Measurement of NORM Waste from decommissioning of petroleum installations

Bjørn Smits
AF Decom Offshore AS

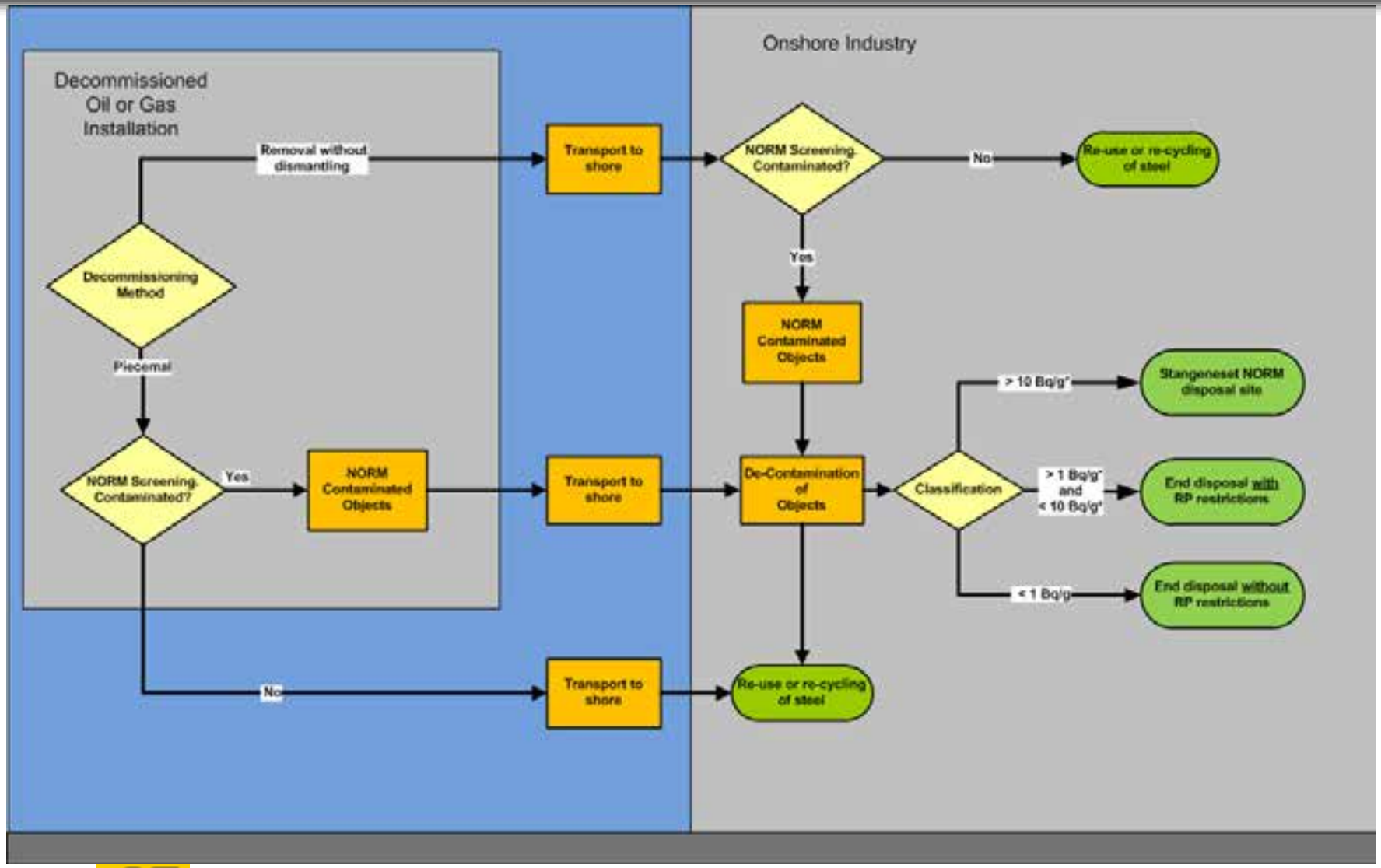
Per Varskog
Zpire Ltd

Contact info:

bjorn.smits@afgruppen.no

per.varskog@zpire.no

Decommissioning NORM Waste Streams



Decommissioning Key Concerns (NORM related)

