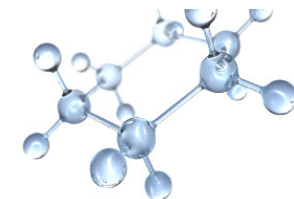

NORM Measurement Strategies using Personal Dosimeter

Based on Exposure Assessment
Strategies in the E&P-Industry.

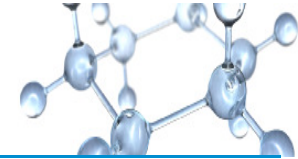


December, 4th – 7th 2012,

EAN_{NORM} Workshop - Dresden



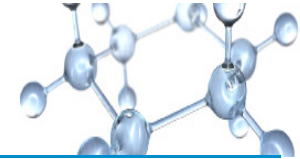
Agenda



OVERVIEW / PURPOSE

- **Forms of NORM**
- **Sampling of Personal Dose Data**
- **Risk Classification of tasks**
- **Worker Groups (Similar Exposure Groups)**
- **Core Job / Task Analysis**
- **NORM Sampling Strategies**
- **Summary and Discussion**

Forms of NORM



Two main forms of NORM

• “Water based” NORM

- Associated with crude oil and water streams
- Radium

Barium-Strontium
Sulfat Scale



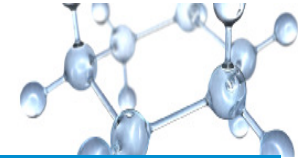
• “Gas / LPG based” NORM

- Mainly associated with gas and LPG streams
- Radon

Lead-/ Lead₂₁₀ -
Scale



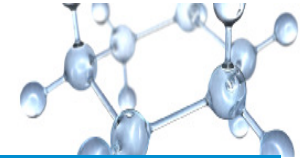
Forms of NORM



Radium as a NORM source

- **^{226}Ra (U series) and ^{228}Ra (Th series) are soluble in formation water:**
 - Solubility increases with temperature, salinity and lowered pH
 - Therefore, Ra concentration varies from field to field.
- **Radium precipitates out in production equipment.**
- **Precipitate occurs as a hard scale or in oily sands (sludges)**
 - In some fields can be a significant source of γ radiation coming through the equipment
- **Half-lives:** ^{226}Ra – 1,602 years; ^{228}Ra – 5.75 years

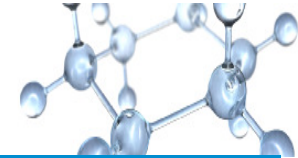
Forms of NORM



Radon as a NORM source - Lead₂₁₀ - Scale

- Radon (Rn) is an inert gas produced by the radioactive decay of radium
 - ²²²Rn (U-series) has a half life of 3.8 days
 - ²²⁰Rn (Th-series) has a half life of 55 seconds
- ²²²Rn can escape the formation and enter the interstitial gas or dissolve in the gas condensate/oil or water
- When the gas, oil and water are produced, ²²²Rn follows the LPG/ (ethane-propene) gas stream in processing.
 - Because of its longer half-life, ²²²Rn can progress through many processing steps, resulting in local Lead-/Lead Scales.

Sampling of Personal Dose Data



The sampling of exposure data is conducted on base of a exposure assessment strategy.

Within the scope of this strategy all personal exposed against NORM within an organization and / or a work area are allocated to worker groups with similar tasks and / or exposures.

- The tasks with exposure against NORM are analysed and rated according to the effective additional work hour body dose. The rated tasks are sorted by frequency and durance, and allocated to distinct Worker Groups.

Task Rating (additional effective work hour dose)

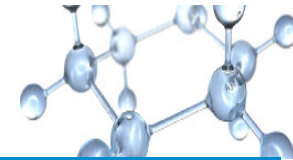
- 0.0 to < 0.01 μSv per work hour (E-rating)
- 0.01 to < 0.1 μSv per work hour (D-rating)
- 0.10 to \leq 0.5 μSv per work hour (C-rating)
- 0.50 to \leq 1.0 μSv per work hour (B-rating)
- > 1.0 μSv per work hour (A-rating)

- The Worker Groups are categorized due to exposures of resulting from “Works” are rated according to the effective additional dose per annum!

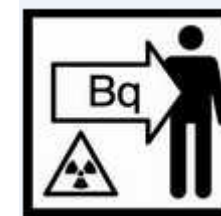
Categorizing of Worker Groups (eff. annual dose)

- 0.0 to < 0.01 mSv per year (Cat. IV)
- 0.01 to < 0.1 mSv per year (Cat. III)
- 0.10 to \leq 0.5 mSv per year (Cat. II)
- 0.50 to \leq 1.0 mSv per year (Cat. I)

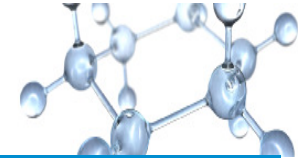
NORM Risk Matrix



		Additional dose level (direct radiation) and Exposure Risk				
		> 1	=====>			0
Consequence of Exposure to Health	Additional dose up to 1 mSv/a and greater	A > 1 μSv/wh	B ≤ 1 to 0,5 μSv/wh	C ≤ 0.5 to 0,1 μSv/wh	D ≤ 0.1 to 0.01 μSv/wh	E ≤ 0.01 to > 0 μSv/wh
	I 0,5 to ≥ 1 mSv/a					
	II 0,5 to ≥ 0.1 mSv/a					
	III 0,1 to ≥ 0.01 mSv/a					
	IV 0.01 to ≥ 0.01 mSv/a					
No measurable additional annual dose						
Measures for risk minimization		No specific precaution measures required				
		No specific precaution measures required, either NORM can be incorporated				
		Organizational exposure minimization measures required				
		Works requires special PPE or technical dose minimization measures				



