QUANTITIES GENERATED AS METALLIC SCRAPS
  - THE VALUES ARE BASED ON THE UPPER END OF WORLDWIDE ACTIVITY CONCENTRATIONS IN SOILS VERY BELOW THE VALUES IN METALLIC SCRAPS

Radionuclide	**Bq/g**
K-40	10
All other radionuclides	1

REFERENCE LEVELS

- IAEA SAFETY SERIES 111-P-1.1
  - APPLICATION TO THE EXEMPTION TO RECYCLING AND REUSE OF MATERIALS FROM DECOMMISSIONING OF NUCLEAR POWER PLANTS.
  - ANALYSES THE RECYCLING OF METALLIC MATERIALS.
  - THE VALUES ESTABLISHED ARE BASED ON A DOSE CRITERION OF 10 microSv/year AND 100 TONS OF CONTAMINATED STEEL PROCESSED
  - THE CALCULATION METHODOLOGY IS SUITABLE FOR THE RECYCLING OF METALLIC SCRAPS CONTAMINATED WITH NORM BUT THE DOCUMENT ONLY INCLUDED THE ARTIFICIAL RADIONUCLIDES GENERATED AT NUCLEAR POWER PLANTS
  - A REFERENCE VALUE CAN BE 1 Bq/g FOR U-238.

REFERENCE LEVELS

- EU RADIATION PROTECTION 89
  - APPLICATION TO THE EXEMPTION TO RECYCLING OF METALLIC MATERIALS FROM DECOMMISSIONING OF NUCLEAR POWER PLANTS.
  - THE VALUES ESTABLISHED ARE BASED ON A DOSE CRITERION OF 10 microSv/year AND 4000 TONS OR 2000 TONS OF CONTAMINATED MATERIAL DEPENDING OF THE FURNACE TYPE (ARC OR INDUCTION)
  - THE SPECIFIC SCENARIOS ARE DEVELOPED IN ANOTHER DOCUMENT (RP-117) AND ARE THE FOLLOWING:
    - TRANSPORTATION FROM THE NUCLEAR PLANT TO THE FOUNDRY
    - EXPOSURE OF FOUNDRY WORKERS AND MEMBERS OF THE PUBLIC IN THE VICINITY
    - EXPOSURE OF WORKERS IN THE PRODUCTION OF RESULTING PRODUCTS
    - EXPOSURE OF USERS OF THE PRODUCTS MANUFACTURED.
    - FINAL DISPOSAL OF THE MANUFACTURED PRODUCTS.

REFERENCE LEVELS

- EU RADIATION PROTECTION 89
  - ALTHOUGH THIS DOCUMENT IS NOT SPECIFIC FOR NORM THESE RADIONUCLIDES ARE INCLUDED WITH THESE VALUES

Radionuclide	Bq/g
Ra-226	1
Th-232	1

  - THE REFERENCE LEVELS ESTABLISHED IN SPAIN ARE BASED IN THESE VALUES
  - THESE VALUES COULD BE DIFFERENT FOR NORM BECAUSE:
    - THE DOSE CRITERION FOR NORM IS 300 microSv/year NOT 10 microSv/yea
    - THE QUANTITIES PROCESSED IN THE FOUNDRY ARE GREATER THAN THOSE DETECTED IN SPAIN

REFERENCE LEVELS

- EU RADIATION PROTECTION 122 PART II
  - APPLIED TO THE PRACTICAL APPLICATIONS OF EXEMPTION AND CLEARANCE TO NATURAL RADIOACTIVE SOURCES (NORM)
  - SET DIFFERENT SCENARIOS TO OBTAIN VALUES APPLICABLE TO NATURAL MATERIALS USE IN CONVENTIONAL INDUSTRIES FOR BULK QUANTITIES
  - ONLY SCENARIOS RELATED TO THE HANDLING, PROCESSING, USE AND DISPOSAL OF **WASTE** GENERATED AT THESE INSTALLATIONS ARE ANALYSED
  - THE MATERIAL TYPES CONSIDERED ARE: WASTE ROCK, ASH, SAND, SLAG, AND SLUDGE FROM THE OIL/GAS INDUSTRY (NOT SCRAPS)
  - THE VALUES ESTABLISHED ARE BASED ON A DOSE CRITERION OF 300 microSv/year