- A successful decommissioning project is dependent on proper identification, handling and end disposal of all waste (NORM included).
- Aboard disused petroleum installations NORM is often present as a contaminant on the inner surfaces of the production equipment.
- The NORM waste is often mixed with other hazardous substances (e.g. hydrocarbons, HMs including Hg, asbestos).
- Large practical challenges related to carrying out the work offshore:
  - Lack of infrastructure
  - Weather
  - Logistics
  - HSE
  - Handling and disposal of mixed waste

NORM Issues in Decommissioning





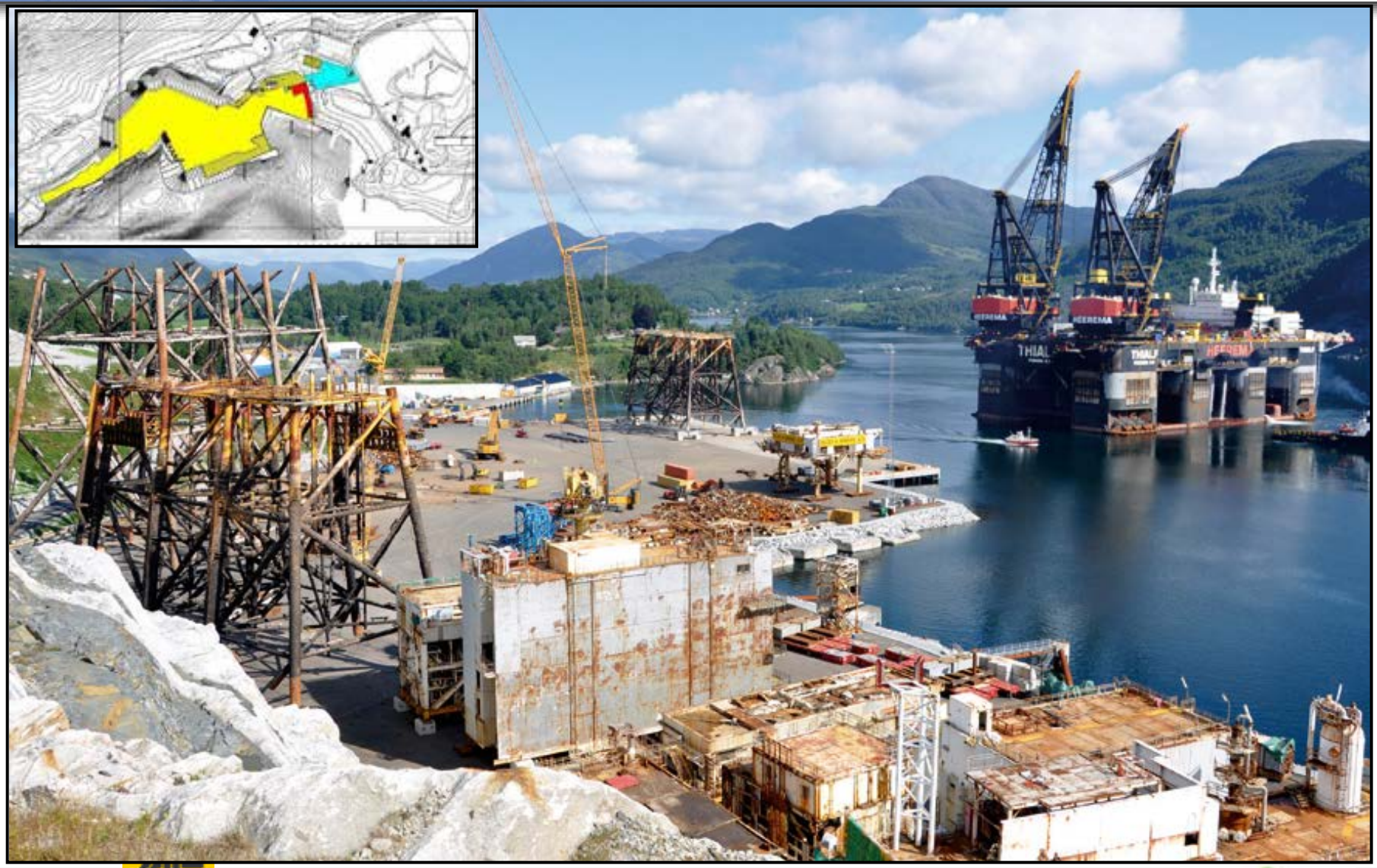

NORM issues include:

- Identification and quantification
- Removal of NORM contaminated components and vessels
- Transport
- De-contamination and storage
- End disposal
- Trans-boundary issues
- Radiation protection

Ekofisk 2/4T topside removal by AF Decom

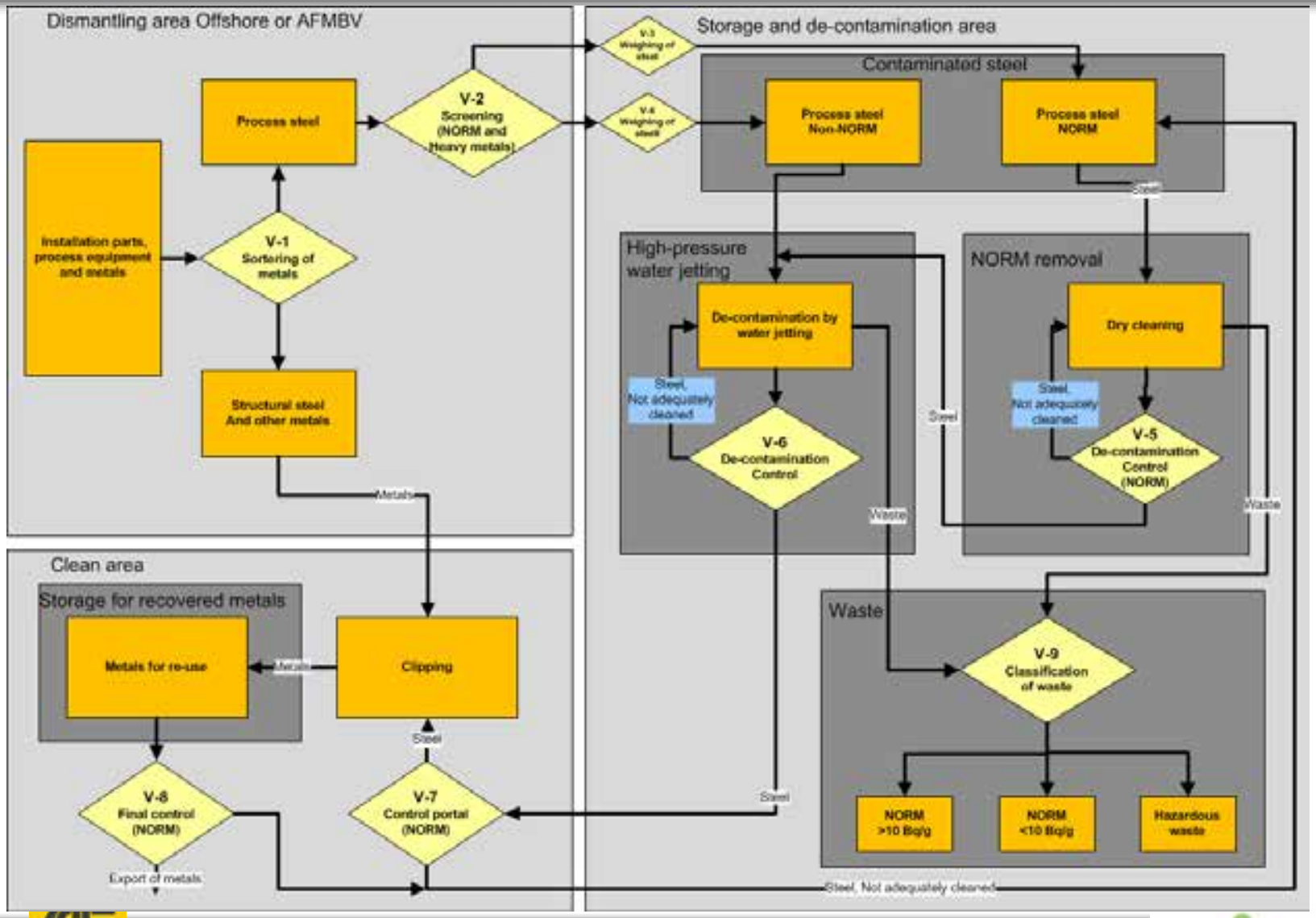
- 25 000 tons of steel removed
- 300 000 hours offshore work
- HSE: no injuries
- Completed in 19 months

