

Practical experience and implementing occupational radiation protection and training in the oil & gas industry

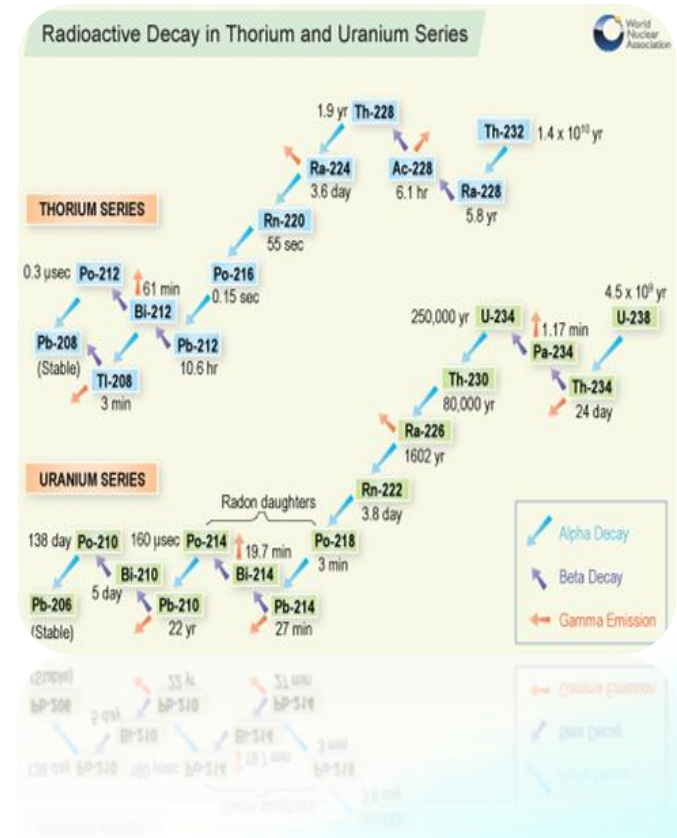


International Conference on
Occupational Radiation Protection:
Enhancing the Protection of Workers
Gaps, Challenges and Developments
Vienna, Austria
1 - 5 December 2014

Natural radiation consists of cosmic radiation and the radiation arising from the decay of naturally occurring radionuclides.

The radionuclides identified in oil and gas streams belong to the decay chains of the naturally occurring elemental radionuclides ^{238}U and ^{232}Th

Uncontrolled activities associated with enhanced levels of Naturally Occurring Radioactive Material (NORM) can contaminate the environment and pose a risk to human health.



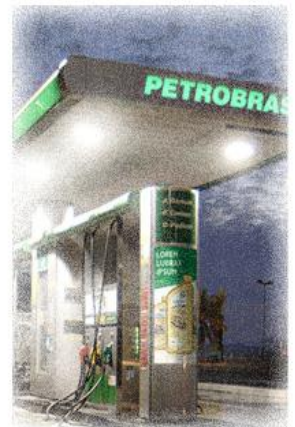
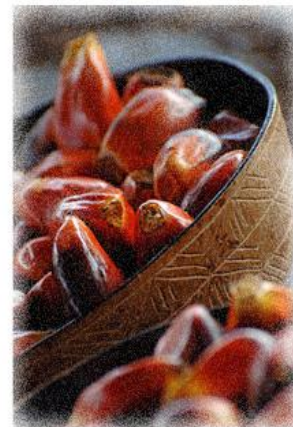
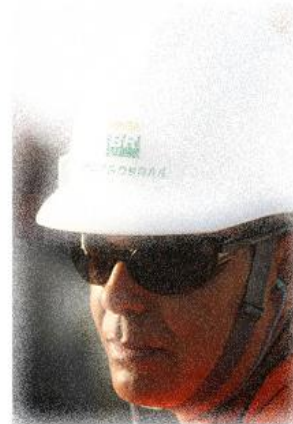
Objectives

Share

Experience achieved by the oil and gas industry in Brazil in implementing occupational radiation protection to meet the recommendations of the International Atomic Energy Agency, (BSS 115 – IAEA 1996)

Present

Challenges and opportunities yet to overcome by the sector due to NORM presence in its operational activities



NORM formation in the oil and gas industry

- The decaying process of these unstable radioactive elements produces progeny radionuclides that can be transported from the reservoir to the surface while oil & gas products are being recovered.
- Under certain conditions (solubility, pressure, temperature, acidity etc.) in the subsurface environment these descendant elements can be more or less mobile
- During the production process, NORM flows with the oil, gas and water mixture and accumulates in sludge and scale.



Composition and the Specific Activity



- The composition and specific activity on sludge, sediment and scale of oil production vary widely and depend on many operational factors.

- activity concentrations of ^{226}Ra and ^{228}Ra

- ▶ from undetectable levels to more than 1000 Bq/g⁻¹.
- ▶ much higher than the recommended values established
- ▶ large amounts of NORM
- ▶ potential radiological hazards

Role of NORM Regulators in Brazil

“The Study”

- The first NORM scale occurrence was noticed in 1988
- since then a strong radioprotection partnership Institute of Radiation Protection and Dosimetry (IRD)
- conducted survey, sampling and analysis
- determine the extension of NORM generation
- promote best practices and knowledge concerning radiation protection in the oil and gas industry.



