

**6th INTERNATIONAL SYMPOSIUM ON
NATURALLY OCCURRING RADIOACTIVE MATERIAL
NORM VI**

**MANAGEMENT OF METALLIC SCRAP CONTAMINATED
WITH NATURAL RADIONUCLIDES**

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MANAGEMENT (ENRESA)**

MARRAKECH, March 22-26 2010

INTRODUCTION

- METALLIC SCRAPS CONTAMINATED WITH NATURAL RADIONUCLIDES DETECTED IN SCRAP YARDS AND MELTING INSTALLATIONS (LAST 10 YEARS)
- SCRAPS FROM DECOMMISSIONING OF CONVENTIONAL INDUSTRIES
 - ORE PROCESSING INDUSTRIES (NOT URANIUM/THORIUM)
 - OIL AND GAS PRODUCTION FACILITIES
 - PHOSPHATE INDUSTRIES (FERTILISER PRODUCTION)
 - OTHER INDUSTRIES



- 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
 - ESTABLISHING RADIOLOGICAL CONTROL OF METALLIC MATERIALS AND FINAL PRODUCTS TO DETECT THE EXISTENCE OF RADIOACTIVE MATERIALS

- SIGNED BY ALL THE PARTIES CONCERNED
 - 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

TRANSFER TO ENRESA

- PUBLISHED BY THE MINISTRY OF INDUSTRY AND ENERGY (FEBRUARY 2000)
- RADIOACTIVITY LEVELS TO DEFINE WHAT MATERIALS ARE RADIOACTIVE WASTES WERE PROPOSED BY THE NUCLEAR SAFETY COUNCIL
- 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
- MATERIALS WITH LOW LEVEL ACTIVITY ARE PROCESSED AT THE INSTALLATIONS

ENRESA ACTIVITIES

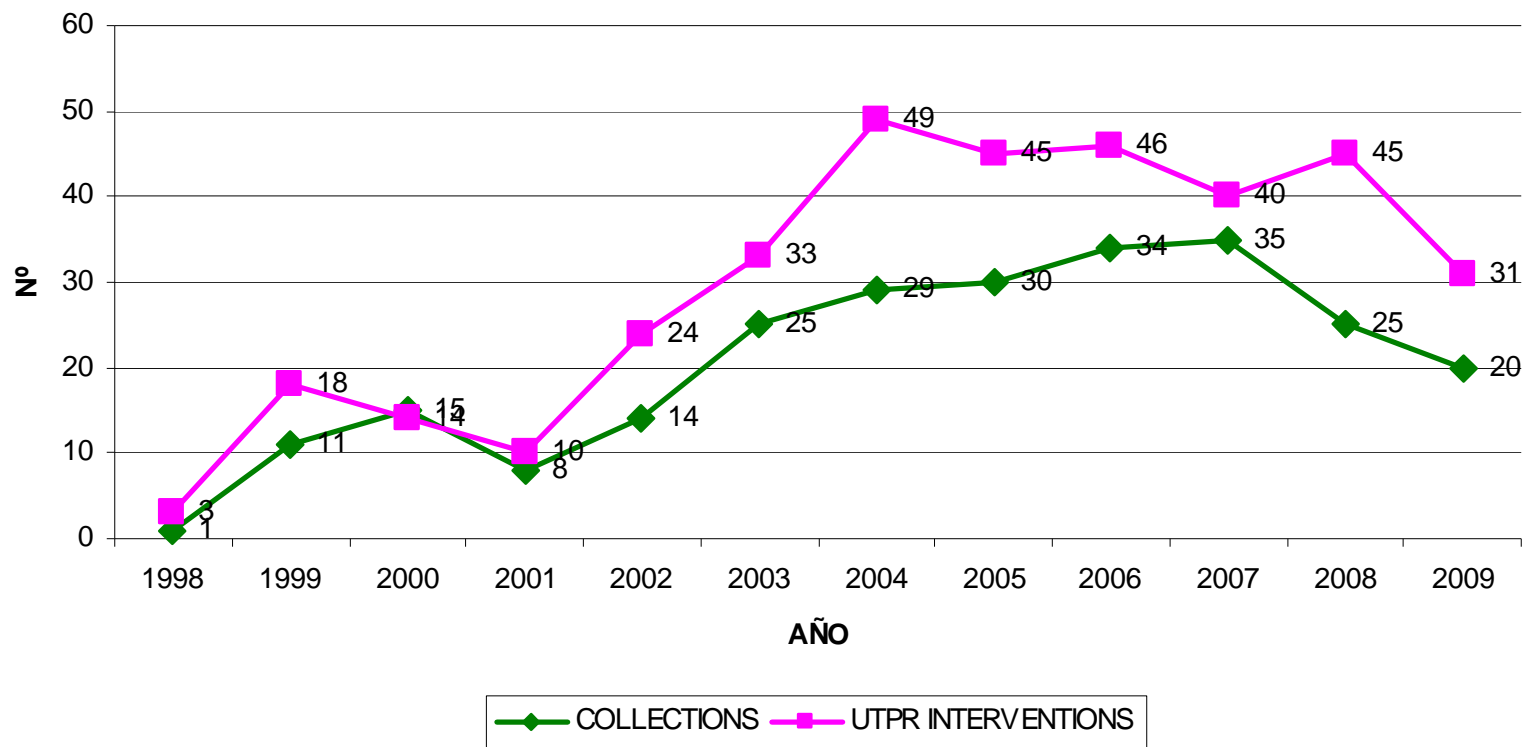
- KIND OF INTERVENTIONS
 - RADIOLOGICAL SURVEILLANCE REQUIRED BY CSN AFTER INCIDENTS IN MELTING FACILITIES AND SCRAP YARD
 - LOCALISATION, SEGREGATION AND COLLECTING OF RADIOACTIVE SOURCES ALSO REQUIRED BY CSN
 - CHARACTERISATION AND CONDITIONING OF RADIOACTIVE MATERIALS (SOURCES, CONSUMER GOODS, CONTAMINATED MATERIALS) BEFORE THEIR REMOVAL AS RADIOACTIVE WASTES
- THE ACTIVITIES REQUIRED BY THE CSN AND THE CHARACTERISATION AND CONDITIONING ARE CARRIED OUT BY THE ENRESA RADIATION PROTECTION UNIT (UTPR)