AF Decom Environmenal Base Vats (AFEBV)

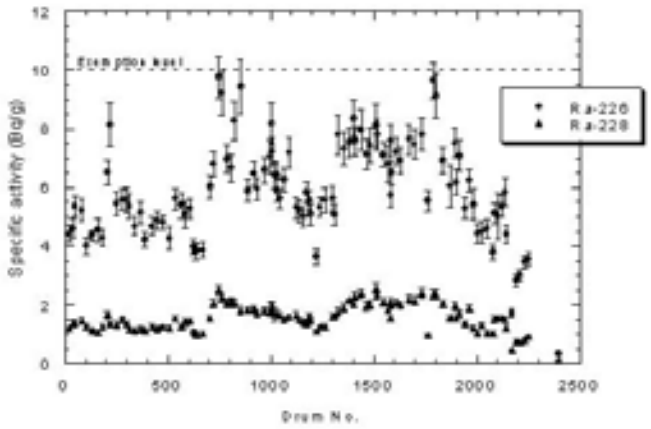


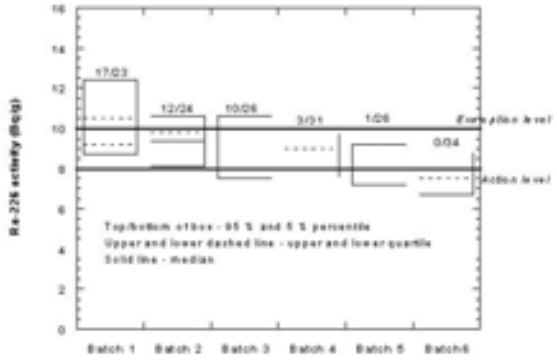
Dismantling work at AFEBV

Mass Flow at AFMBV

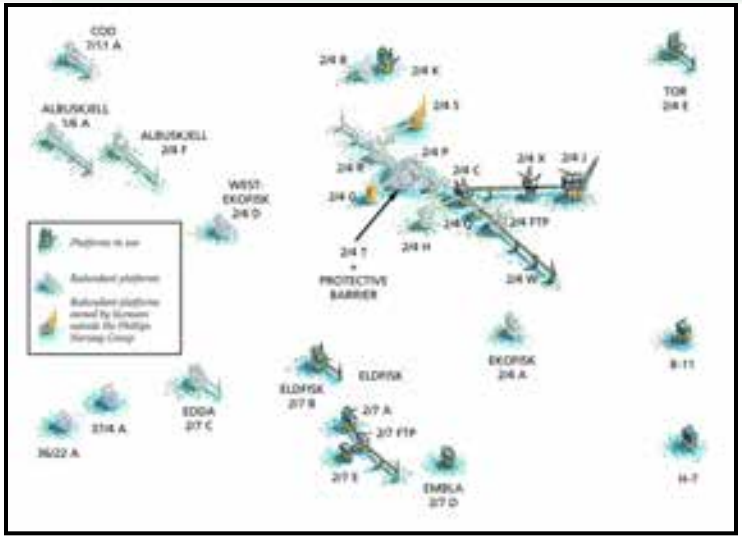


NORM in Decommissioning
Example: Brent Spar





NORM in Decommissioning
Example: Ekofisk



Installation	NORM Occurrence	NORM amounts tons
Cod 7/11A	Not found	none
Albuskjell 1/6A	Production Header (W), Separators	0.1 - 4
Albuskjell 2/4F	Production Header (W), Separators	0.1 - 4
Edda 2/7C	Not found	none
Tommeliten module	Not found	none
West Ekofisk 2/4D	Pig launcher Unit	0.2
Ekofisk 2/4R	Possible TENORM in Ula line	1 (if present)
Booster 36/22A	Not found	none
Booster 37/4A	Not found	none
Papa 2/4P	Export pipe	1 - 2.6
Tank topside 2/4T	Oil metering, Export pipe to Papa	3
Total		5.4 – 14.8
Mean value		0.5 - 1.3

