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Current Practice for Classification of NORM in the Norwegian Petroleum Industry

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Classification System

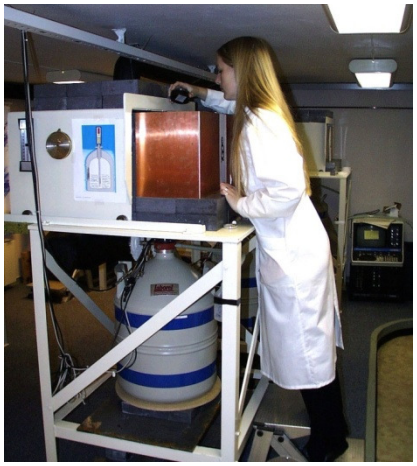
- Regulations on the use of the pollution act on radioactive pollution and on radioactive waste
  - In force from January 2011
  - Exemption values provided
  - 2 levels

The Practical Approach…

- A_{tot} < 1 Bq/g → excempted
- 1 Bq/g < A_{tot} < 10 Bq/g any licensed repository
- A_{tot} > 10 Bq/g → licensed LSA scale repository (Sløvåg)

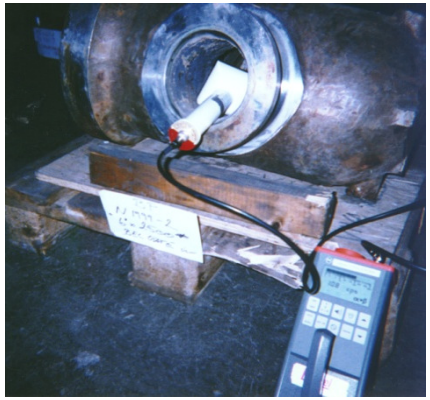
Monitoring Practice

- On-site screening: The Puck Method
- Developed by IFE/NRPA 1998
- Beta-detection by hand instruments
- Works well on Sulphate scale
  - Detection limit: > 1-2 Bq/g
- Should not be used on lead scale
- Combined with gamma spectrometry (lab)



The Puck Method

- STEP 1
  - Establish relation between instrument reading (CPS) and total specific activity (calibration)
    - Users are equipped from IFE with a set of 3 calibration pucks with different activity concentrations
- STEP 2
  - Make the on-site measurement
    - Direct on component in contact with scaling
    - On samples from hard scale/sludge