ENRESA ACTIVITIES

- ♦ NUMBER OF INTERVENTIONS (1998 – 2009)
 - ♦ INTERVENTIONS IN INCIDENTS 5
 - ♦ UTPR INTERVENTIONS 353
 - ♦ COLLECTING/TRANSPORT 247
- ♦ INSTALLATIONS
 - ♦ MELTING FACILITIES 24
 - ♦ SCRAP RECOVERING INSTALLATIONS 37

ENRESA ACTIVITIES

ENRESA INTERVENTIONS 258
1998-2009



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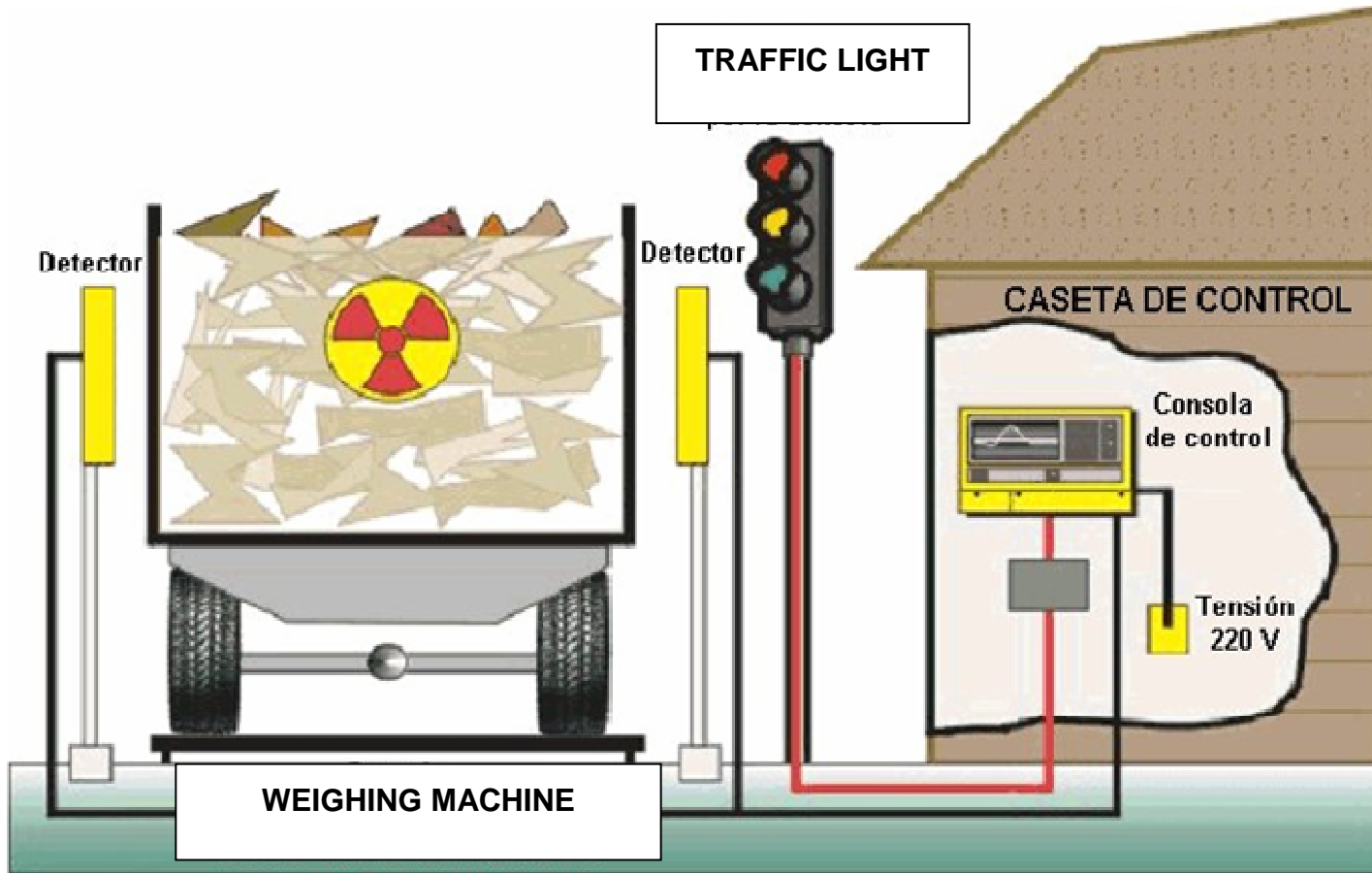
DETECTION OF MATERIALS

- CONTROL SYSTEM
 - CAPABLE OF DETECTING THE PRESENCE OF RADIOACTIVITY
- MONITORING SYSTEM
 - PORTAL DETECTORS AT THE ENTRANCE OF THE FACILITY
 - PORTABLE EQUIPMENTS TO LOCATE RADIOACTIVE MATERIALS
 - CONTROL OF MELTING PRODUCTS, SLAG AND OFF-GAS DUST