New classification method based on handheld instruments and sampling

The method combines the swiftness and cost efficiency of handheld measurements with the accuracy and reliance of sampling and analysis

Matrix:
- Fairly uniform waste containing rust and scale
- Practically no Ra-228 due to age
- Known origin – easy to include Pb-210

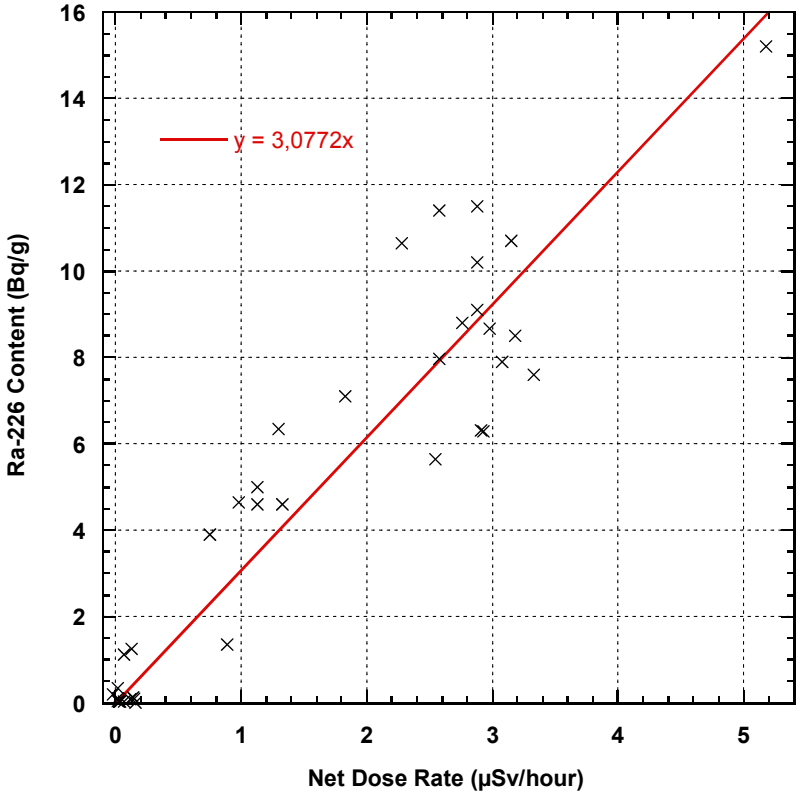


Fig 1: Plot of Net Dose Rate vs. Ra-226 Content for NORM-containing waste drums from the EPRD project at AF Decom Environmental base Vats (linear regression: Forced Zero, n = 57, r-square = 0.88)

New method: Implementation

Procedure:

1. Drum is measured on two sides using a dose rate meter
2. Mean value is compared with the classification matrix
3. Measurement < 0.2 µSv/h: non-radioactive
4. Measurement > 0.2 µSv/h and < 1.7 µSv/h : NORM Cat II
5. Measurement > 1.7 µSv/h: sample taken and analysed

