



# NORM Management in Decommissioning of Petroleum Installations

Bjørn Smits, AF Decom Offshore





# AF Decom Offshore

- Turnover of EUR 59 million (2009)
- 150 employees
- Subsidiary of the AF Group

## Services:

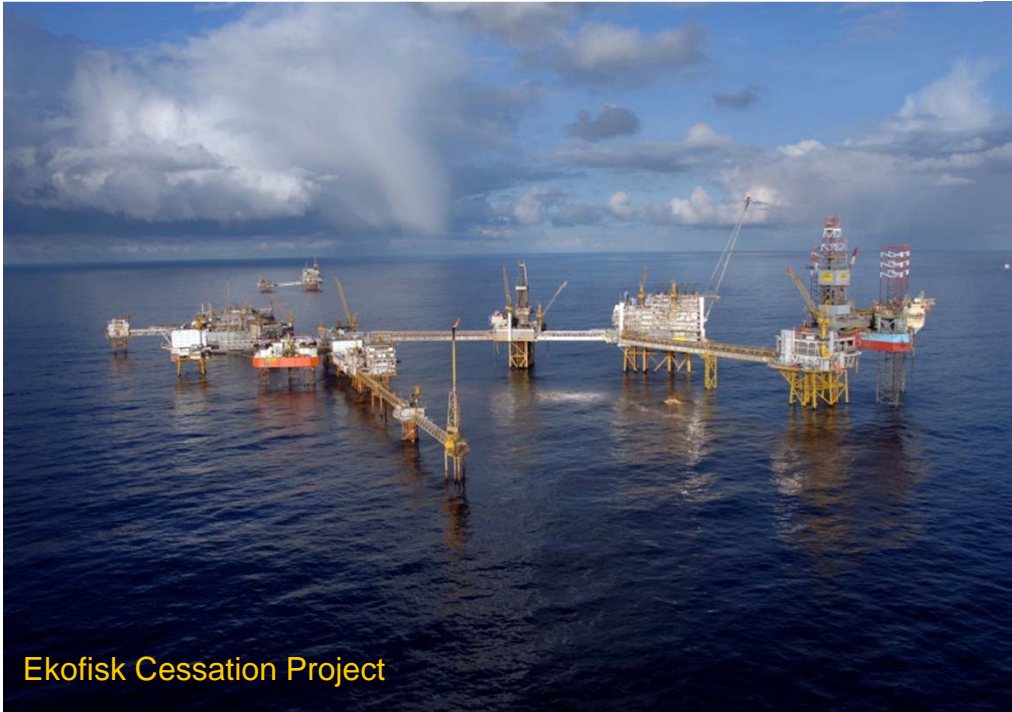
- Program management
- Project management
- Engineering
- Feasibility studies
- Removal of offshore installations
- Onshore recycling