- The IRD institute is one of Brazil's most important center of expertise in radiation protection, dosimetry and metrology of ionizing radiation
- IRD activities cover all the areas in which man and environment can be exposed to radiation: power generation, medicine, industry and research.

NORM in the Oil and gas industry in Brazil



■ Risks can be mitigated by “Safety Culture”

- ▶ identify where NORM is present
- ▶ control of NORM-contaminated equipment
- ▶ control of waste
- ▶ measures to protect workers
- ▶ measures to protect environment

NORM in the Oil and gas industry in Brazil

Typical values of ^{226}Ra , ^{228}Ra and ^{228}Th

Scale samples

- 16.2 to 93.2 kBq.kg⁻¹ for ^{226}Ra ,
- 4.0 to 36.9 kBq.kg⁻¹ for ^{228}Ra
- 4.5 to 18.5 kBq.kg⁻¹ for ^{228}Th .

Sludge samples

- 0.13 to 331 kBq.kg⁻¹ for ^{226}Ra ,
- 0.10 to 245 kBq.kg⁻¹ for ^{228}Ra
- 0.10 to 272 kBq.kg⁻¹ for ^{228}Th

- Measured gamma dose rates inside onshore sludge deposits ranged from 0.2 to 2.0 $\mu\text{Sv.h}^{-1}$ and the same dose measures, when taken on surface of sludge barrels rise up to 0.3 mSv.h⁻¹.



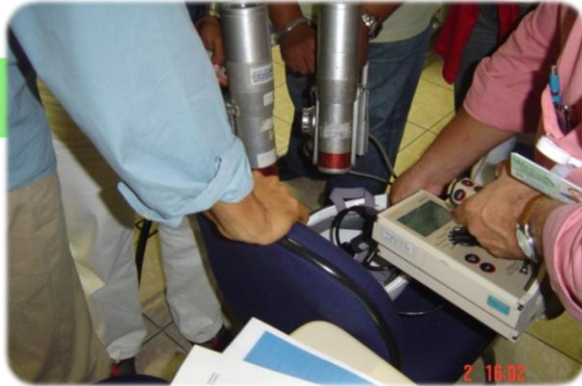
NORM occupational exposure from O&G

- current working time per employee - 2000 hours.year⁻¹ on field activities
 - ▶ no significant radiological impact on workers
 - ▶ was expected from NORM in oil and gas plants.
- potential additional annual dose for individuals
 - ▶ due to external exposure
 - ▶ can be higher than 1.0 mSv
 - ▶ some restrictions can be applied
- activity cannot be regarded as exempted
 - ▶ urgent need for technical guidelines for the sector.
- radon levels inside
 - ▶ since these deposits are well ventilated,
 - ▶ mean value of 6 Bq.m⁻³ was measured
 - ▶ during several working day period
- dosimetry
 - ▶ Due to the maintenance requirements
 - ▶ operational dynamics of constant removal and cleaning of scale deposits,

NORM Control



NORM Training





Challenges and Gaps

#1 - Legislation

#2 - Limits to Workers and Public

#3 - Metrics

#4 - Area Classification

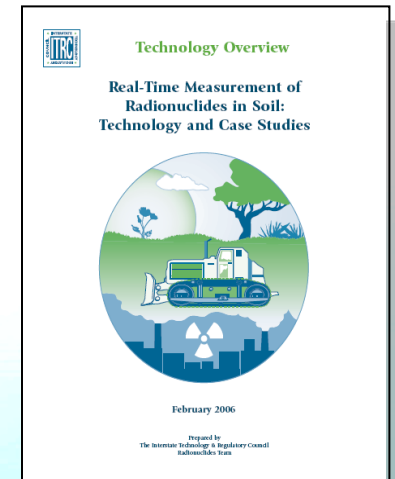
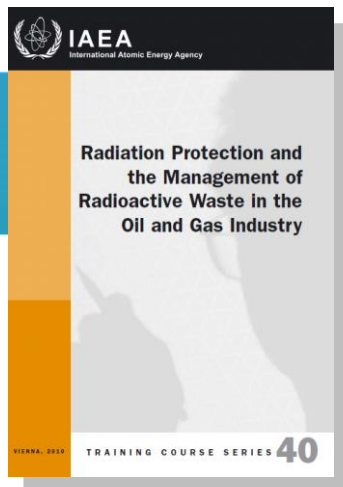
#5 - Temporary Storage of NORM Material

#6 – Final Disposal of NORM

#1 - Legislation

Oil and Gas Radiation Safety Standards

- The O&G companies need experts in every aspect of the technology applied in their industry and frequently, the necessary expertise is provided to the industry by specialized support organizations.
- O&G INDUSTRY
 - Basic Radiation Safety - Environmental Protection - Waste Management
- EFFICIENT AND SAFE OPERATIONS



#1 - Legislation

Norm management guidelines

A strategy for NORM management:

- ✓ NORM monitoring
- ✓ Control of NORM contaminated waste
- ✓ Control of NORM contaminated equipment
- ✓ Worker protection and training
- ✓ Development of NORM management guidelines
- ✓ Compliance monitoring.