DETECTION OF MATERIALS

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

DETECTION OF MATERIALS



DETECTION OF MATERIALS

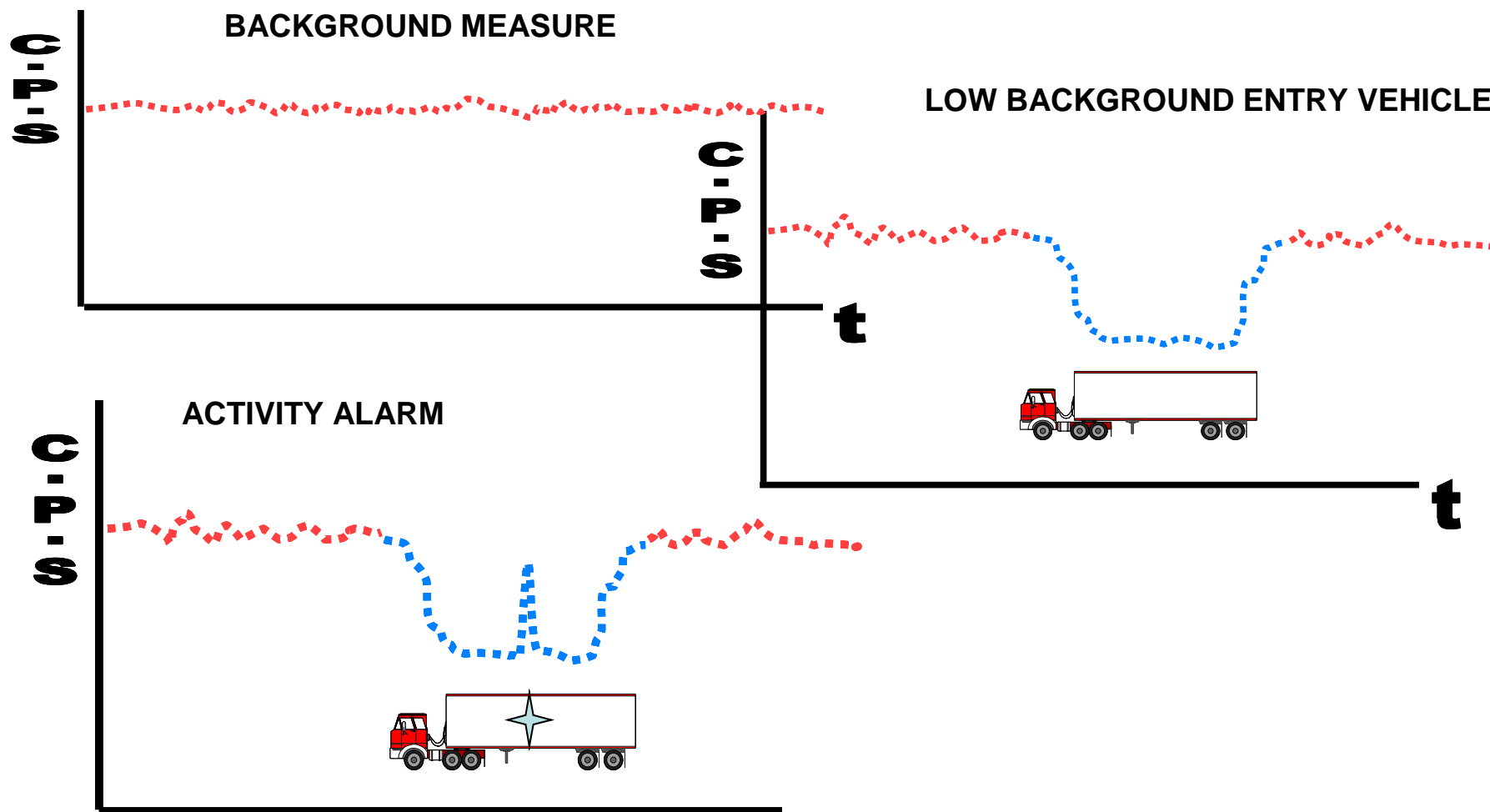


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DETECTION OF MATERIALS

- MEASURING PROCESS
 - WITHOUT VEHICLE BACKGROUND IS MEASURED
 - VEHICLE ENTERING SENSOR CONTROL ACTIVATES MEASURE
 - EXIT SENSOR STOP MEASURE
 - SPEED ALARM TO ASSURE THE QUALITY OF MEASURE
 - VEHICLE IN MEASUREMENT ZONE DECREASE BACKGROUND
 - EQUIPMENT CALCULATES ATTENUATED “BACKGROUND LEVEL”
 - ALARM SET AT NUMBER OF STANDARD DEVIATION ABOVE BACKGROUND

DETECTION OF MATERIALS



DETECTION OF MATERIALS

- ALARM
 - VEHICLE PASS AT LEAST TWICE MORE
- ALARM CONFIRMED
 - VEHICLE ISOLATED
 - MEASURE OF DOSE RATE, IF ACCEPTABLE
 - *UNLOADED VEHICLE*
 - *MEASURES WITH PORTABLE EQUIPMENTS*
 - *RADIOACTIVE MATERIAL IS LOCATED OR NOT*



DETECTION OF MATERIALS

- ALARM NOT CONFIRMED
 - LARGE HOLLOW PIECES OR DIFFERENT DENSITY
 - DRIVER SUBMITTED TO MEDICAL PROBES WITH RADIONUCLIDES
- ALWAYS CONFIRM ALARM
 - ALTHOUGH THE LEVEL IS LOW
 - A LOW LEVEL CAN BE DUE TO
 - *NATURAL MATERIAL, VERY LOW RISK*
 - *A SHIELDED HIGH ACTIVITY SOURCE, HIGH RISK*