Worker Groups (Similar Exposure Groups)



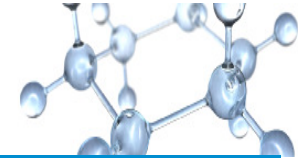
Worker Groups belong to:



- an organizational grouping or contractor company
- a group working in the same Work Area
- a group performing similar tasks/activities
- persons having similar exposure potential
- persons conducting tasks having similar frequency and duration



Core Job / Task Analysis



An exposure profile requires the identification of the:

- kind of radiation and the NORM material of concern
- work activities (tasks) of concern, inclusive the knowledge of frequency and duration

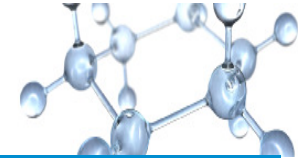
Exposure data of representative tasks are sampled, and the task risks are rated according to the effective dose per work hour.

- either by use of personal dose meters, to assess the external exposure and/or, if associated with the emission of dust or aerosols containing NORM, by analyzing respiratory mask filter masses, to assess the internal exposure

To discriminate the kind of radiation and the NORM material of concern, it is necessary to take and analyze representative NORM samples.

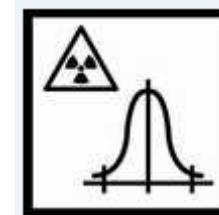
•NORM-waste sampling follows in Germany industry guide-lines like the German “LAGA PN-98”.

NORM Sampling Strategies

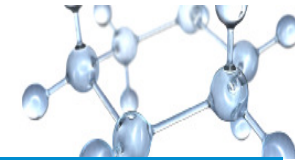


Always, comparable lots are sampled only

- LSA-sludges are packed in plastic drums, or in 1m³ cube containers. Grab samples are taken from each single drum or container and analysed.
- Hard scales are either scraped off the surface of metal scrap, and / or coin sized coupons are drilled at representative positions. Up to 20 “scrap samples” are forming one composite sample for analysis.



Example of PDM Ia



Sampling of 322 barrels with a total of 38.94 tons of “Hg-/LSA-sludges”

1. “Warehouser” works:

- Taking out of packages (four barrels per wooden stillage) from storage box, using a folk lift.
- Arranging of barrels in line for sampling by hand.
- Taking in of packages (four barrels per wooden stillage)
- Taking back into storage box, using a folk lift.



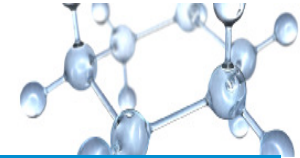
“Warehouser” carrying a personal dosimeter (at belt)

Mean effective (additional) dose of worker group “Warehouser”: 0.480 μ Sv per work hour.

- Required working time (with exposure against radiation) for one sampling campaign: **9 hrs.**
- Total additional dose per single job: **4.32 μ Sv**

RATING: C II

Example of PDM Ib



Sampling of 322 barrels with a total of 38.94 tons of “Hg-/LSA-sludges”

2. “Sampler”

- Remove of barrel lids, and taking samples
- Conducting dose measurements at the barrels to control guarantee representatively of sample.
- Close-up of barrels



“Sampler” wearing respiratory protection (half mask with Hg-filter) and disposable coverall

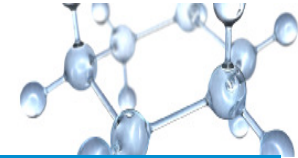
Mean effective (additional) dose of worker group “Sampler” : 0,255 μSv per work hour.

- Required working time (with exposure against radiation) for one sampling campaign: **6 hrs.**
- Total additional dose per single job: **1.53 μSv**

RATING: C I

Reference reader showing local dose: 0.12 $\mu\text{Sv/h}$

Example of PDM II



Handling of Barium-sulfate-scale from pipe pig trapping operations.

- Source: Formation water transportation line from sweet gas production.
- Specific scale activity: about 260 Bq/g.



- Scale mass: 160 liters, respectively 360 kg
- Maximum dose measured at production residuals: 60 $\mu\text{Sv/h}$
- At a distance of 1 m above the production residues a maximum dose of about 14 μSv was measured
- Local dose at location: 0.11 $\mu\text{Sv/h}$

Required working time (with exposure against NORM radiation): 45 Min.

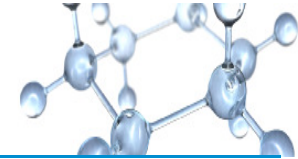


- Work force wearing personal dosimeter on waist belt, mask with Hg-filters, washable coverall and washable boots.

The additional dose was assessed, using CAMBERRA personal dose meter. The effective dose accumulated during the work “loading” sum up to 793 nSv for worker #1 and 628 nSv for worker #2 (difference between dose reading of personal dose meter and the dose reading of a dose meter at a reference location).

RATING: B I

Summary



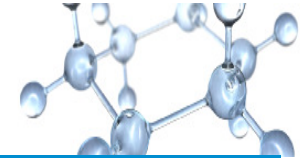
May I run through some of my key points again.



Exposure Profiles:

- Less than 5 % of the tasks with exposure against radiation are “A” rated (works with potential body doses of $> 1 \mu\text{Sv}$ per work hour).
- About 25 % of the tasks with exposure against radiation are “B” rated (works with potential body doses of > 0.5 to $1 \mu\text{Sv}$ per work hour).
- About 45 % of the tasks with exposure against radiation are “C” rated (works with potential body doses of ≥ 0.1 to $0.5 \mu\text{Sv}$ per work hour).
- About 25 % of the tasks with exposure against radiation are “D” and “E” rated (works with potential body doses of $< 0.01 \mu\text{Sv}$ per work hour).

Discussion



QUESTIONS?

Thank you for listening so attentively!