#2 - Limits to Workers and Public International Legal Framework

Table 1: An illustration of the development of waste regulation from international sources.

	WHO	WHAT	Examples
Expert advisory organisations	ICRP ICRU IAEA UNSCEAR WHO Others	Recommendations and standards	ICRP 103 International BSS
International organisations	IAEA Euratom Community European Community OECD NEA Others	Instruments that are legally binding on member states + guidance & policy etc	Euratom BSSD Paris and Brussels conventions OSPAR convention Joint convention on safety of spent fuel management & safety of rad waste management
National governments	UK Gov't Devolved Administrations	Domestic legislation and policy	RSA 93 / EPR 10 IRR 99 LLW Policy REPIR
Regulators	environment agencies HSE ONR (NII, DFT, OCNS, SAFEGUARDS)	Implement the law taking account of relevant policy and standards	Environmental permit/ RSA authorisation and associated conditions Guidance

Source:
UK Government, the Scottish Government, the Welsh Government and the Northern Ireland Department of the Environment. Strategy for the management of Naturally Occurring Radioactive Material (NORM) waste in the United Kingdom: A consultation 13 February 2014

<http://www.scotland.gov.uk/Publications/2014/02/8435/downloads>

URGENT NEED OF HARMONIZED INTERNATIONAL REGULATION

#2 - Limits to Workers and Public

Brazilian NORM Regulation - 2014

Norma CNEN NN 8.02
Resolução CNEN 168/14
Abril / 2014

LICENCIAMENTO DE DEPÓSITOS DE REJEITOS RADIOATIVOS DE BAIXO E MÉDIO NÍVEIS DE RADIAÇÃO

Resolução CNEN 168/14
Publicação: DOU 14.05.2014



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Norma CNEN NN 8.01
Resolução CNEN 167/14
Abril / 2014

GERÊNCIA DE REJEITOS RADIOATIVOS DE BAIXO E MÉDIO NÍVEIS DE RADIAÇÃO

Norma CNEN NE 6.05
Publicação: DOU 17.12.1985

Resolução CNEN 167/14
Publicação: DOU 15.05.2014



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Norma CNEN NN 6.09
Resolução CNEN 012/02
Setembro / 2002

CRITÉRIOS DE ACEITAÇÃO PARA DEPOSIÇÃO DE REJEITOS RADIOATIVOS DE BAIXO

Resolução CNEN 012/02
Publicação: DOU 23.09.2002



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#3 - Metrics

Types of NORM survey

- Monitoring is required to ascertain whether NORM is present in a medium.
- It can utilize direct measurement instruments to measure the levels of radiation emitted or samples can be collected and sent to a laboratory for radiometric analysis.
- In practice, a monitoring programme will usually make use of all available monitoring methods and techniques based on specific requirements



#3 - Metrics

Norm survey devices

- Field detectors for radiological contamination
- Location control technology global positioning system (GPS)
- Detection system can be used turned on behind a windshield in a moving vehicle as a radiation detection system Gamma-ray detector based on NaI crystal
- Car borne gamma mapping equipment with large NaI(Tl) detectors
- Can cover great distances in very short time



#3 - Metrics

Norm survey devices

- Highly-sensitive detection at a distance of both gamma and neutron sources (1-25) nSv/hr above background gamma
- Real time spectrum recording, dose rate calculation and isotope identification, audio alarms if elevated radiation, sound pattern depending of the isotope identified
- Integrated GPS positioning
Storing spectra and count rates for about 40 hours of scanning



#4 - Area Classification



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#5 - Temporary Storage of NORM Material



#6 – Final Disposal of NORM - disposal options

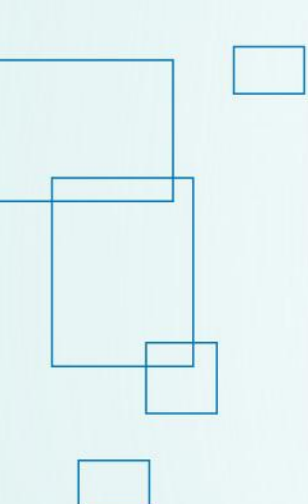
Table 5-3. Summary of disposal option ranking

Option	Acceptability
Sea disposal offshore discharge	Good
Re-injection	Good
In situ downhole abandonment	Good
Sea disposal nearshore discharge	Fair
Encapsulation and downhole disposal	Fair
Onshore built disposal facility	Fair
Onshore landfill	Fair
Smelting	Fair
Disposal in salt caverns	Fair
Export	Fair
Landspreading	Unacceptable
Incineration	Unacceptable
Disused mine disposal	Unacceptable
Sewer	Unacceptable

1 Choice

2 Choice

Sniffer – 2005 Technical Summary Report
Project UKRSR07 Identification and
assessment of alternative disposal
options for radioactive oilfield wastes



Credits:

Team of Radioprotection Officers

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