REFERENCE LEVELS

- EU RADIATION PROTECTION 122 PART II
  - THE SCENARIOS ANALYZED ARE THE FOLLOWING;:
    - TRANSPORT OF MATERIAL: WORKERS;
    - STORAGE OF MATERIAL: WORKERS;
    - DISPOSAL IN A LANDFILL OR ON A HEAP: LANDFILL OPERATORS AND PEOPLE DWELLING NEAR THE LANDFILL OR HEAP;
    - RECYCLING AS ADDITIVE IN BUILDING MATERIAL: WORKERS AND MEMBERS OF THE GENERAL PUBLIC LIVING IN THE HOUSE;
    - RECYCLING AS FILLING MATERIAL IN ROAD CONSTRUCTION: WORKERS AND MEMBERS OF THE GENERAL PUBLIC STAYING ON PUBLIC PLACES.

REFERENCE LEVELS

- EU RADIATION PROTECTION 122 PART II

Radiouclides	All materials	Wet sludges from oil and gas industry
U 238sec incl. U 235 sec	0.5	5
U nat	5	100
Th 230	10	100
Ra 226+	0.5	5
Pb 210+	5	100
Po 210	5	100
U 235sec	1	10
U 235+	5	50
Pa 231	5	50
Ac 227+	1	10
Th 232sec	5	100
Ra 228+	1	10
Th 228+	0.5	5
K –40	5	100

REFERENCE LEVELS

- SUMMARY OF THE REFERENCE LEVELS

ACTIVITY CONCENTRATION (Bq/g)			
	Ra-226	**Th-232**	**Comments**
IAEA RS-G-1.7	1	1	✓ Bulk quantities ✓ Based upper end of worldwide activity concentrations in soils ✓ No dose criterion
IAEA SS 111-P-1.1	-	-	✓ Apply to metallic scarps ✓ Only artificial radionuclides
EU RP-89	1	1	✓ Bigger quantities 4000 t/year ✓ Induction furnace more restrictive ✓ Different dose criterion (10 uSv/year)
EU RP-122 II	0.5 - 5	0.5 - 5	✓ Scrap not included ✓ Direct handling of materials ✓ ***"Norm"*** built buildings ✓ Storage of moderate quantities of slags
IAEA Transport regulations	10 - 100	1 - 10	✓ Equal UE directive ✓ Higher levels for NORM

ENRESA STUDY

- ENRESA HAS CARRIED OUT A STUDY OF THE RADIOLOGICAL CONSEQUENCES OF MELTING SCRAPS CONTAMINATED WITH NORM
- CONTAMINATED MATERIALS WITH "NORM" UPPER THE REFERENCE VALUES COULD BE MELTED WHEN THE QUANTITY OF MATERIAL IS LOW, ALWAYS IF THE REGULATORY BODY ACCEPTED
- THE GENERAL DATA OF THIS STUDY ARE:
  - NATURAL RADIONUCLIDES: Ra-226 AND Th-232
  - RADIOACTIVE MATERIAL DEPOSITED INSIDE PIPES AND ANOTHER PIECES (PUMPS, VALVES, SHEETS)
  - SPECIFIC PARAMETERS OF SPANISH MELTING FACILITIES

CHARACTERISTICS OF INSTALLATIONS

STEEL PLANT	200000-600000 t/year
SCRAP YARD	20000-100000 t/year
SCRAP TRANSPORT	18 t/truck
DUST DISPOSAL PLANT	50000 t/year
SLAG DISPOSAL PLANT	150000 t/year

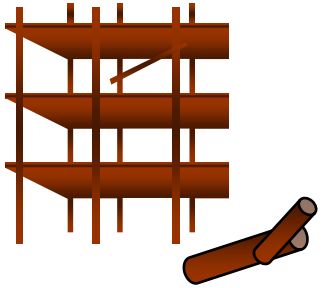
CHARACTERISTICS OF MELTING PROCESS

PROCESSED SCRAP QUANTITY	1-3-100 t
TYPE OF FURNACE	ARC
DUST PRODUCTION RATE	15 kg/t
DUST FACTOR	67
SLAG PRODUCTION RATE	150 kg/t
SLAG FACTOR	6.7

SCENARIOS AND FORMULAE USED

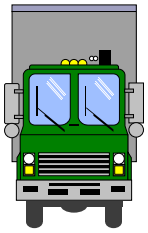
- SCENARIOS OF RADIATION PROTECTION 117 (EUROPEAN COMMISSION)
- SPECIFIC PARAMETERS OF SPANISH INSTALLATIONS
- FORMULAE FROM RP 117 FOR RA-226 AND TH-232 WITH PROGENY IN SECULAR EQUILIBRIUM
- QUANTITIES BASED ON DETECTED MATERIALS