CHARACTERISTICS OF DETECTED MATERIALS

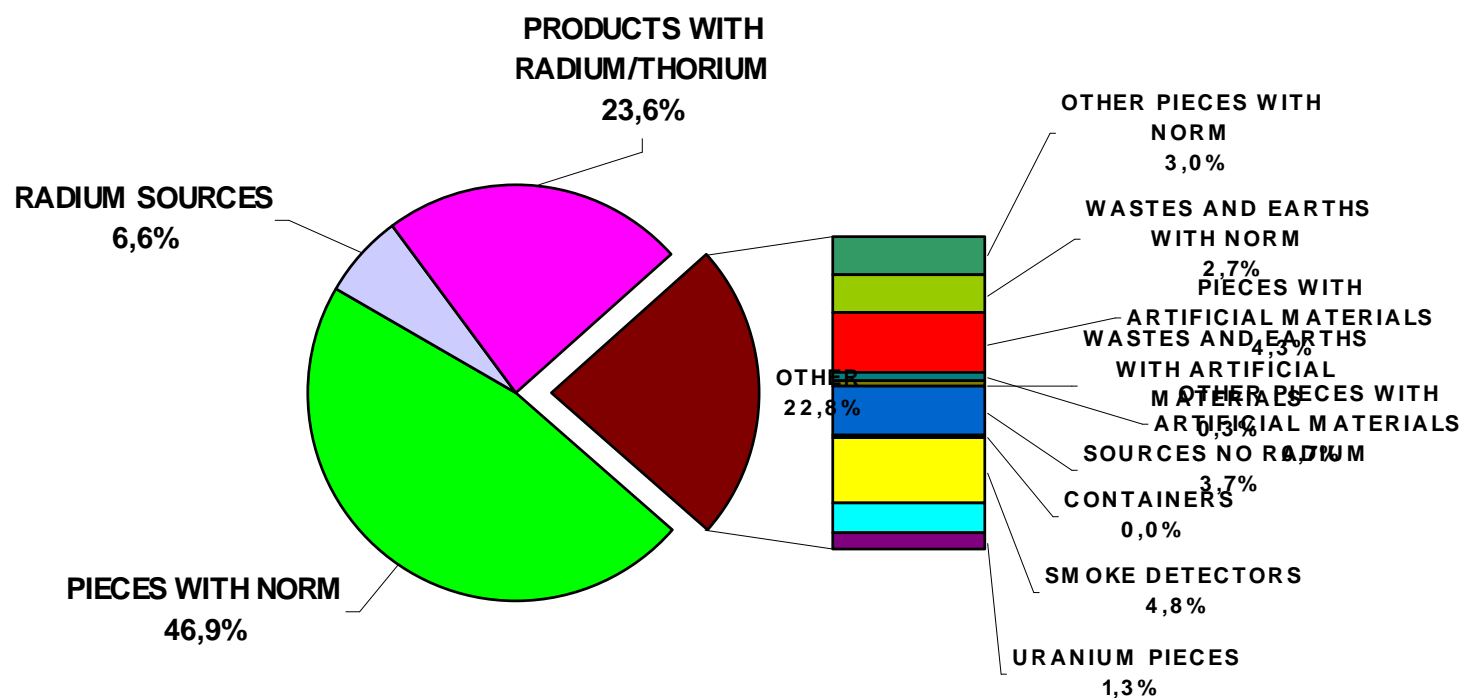
- MORE THAN 1000 DETECTIONS (1998- 2009)
 - IN MANY CASES MORE THAN ONE RADIOACTIVE MATERIAL DETECTED
 - DIFFERENT MATERIALS DETECTED
 - *RADIOACTIVE SOURCES WITH OR WITHOUT SHIELDING 18.7%*
 - *CONSUMER PRODUCTS (SMOKE DETECTOR, LIGHTNING RODS, ALLOYS WITH THORIUM, ARTICLES WITH LUMINOUS PAINT WITH RADIUM) 28.5%*
 - *METALLIC PIECES WITH NORM 41.0%*
 - *METALLIC PIECES WITH ARTIFICIAL RADIONUCLIDES 7.7%*
 - *PIECES OF DEPLETED URANIUM 2.6%*
 - *WITHOUT RADIOACTIVE MATERIAL 1.5%*

CHARACTERISTICS OF DETECTED MATERIALS

- DETECTED 2648 PIECES (1998- 2009)
 - RADIOACTIVE SOURCES 275
 - *RADIUM SOURCES 64%*
 - NO RADIOACTIVE SOURCES 2373
 - *PIECES WITH NATURAL RADIOACTIVE MATERIAL 59%*