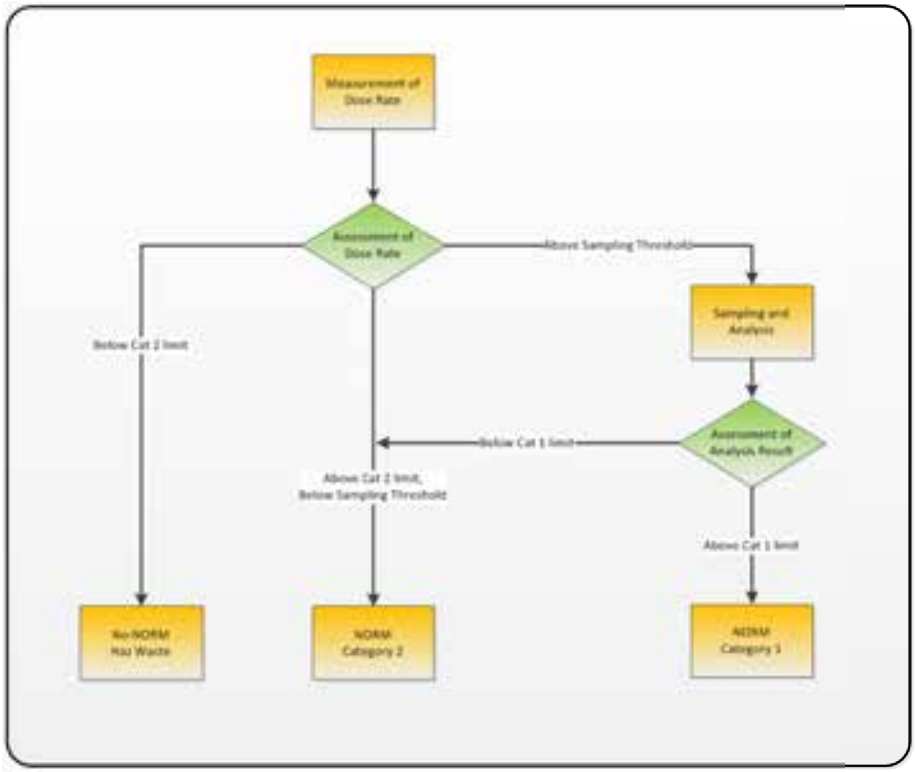


Table 2: Calculation of the concentrations of ^{228}Ra, ^{226}Ra, ^{210}Pb and the sum of the three based on the calculation data given in Table 1. The three classification and action limits are given at the bottom of the table.

Net Dose Rate (µSv/hour)	Calculated Activity Concentration (Bq/g)				Classification/Action
	^{228}Ra	^{226}Ra	^{210}Pb	Sum	
0,1	0,3	0,0	0,2	0,5	
0,2	0,6	0,0	0,3	0,9	**Category 2 limit**
0,3	0,9	0,0	0,5	1,4	
0,4	1,2	0,0	0,6	1,9	
0,5	1,5	0,0	0,8	2,3	
0,6	1,8	0,0	0,9	2,8	
0,7	2,2	0,1	1,1	3,3	
0,8	2,5	0,1	1,2	3,7	
0,9	2,8	0,1	1,4	4,2	
1,0	3,1	0,1	1,5	4,7	
1,1	3,4	0,1	1,7	5,1	
1,2	3,7	0,1	1,8	5,6	
1,3	4,0	0,1	2,0	6,1	
1,4	4,3	0,1	2,1	6,5	
1,5	4,6	0,1	2,3	7,0	
1,6	4,9	0,1	2,4	7,5	
1,7	5,2	0,1	2,6	7,9	**Sampling threshold**
1,8	5,5	0,1	2,7	8,4	
1,9	5,8	0,1	2,9	8,8	
2,0	6,2	0,1	3,0	9,3	
2,1	6,5	0,2	3,2	**9,8**	**Category 1 limit**
2,2	6,8	0,2	3,3	10,2	
2,3	7,1	0,2	3,5	10,7	
2,4	7,4	0,2	3,6	11,2	
2,5	7,7	0,2	3,8	11,6	
2,6	8,0	0,2	3,9	12,1	
2,7	8,3	0,2	4,1	12,6	
2,8	8,6	0,2	4,2	13,0	
2,9	8,9	0,2	4,4	13,5	
3,0	9,2	0,2	4,5	14,0	
3,1	9,5	0,2	4,7	14,4	
3,2	9,8	0,2	4,8	14,9	
3,3	10,2	0,2	5,0	15,4	
3,4	10,5	0,2	5,1	15,8	
3,5	10,8	0,3	5,3	16,3	