Picture: Indefield Kilo, North Sea, UK









Ekofisk Cessation Project



H7 – B11



Dales Voe – new environmental base at Shetland



Statfjord C Loading Buoy



# Reversed Installation





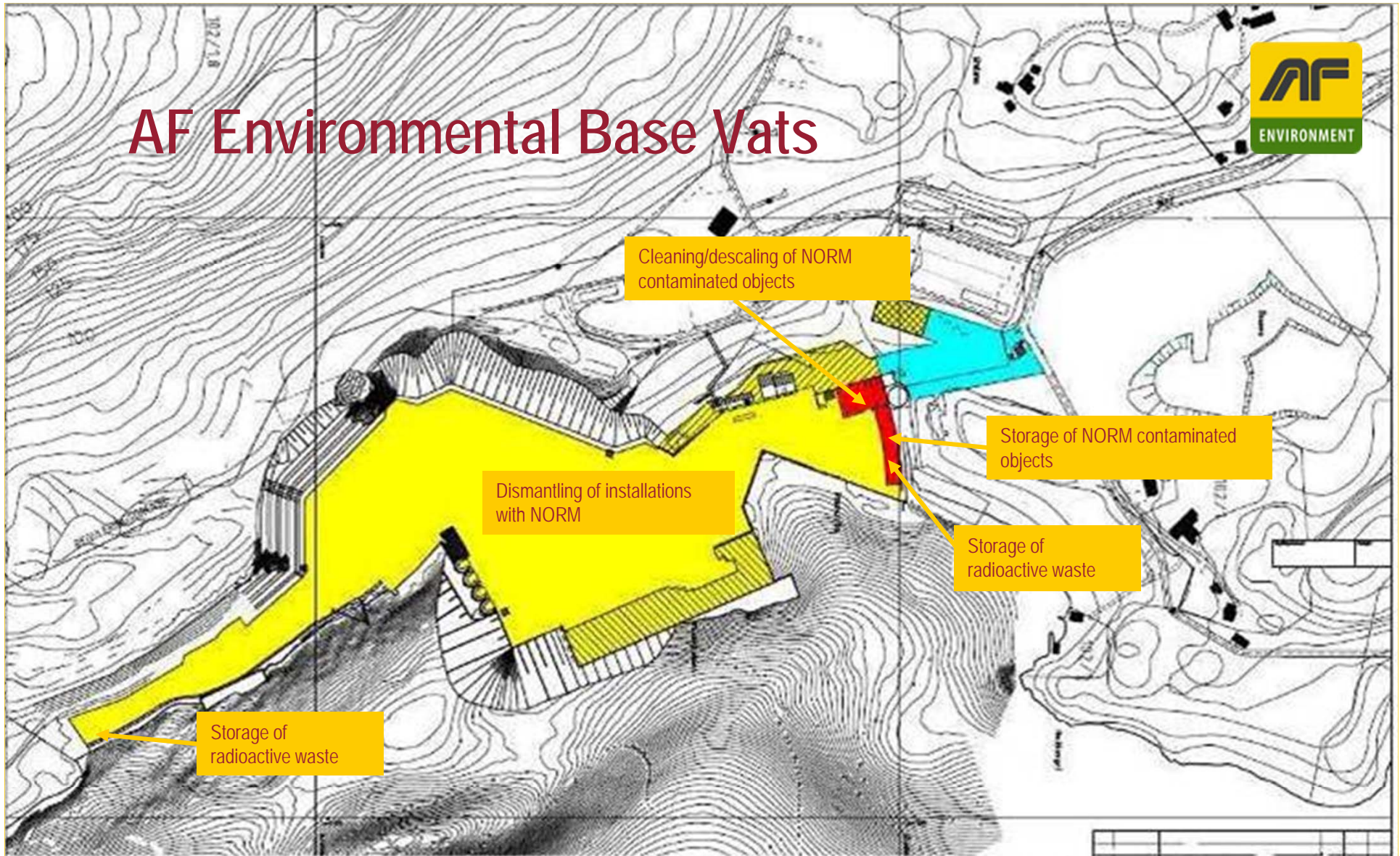








# AF Environmental Base Vats



PLAN  
1:5000

FORPLANEN:

- AREAL TIL LAGRE, BEARBEJDE OG FØRBEREDE AF ENVIRONMENT ANVÆL  
MED TILBUDTILTAGNINGER OG UDFØRELSE AF UDFØRELSE
- AREAL TIL  
AREAL TIL METAL, LAGRE, SORTERE OG BEARBEJDE AF AFFALL MED HØJ  
TE INHOLD AV FØLLAVANGSSTOFFER
- AREAL TIL METAL, LAGRE, SORTERE OG BEARBEJDE AF AFFALL MED HØJ  
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- AREAL TIL METAL, LAGRE, SORTERE OG BEARBEJDE AF AFFALL  
MED HØJ TE INHOLD AV FØLLAVANGSSTOFFER