STEP 1 - calibration

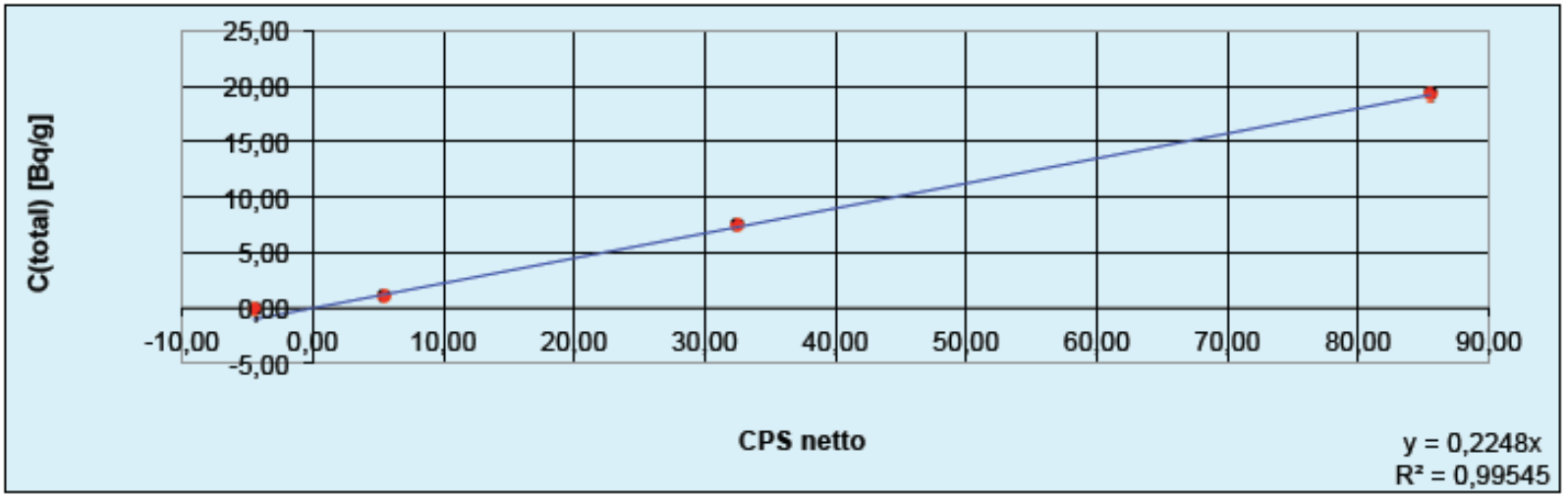
Kalibrering

Instrument type:	NE Electra	Serienr:	6123
Probe:	DP4R		
Sist kalibrert dato:	01.10.11	Neste kalibrering:	Oct 2012

Bakgrunnsstråling:	CPS
	4,60

Kalibrering:

Kalibreringsstandard ID	Startdato Puck	Dagens dato	Start C(^{226}Ra) [Bq/g]	Start C(^{226}Ra) [Bq/g]	Korr C(total) [Bq/g]	CPS målt	CPS netto
301	01.10.1998	19.11.2011	1,00	0,40	1,08	**10,00**	5,50
302	01.10.1998	19.11.2011	7,00	2,10	7,43	**37,00**	32,50
303	01.10.1998	19.11.2011	18,00	6,00	19,23	**90,00**	85,50
					0,00		-4,50



STEP 2

Activity measurement

Isotopforhold på målestedet:

^{226}Ra	^{228}Ra

Måleverdi [CPS]	Spesfikk aktivitet Total [Bq/g]	Spesifikk aktivitet ^{226}Ra [Bq/g]	Spes ^{22}
35	6,9		

Activity measurement

Isotopforhold på målestedet:

^{226}Ra	^{228}Ra
3	1

Måleverdi [CPS]	Spesfikk aktivitet Total [Bq/g]	Spesifikk aktivitet ^{226}Ra [Bq/g]	Spesifikk aktivitet ^{228}Ra [Bq/g]
55	11,4	8,5	2,8

Pros & Cons

+

- Works with all components and samples
- Fast and simple
- Fairly accurate classification

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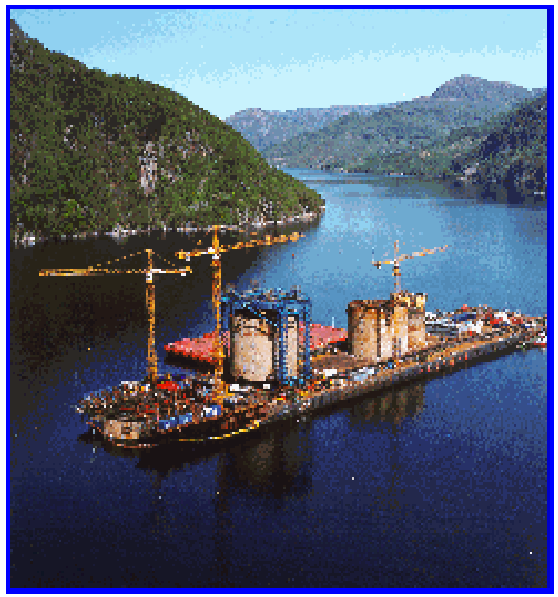
- Need access to inner surface or sample
  - Might be difficult to get probe close
  - Water layer on top of samples absorb beta
- No/few Ex-safe instruments available

Example project
Brent Spar

- Towed to a Norwegian fjord for dismantling and re-use
- Storage tanks known to contain sludge with a certain activity concentration
- After cleaning of tanks, the sludge was stored in 2268 steel drums