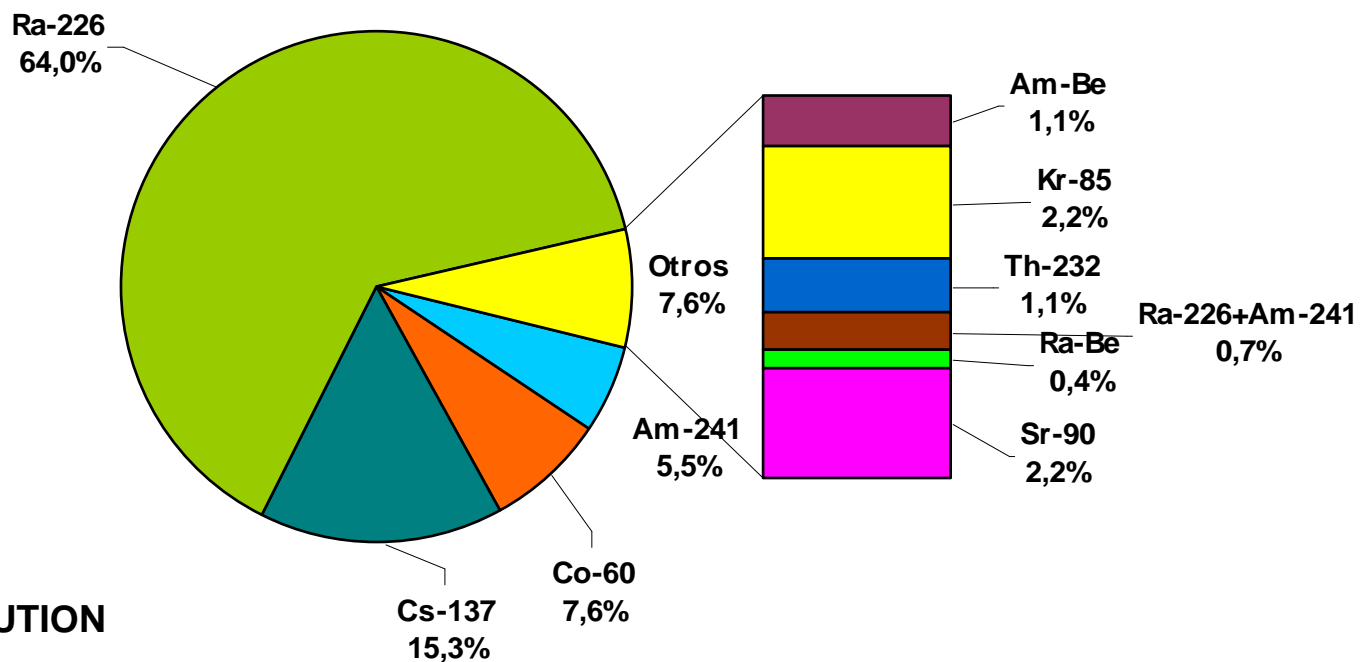
CHARACTERISTICS OF DETECTED MATERIALS

**MATERIALS DETECTED 2648
1998-2009**



CHARACTERISTICS OF DETECTED MATERIALS

**RADIOACTIVE SOURCES 275
RADIONUCLIDES DETECTED (1998-2009)**



ACTIVITY DISTRIBUTION

- RADIUM 0.37%
- OTHER 99.63%

EXAMPLES OF DETECTED MATERIALS



LUMINOUS PAINT



LIGHTNING ROD



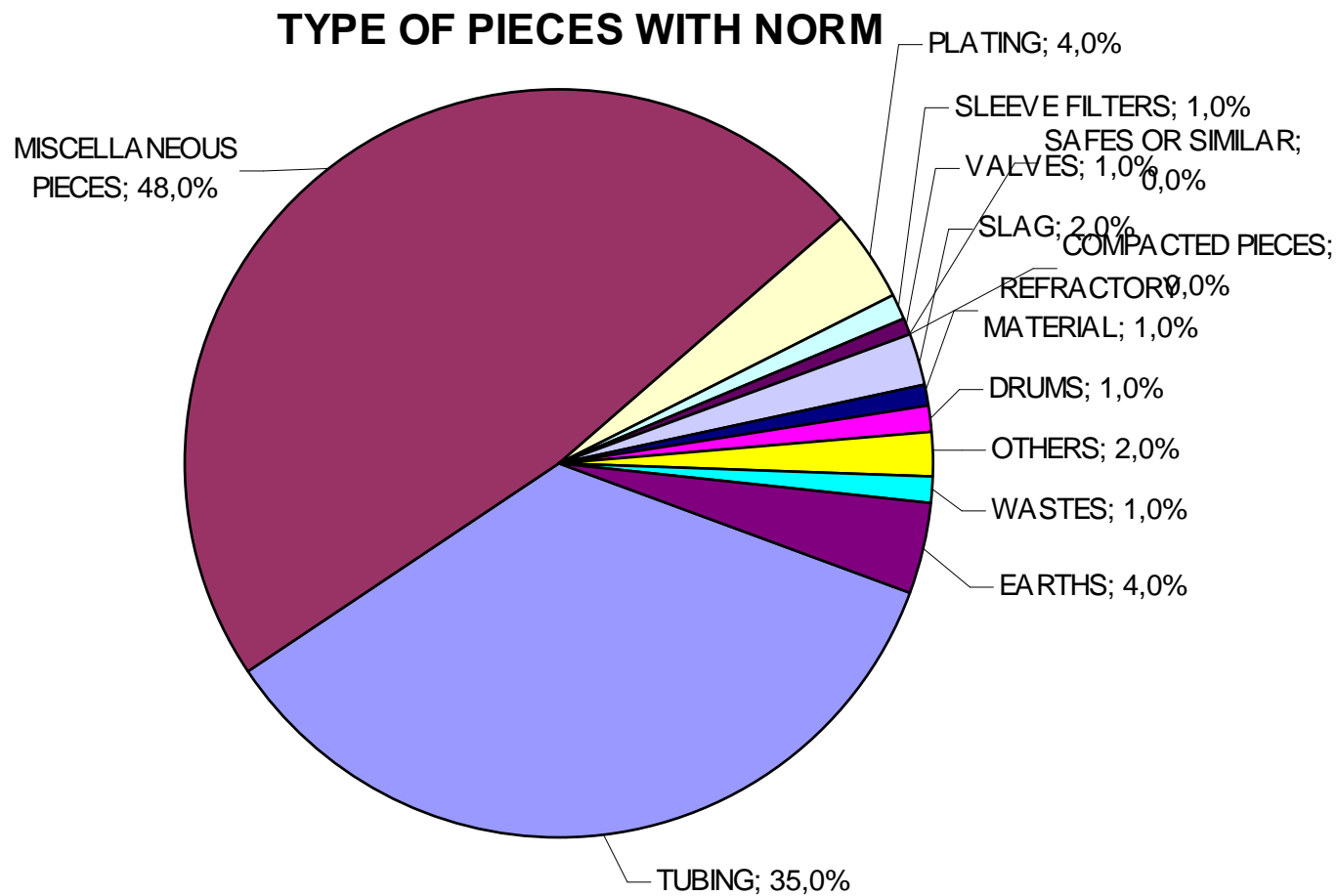
RADIOACTIVE SOURCES



PIECE WITH ARTIFICIAL RADIOACTIVITY

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CHARACTERISTICS OF DETECTED MATERIALS



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CHARACTERISTICS OF DETECTED MATERIALS