ENRESA STUDY



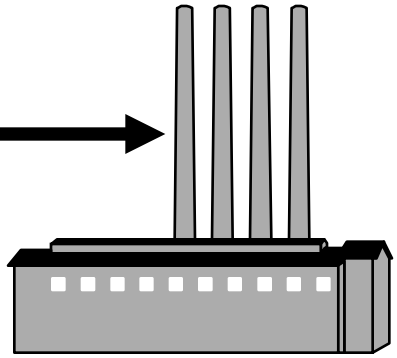
PRODUCTION

- RECOVERING FACILITY
- SCRAP YARD

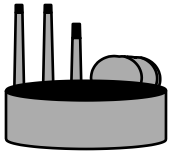


TRANSPORT

PROCES IN THE MELTING FACILITY



- MELTING
- REFINING PROCESS
- CASTING IN INGOTS OR OTHER ELEMENTS



- MANUFACTURE OF
- CONSUMER PRODUCTS

- USE OF CONSUMER PRODUCTS
- KITCHEN
- EQUIPMENTS
- VESSEL
- SHIP

- DISPOSAL OF BY-PRODUCTS
- SLAG
- DUST

ENRESA STUDY

SCENARIOS

- SCRAP PROCESSING (SCRAP YARD)
  - SCRAP HANDLING (IRRADIATION)
  - SCRAP SEGMENTATION (INHALATION AND INGESTION)
  - TRANSPORTATION (IRRADIATION)
  - STORAGE (IRRADIATION)
- STEEL FOUNDRY
  - SCRAP HANDLING AND STORAGE (IRRADIATION, INHALATION AND INGESTION)
  - DISCHARGE TO ENVIRONMENT (IRRELEVANT RP-117)
  - PRODUCT MANUFACTURING (IRRADIATION AND INHALATION)

ENRESA STUDY

SCENARIOS

- USE OF CONSUMER GOODS
  - WORKERS: KITCHEN, SHIP, VESSEL, LARGE MACHINE (IRRADIATION)
  - PUBLIC: REINFORCEMENT BARS, RADIATORS (IRRADIATION)
- USE OR DISPOSAL OF BY-PRODUCTS
  - WORKERS: (IRRADIATION, INHALATION AND INGESTION)
  - PUBLIC: (IRRADIATION, INHALATION AND INGESTION)

ENRESA STUDY

RESULTS uSv/year per Bq/g

SCENARIO AND CRITICAL PATHWAY	Ra-226 sec	Th-230 sec
SCRAP YARD (IRRADIATION FROM SCRAPS HEAPS)	0.3	0.42
TRANSPORT FROM SCRAP YARD	3.1	4.3
FOUNDRY (INGESTION)	0.8	0.1
MANUFACTURE OF PRODUCTS (IRRADIATION)	0.001	0.007
USE OF PRODUCTS (IRRADIATION IN SHIP)	2.4	3.2
DISPOSAL OF BY-PRODUCTS (IRRADIATION)	0.5	0.7

THESE VALUES ARE FAR BELOW THE DOSE CRITERIA OF 300 microSv/year

SO VALUES HIGHER THAN 1 Bq/g COULD BE PROCESSED

CONCLUSIONS

- MOST OF THE METALLIC PIECES DETECTED AT THE ENTRY OF THE RECYCLING METAL INDUSTRY FACILITIES CONTAIN NATURAL RADIOACTIVE MATERIALS (NORM)
- MANY OF THESE PIECES HAVE A VERY LOW VALUE OF CONCENTRATION ACTIVITY AND MAY BE INCORPORATED INTO THE SMELTING PROCESS FOLLOWING A RIGOROUS PROCEDURE TO SUPPORT THE DECISIONS
- FOR THIS KIND OF MATERIALS CAN BE APPLIED THE VALUES ESTABLISHED FOR METALLIC SCARP, BUT THEY ARE NOT CALCULATED FOR THIS MATERIALS
- THE EXCEPTION/CLEARANCE LEVELS ESTABLISHED FOR NORM MATERIALS ARE NOT APPLICABLE SPECIFICALLY TO METALLIC SCRAPS CONTAMINATED WITH NORM
- IT IS POSSIBLE ESTABLISH SPECIFIC VALUES FOR SCRAPS CONTAMINATED WITH NORM.