Classification program

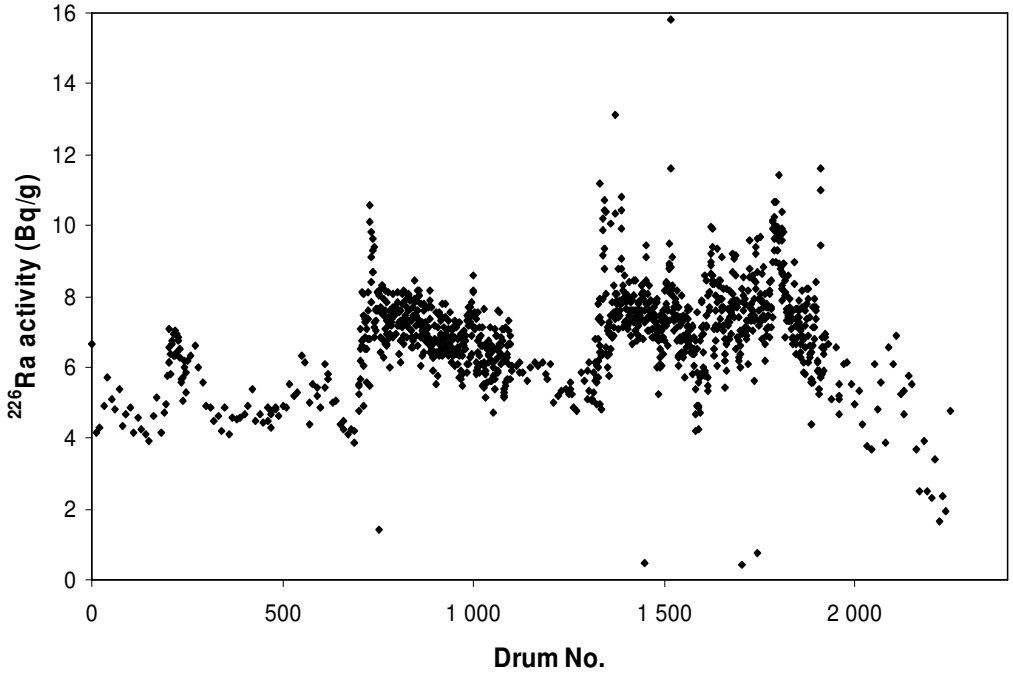
- A program was initiated to map the activity concentration
  - How many drums did actually exceed the exemption level ?
- Two phases:
  1. Survey of distribution of activity levels and homogeneity within a drum
  2. Final assessment and classification of all drums using on-site classification methods

On-site measurements

- Carried out using the method previously described
- 1 minute measuring time
- Fixed geometry
- Set-up calibrated using LSA scale calibration standards
- Action level of 8 Bq/g
  - Uncertainty in method estimated to 20%

Final assessment

- Samples were taken from
  - Every drum from high activity batches
  - Every tenth drum from low activity batches
- Spectrometric methods too time consuming
  - On-site classification methods applied
  - Action level of 8 Bq/g
- Control of samples close to exemption level (γ-spectr.)



Results

- 44 drums classified as radioactive waste (< 2% of total volume)
- Average activity concentration of ^{226}Ra was 6.0±0.6 Bq/g
- Total activity in all sludge was estimate to 3.1 GBq
  - Only 0.1 GBq was actually located in the drums classified as radioactive waste

Future Monitoring Practice

- NRPA Guideline 13: Guideline on radioactive pollution and radioactive waste from the petroleum industry
  - Current methods accepted
  - NRPA may issue requirements for equipment and methods in 2012
- Puck Method based on 1998 technology
- Improved medium resolution equipment available
  - On-site spectrometry on samples?
- Gamma spectrometric lab measurement basis for classification
  - Address issue with Th-228
- Operator training important