BIG PIECES WITH NORM



TUBING WITH NORM



EARTHS WITH NORM



PLATING WITH NORM



VALVE WITH NORM

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*

➤ PLATING

- *LENGTH: 10 – 20 CENTIMETRES*
- *WIDTH: 10 – 50 CENTIMETRES*
- *WEIGHT: TENS OF KILOGRAMS*

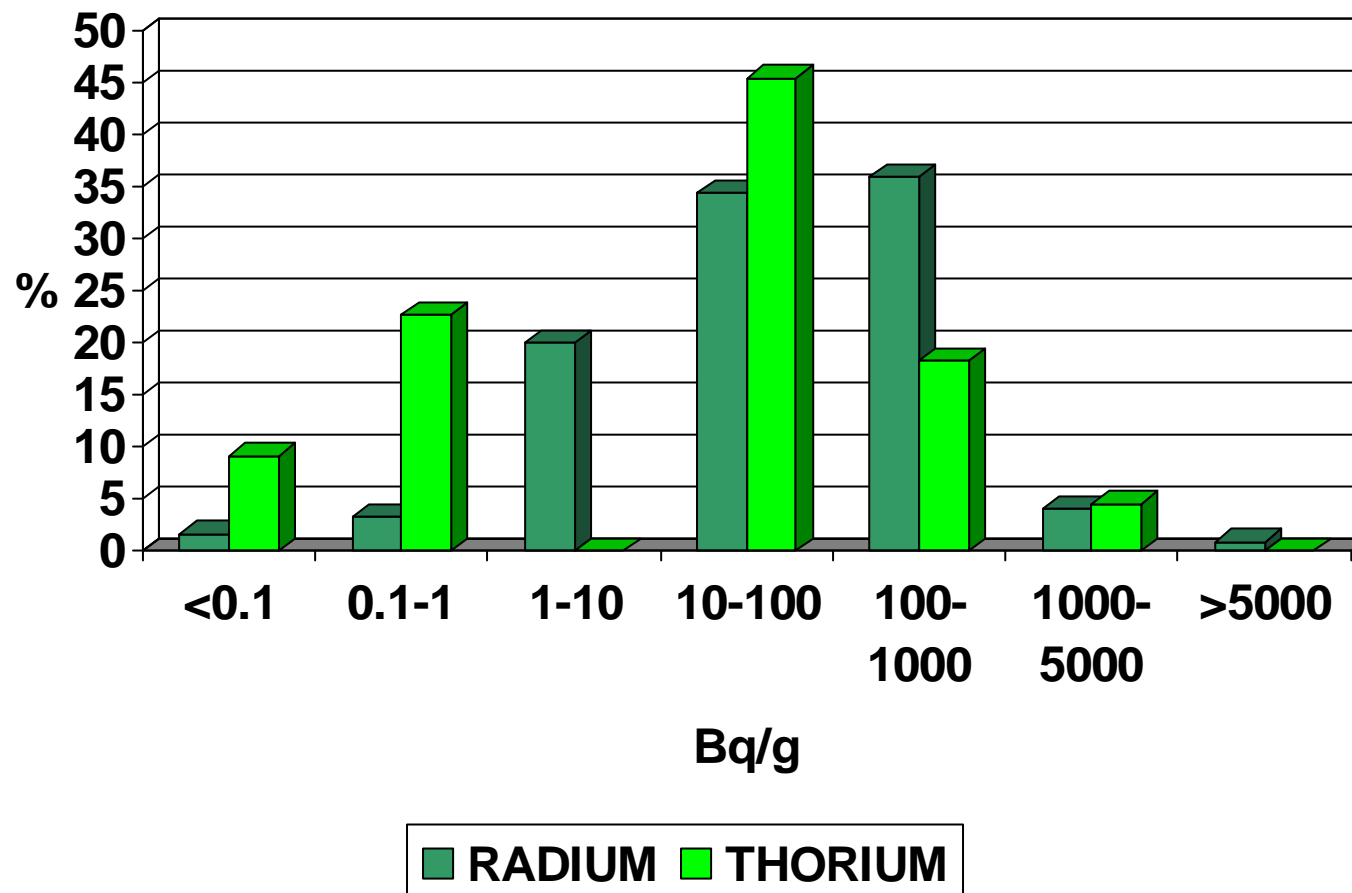
BIGGER PIECES WITH MORE THAN 100 KILOGRAMS HAS BEEN DETECTED

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
 - *RADIONUCLIDES: RADIUM SOME TIMES THORIUM*
 - *DETERMINATION THROUGH GAMMA SPECTROMETRY (DAUGHTERS GAMMA EMITTERS)*
 - RADIUM: Ra-226, Pb-214, Bi-214
 - THORIUM: Ac-228, Pb-212, Tl-208
 - *USUALLY IN EQUILIBRIUM WITH DAUGHTERS*

CHARACTERISTICS OF DETECTED MATERIALS

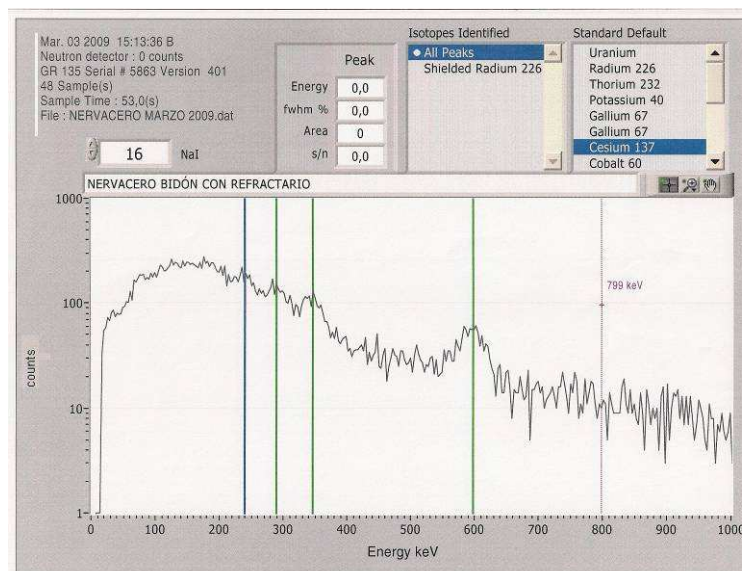
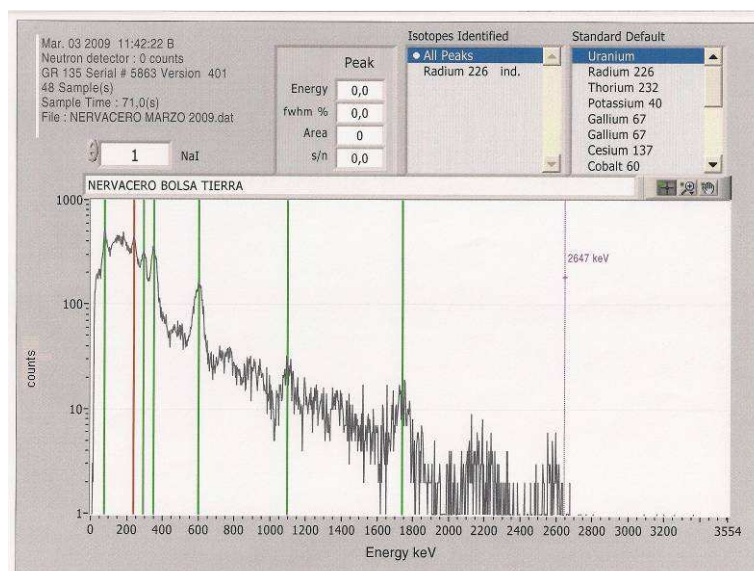
ACTIVITY CONCENTRATION IN SAMPLES