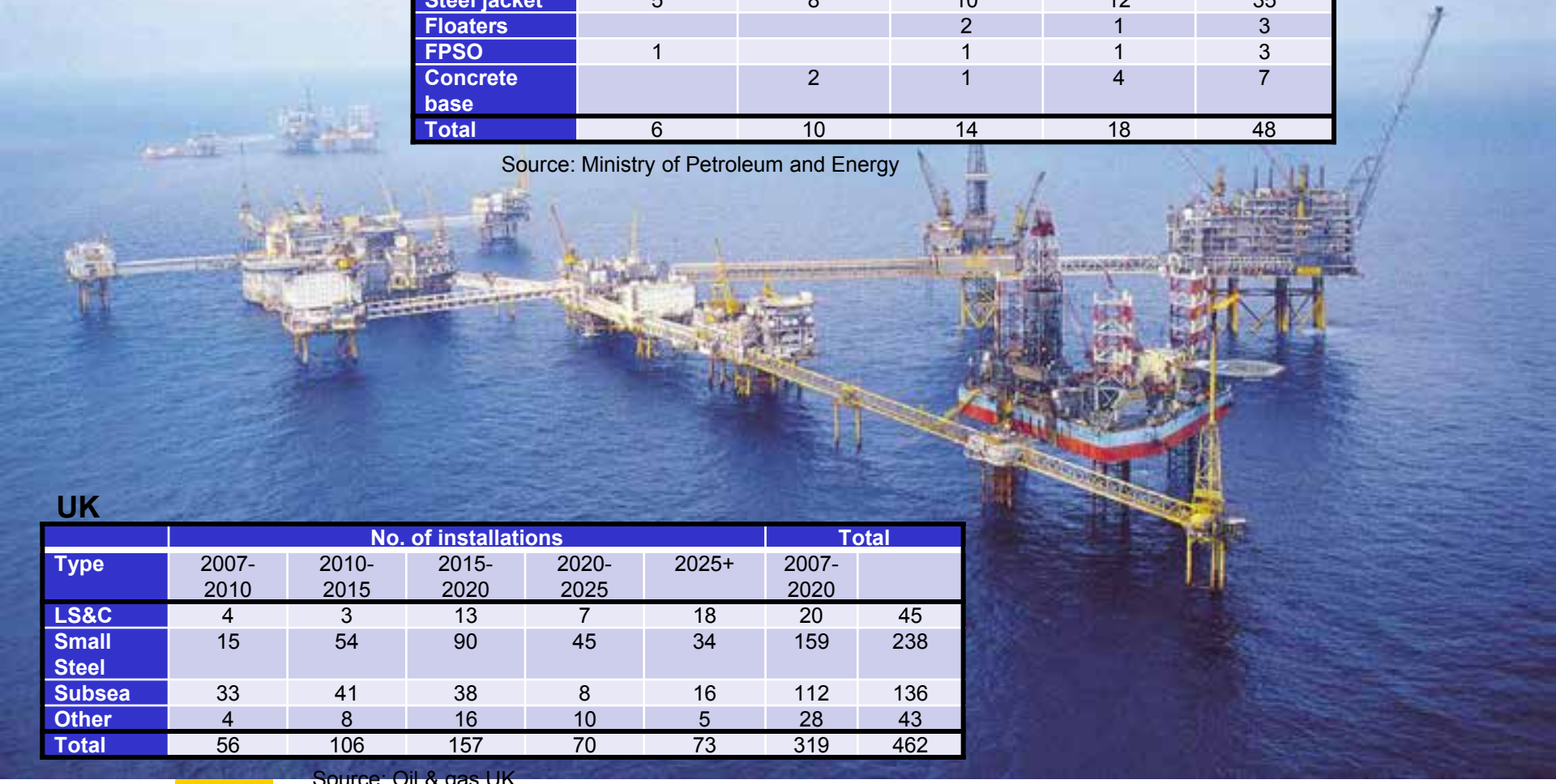
Category 2 limit :	0.2 µSv/hour (compares to the 1 Bq/g exemption level)
Sampling threshold :	1.7 µSv/hour
Category 1 limit :	10 Bq/g

Decommissioning: No. of installations

Norway

Type	No. of installations				Total
	2000 - 2005	2005 - 2010	2010 - 2015	2015 - 2020	2000-2020
Steel jacket	5	8	10	12	35
Floaters			2	1	3
FPSO	1		1	1	3
Concrete base		2	1	4	7
Total	6	10	14	18	48

Source: Ministry of Petroleum and Energy



UK

Type	No. of installations					Total	
	2007-2010	2010-2015	2015-2020	2020-2025	2025+	2007-2020	
LS&C	4	3	13	7	18	20	45
Small Steel	15	54	90	45	34	159	238
Subsea	33	41	38	8	16	112	136
Other	4	8	16	10	5	28	43
Total	56	106	157	70	73	319	462

Source: Oil & gas UK