Gamma analysis of LSA scale

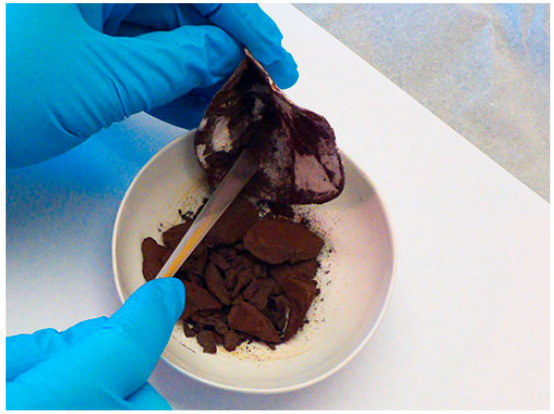
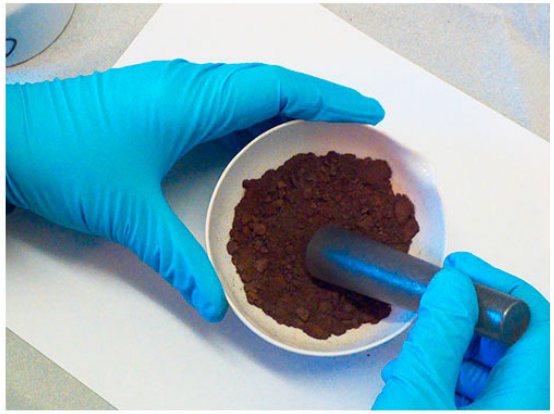
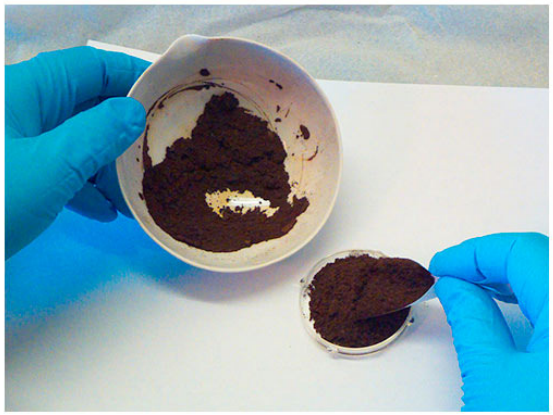
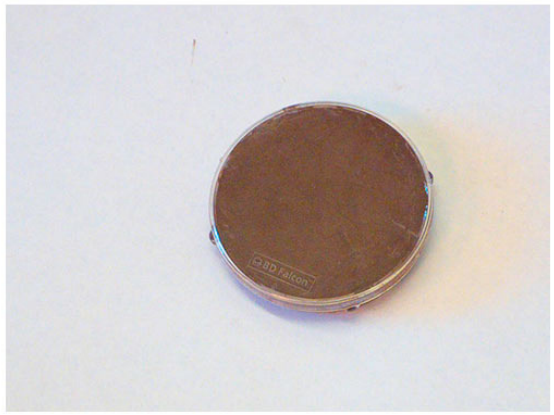
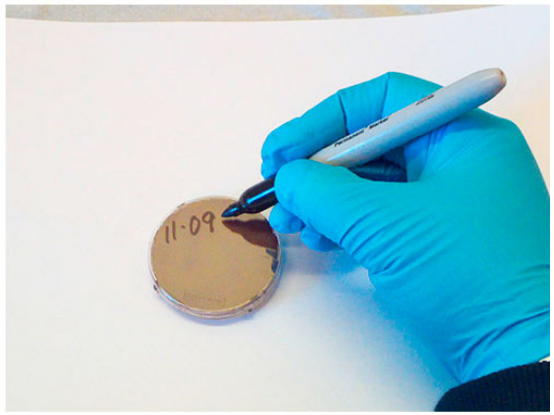
- Mixing
- Packing in petri dish
- Direct determination of ^{210}Pb and ^{226}Ra
- ^{228}Ra via ^{228}Ac
- Self-absorption correction


BD Falcon
11-0894
1990ml
23/8-11

^{210}Pb, ^{226}Ra and ^{228}Ra in produced water

- 2 litre sample
- ^{133}Ba
- Treatment with conc. HNO_3 and $KMnO_4$
- Coprecipitation with $Ba(Pb)SO_4$
- Packing in petri dish and gamma analysis

Preparation

Ra, Th and U in Si materials

- Dissolution with HNO_3 + HF
- Th and U separation with UTEVA-Resin
- Ra separation with sulphate precipitations
- Alpha analysis

Thank You for Your Attention!