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ACTIVITY ESTIMATION

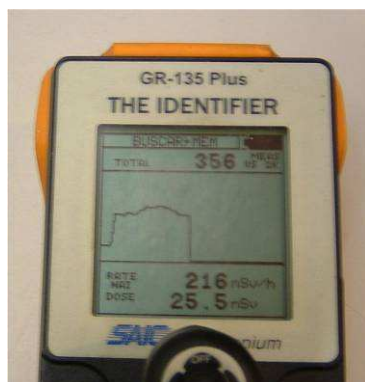
- DIFFICULT TASK
- MEASURE OF DOSE RATE TOGETHER WITH
- IN-SITU SPECTRUM WITH PORTABLE SPECTROMETER
- TAKEN SAMPLE MATERIAL ADHERING FOR LABORATORY ANALYSIS



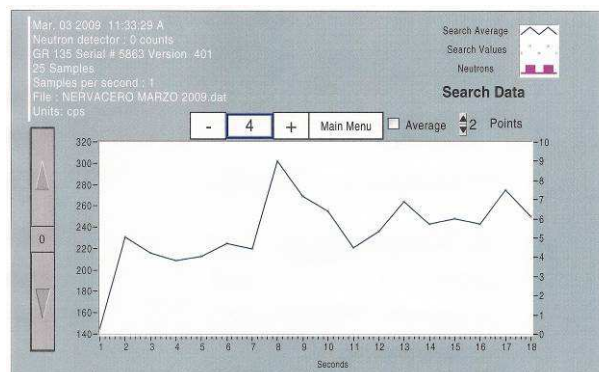
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ACTIVITY ESTIMATION

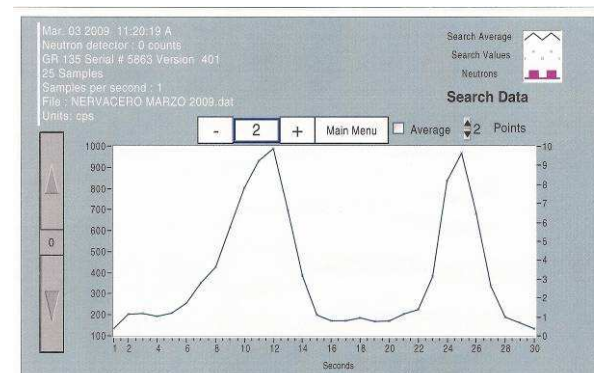
- SURVEY WITH SCINTILLATION CRYSTAL DETECTOR
- ASSURE THERE IS NOT HIGH DOSE RATE POINTS
- CONFIRM LOW ACTIVITY LEVEL TO MELTING THE PIECE (IN GENERAL BELOW THAN 2 microSv/h)



EQUIPMENT IN MODE SURVEY



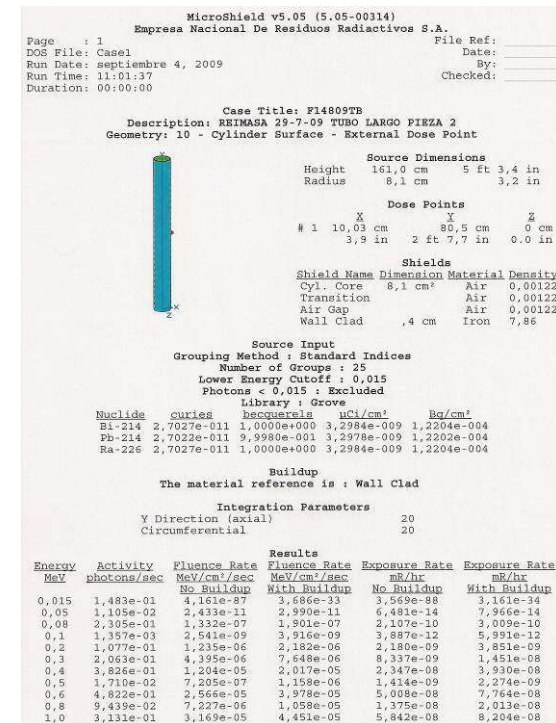
SURVEY PIECE WITH LOW ACTIVITY



SURVEY PIECE WITH HIGH LEVEL AREAS

ACTIVITY ESTIMATION

- IF DOSE RATE IS ABOVE THE BACKGROUND MEASURES AT DIFFERENT DISTANCES ARE MADE
- MODELLING THE PIECE: RADIONUCLIDE, INTERPOSED MATERIALS, GEOMETRY, PHYSICAL AND CHEMICAL CHARACTERISTICS
- CALCULATION OF DOSE RATE PRODUCED BY ACTIVITY UNIT WITH A COMMERCIAL SHIELDING CALCULATION PROGRAMME
- WITH DOSE RATE MEASURED CALCULATION OF ACTIVITY



$$A(MBq) = TD(\mu Sv/h) \times F\left(\frac{MBq}{\mu Sv/h}\right)$$

EXAMPLE OF ACTIVITY ESTIMATION

- SEVERAL CYLINDRICAL PIECES WITH RADIUM
- DOSE RATE MEASURES
- GEOMETRY CYLINDRICAL
- NO SAMPLE
- TOTAL ACTIVITY 3 MBq



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Microshield v5.05 (5.05-0314)
Empresa Nacional de Residuos Radioactivos S.A.
Page: 1
DOS File: F5705DIP.RDS
Run Date: marzo 8, 2009
Run Time: 11:52:44
Duration: 00:00:00
File Ref:
Data:
By:
Checked:

Case Title: F5705DIP
Description: EXPERIMENTAL DOS 2009 4-3-2009 DISCOS PQCUBOS
Geometry: # - Cylinder Volume - Rad Shields

Source Dimensions
Height: 1.0 cm 1.0 in
Radius: 4.25 cm 1.7 in

Dose Points
# 1 0 cm 4.53 cm 0 cm
# 2 0.0 in 1.8 in 0.0 in
# 3 0 cm 3.53 cm 0 cm
# 4 0.0 in 1.4 in 0.0 in

Shield
Shield Name: Dimension: Material: Density:
Source: 170.239 cm3 Iron 7.86
Air Gap: Air 0.0012

Grouping Method: Standard Indices
Number of Groups: 25
Lower Energy Cutoff: 9.015
Photons < 0.015: Excluded
Library: None

Nuclide Curves: Bq/cm2 cm2 MBq/cm2 Bq/cm2
Ra-226 2.7027e-011 1.0000e+000 1.0000e+007 5.8732e+003
Ra-228 2.7022e-011 9.8390e-001 1.5879e-007 5.8732e+003
Ra-226 2.7027e-011 1.0000e+000 1.5879e-007 5.8732e+003

Buildup
The material reference is: Source

Integration Parameters
Radial: 20
Circumferential: 10
Y Direction: Vertical: 10

Results - Dose Point # 1 - (0.4,53,0) cm
Electron Activity Fluence Rate Fluence Rate Exposure Rate Exposure Rate
MWD Photons/cm2 MWD/cm2 MWD/cm2 mR/hr mR/hr
0.05 1.105e-02 7.231e-08 7.231e-08 1.255e-10 2.115e-10
0.06 2.305e-01 8.066e-06 8.066e-06 1.276e-08 1.522e-08
0.1 1.137e-03 9.278e-04 1.248e-07 1.433e-10 1.809e-10
0.2 1.077e-01 1.166e-05 5.651e-05 5.943e-08 9.922e-08
0.3 2.062e-01 1.187e-04 5.056e-04 1.213e-07 1.800e-07
0.4 1.822e-01 1.205e-04 5.210e-04 1.343e-07 1.079e-06
0.5 1.135e-02 1.202e-03 1.221e-03 1.432e-08 6.184e-08
0.6 4.822e-01 6.365e-04 1.110e-03 1.363e-06 2.160e-06
0.8 9.439e-02 1.977e-04 2.977e-04 1.703e-07 5.166e-07
1.0 1.131e-01 6.630e-04 1.255e-03 1.602e-06 2.333e-06
    
```

EXAMPLE OF ACTIVITY ESTIMATION



RADIUM: 0.9 MBq

THORIUM: 0.2 MBq

CONDITIONING



- **PIECE WITH MATERIAL INSIDE**
- **CUTTING PIECE**
- **REMOVAL EARTH**
- **METALLIC PIECE COULD BE MELTED**
- **RADIUM ACTIVITY: 0.2 MBq – 52 Bq/g**

CONDITIONING



- EARTH MIXED WITH METALLIC PIECES
- REMOVAL EARTH
- RADIUM ACTIVITY: 3.5 MBq – 3.4 MBq 130 Bq/g
- DOSE RATE: 1.3 – 1.4 micrSv/h



CONDITIONING



- DOSE RATE: 6 microSv/h
- CUTTING PIECE
- NOT POSSIBLE TO REMOVE THE MATERIAL
- RADIUM ACTIVITY: 5.4 – 4.5 MBq
- RADIUM CONCENTRATION:
 - MATERIAL: 4240 Bq/g
 - PIECES: 212 Bq/g



CONDITIONING



- DOSE RATE: 5 micrSv/h
- CUTTING PIECE
- NOT POSSIBLE TO REMOVE THE MATERIAL
- RADIUM ACTIVITY: 0.9 MBq
- RADIUM CONCENTRATION:
 - MATERIAL: 102 Bq/g
 - TUBING: 54 Bq/g



CONDITIONING



- DOSE RATE: 8 - 20 microSv/h
- CUTTING PIECE INTO TWO PARTS
- NOT POSSIBLE TO REMOVE THE RADIOACTIVE MATERIAL
- RADIUM ACTIVITY: 4 – 0.2 MBq
- RADIUM CONCENTRATION:
 - MATERIAL: 527 Bq/g
 - PIECE: 313 - 20 Bq/g

CONDITIONING



- DOSE RATE: 2 - 7 microSv/h
- CUTTING PIECE IN 4 PARTS
- NOT POSSIBLE TO REMOVE THE MATERIAL
- TOTAL RADIUM ACTIVITY: 1.2 MBq
- RADIUM CONCENTRATION:
 - MATERIAL: 45 Bq/g
 - PIECE: 32 Bq/g



CONDITIONING



- DOSE RATE: 1 microSv/h
- OPEN THE PIECE
- MEASURE OF DOSE RATE AND SURVEY
- PIECE COULD BE MELTED



CONCLUSIONS

- **MOST OF THE METALLIC MATERIALS (PIECES) DETECTED BY THE PORTAL MONITORS AT THE ENTRY TO THE METAL INDUSTRY FACILITIES CONTAIN ONLY NATURAL RADIOACTIVE MATERIAL**
- **MANY OF THESE PIECES HAVE A VERY LOW VALUE OF SPECIFIC ACTIVITY AND MAY BE INCORPORATED INTO THE SMELTING PROCESS**
- **THE DOSE RATE VALUES MEASURED, ALONG WITH THE METHODS USED TO HANDLE THIS TYPE OF PIECES, ENSURE THAT THE RADIOLOGICAL RISK FOR THE WORKERS AT THESE FACILITIES IS NOT SIGNIFICANT**