AF Miljøbase Vats  
Områdeinndeling

Norconsult

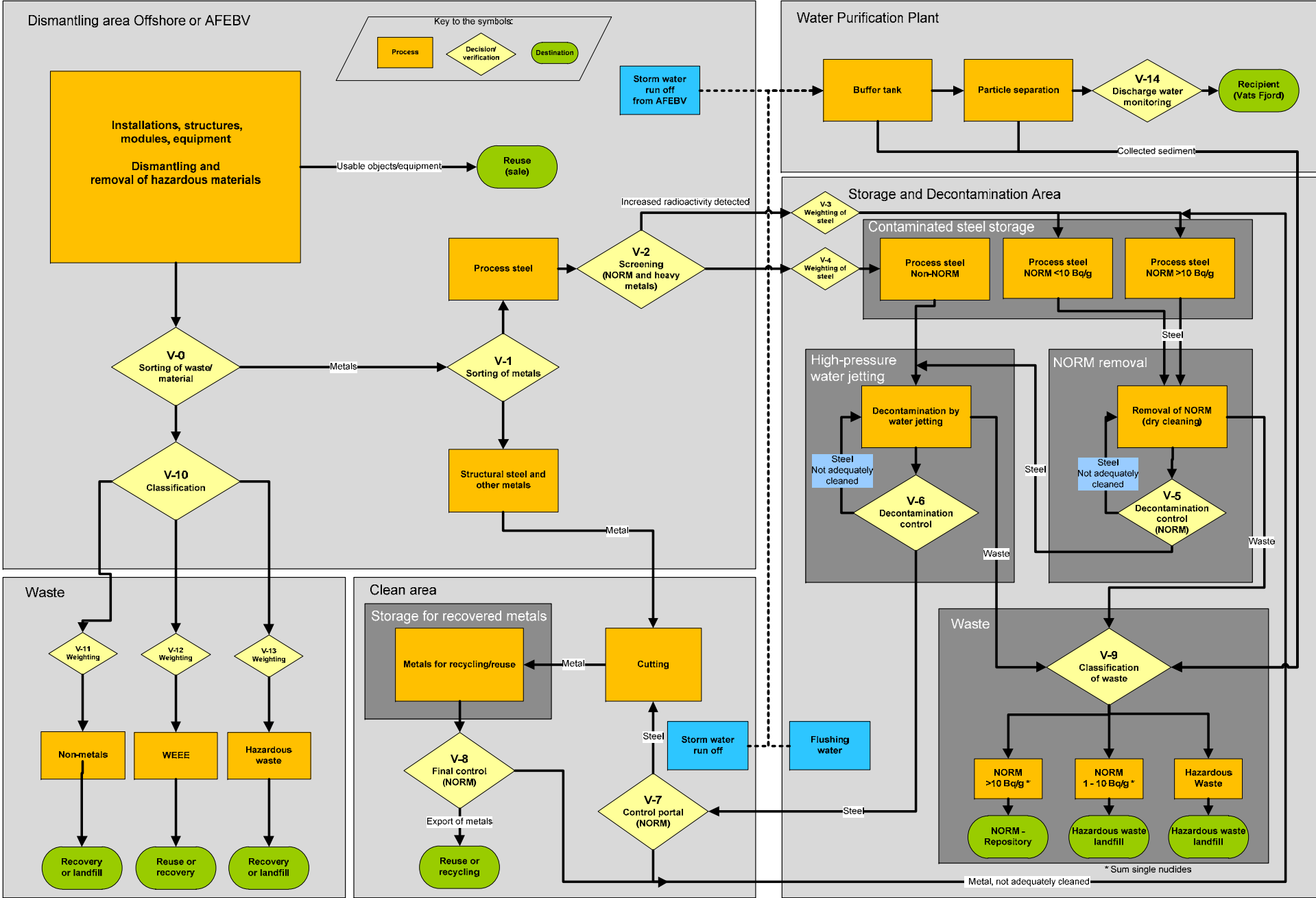


# Naturally Occurring Radioactive Material (NORM)





# Process chart / material flow AF Decom Offshore













Pipe/ content	Tag symbol	Color	Limit	Comments
LEL H <sub>2</sub> S	Pipe ID.		>10% > 6ppm /9 mg/m <sup>3</sup>	Tag with paint value on pipe if value is above 10% Tag with paint value on pipe if value is above 6 ppm /9 mg/m <sup>3</sup>
Cut lines		Orange		
Clean pipes		Green		For Pipes does not contain hazardous substances. Typical pipes as e.g. compressed air, water.
Diesel		Blue		Line to be drawn along the entire side of pipe  No marking for drainage onshore
Lube oil				
Hydraulic				
Crude oil/gas (process pipes and system) incl mercury		Red	Radioactivity not above background level	All process pipe/systems are assumed contaminated with Mercury and other heavy metals. Line to be drawn along the entire side of the pipe
Elementary (liquid) mercury in process pipes and systems		Red	Elementary mercury detected or suspected	Circle to be added on tag symbol for process pipes and systems
NORM		Yellow	Radioactivity detected	The yellow line indicates which part of the pipe/system contains NORM. Line to be drawn along the entire side of the pipe

















## NORM Area

- A NORM area is an area where there is risk of exposure to NORM. The requirements to the NORM area comply with the requirements in The Radiation Protection Regulations -Chapter IV.
- A limited area defined as NORM area is established where:
  - there is dismantling work of NORM-marked process steel going on, or it is not clarified whether the process steel is containing NORM or not.
  - NORM or NORM-marked process steel is stored.
  - work with cleaning of NORM-infected objects is taking place.

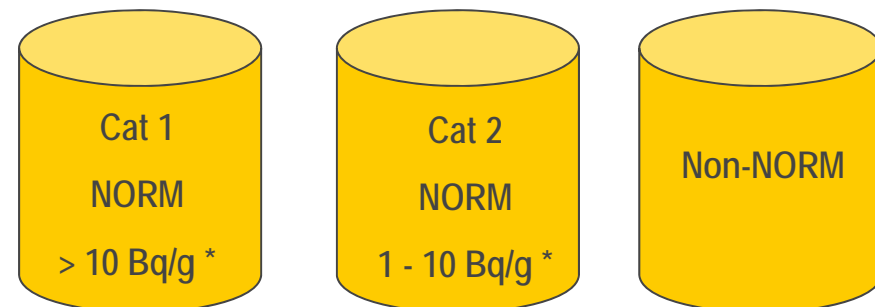


# Classification of the waste

Basis: Inhomogeneous material

Method:

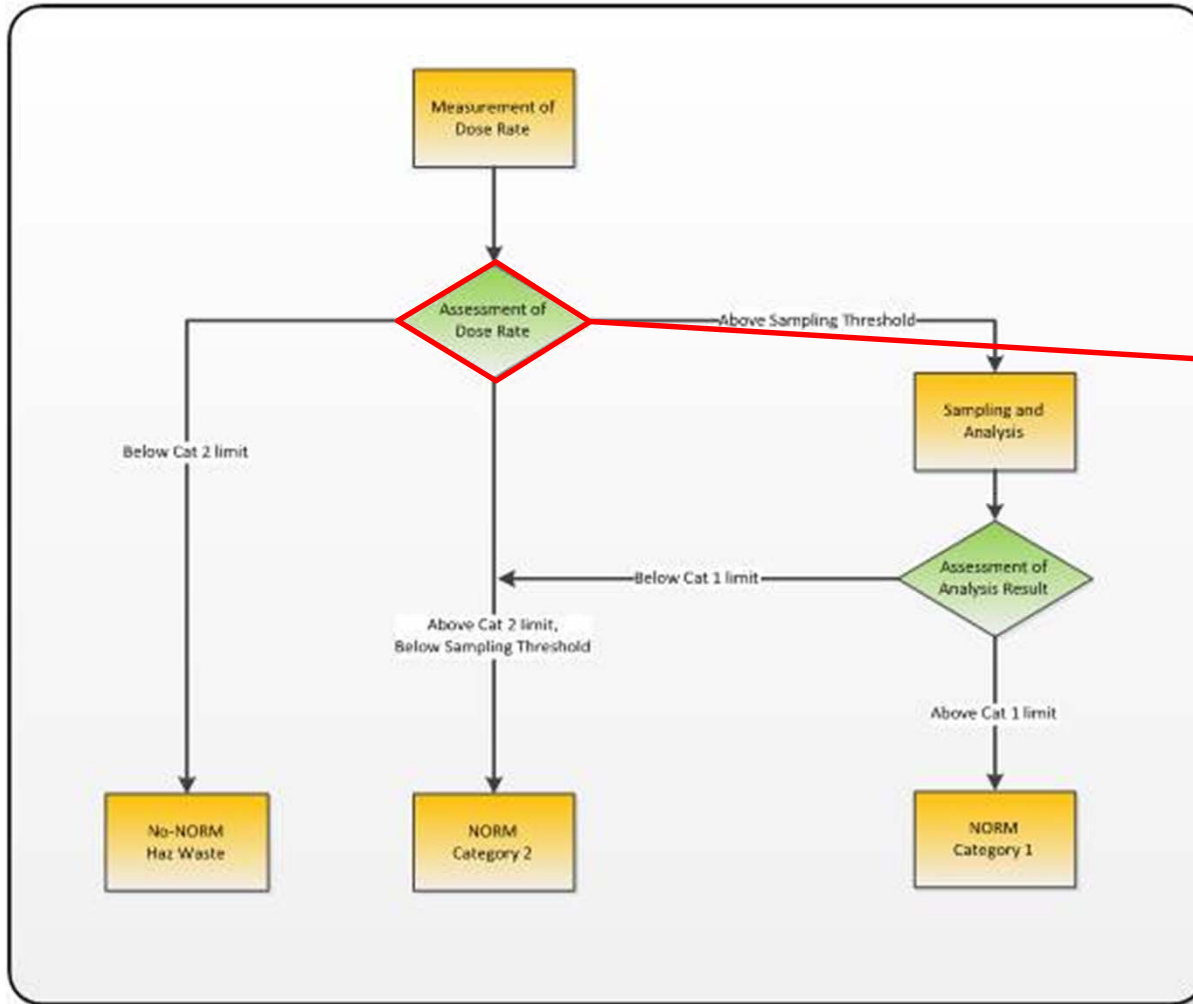
1. Measurement of dose rate  
(on two opposite sides)
2. Determination of radiation level
3. Sampling and analysis
4. Classification



\* Sum single nuclides  $^{226}\text{Ra}$ ,  $^{228}\text{Ra}$  and  $^{210}\text{Pb}$



# Classification Method



Net Dose Rate (µSv/hour)	Calculated Activity Concentration (Bq/g)				Classification/Action
	<sup>228</sup> Ra	<sup>232</sup> Ra	<sup>235</sup> U	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	



# Control of decontamination

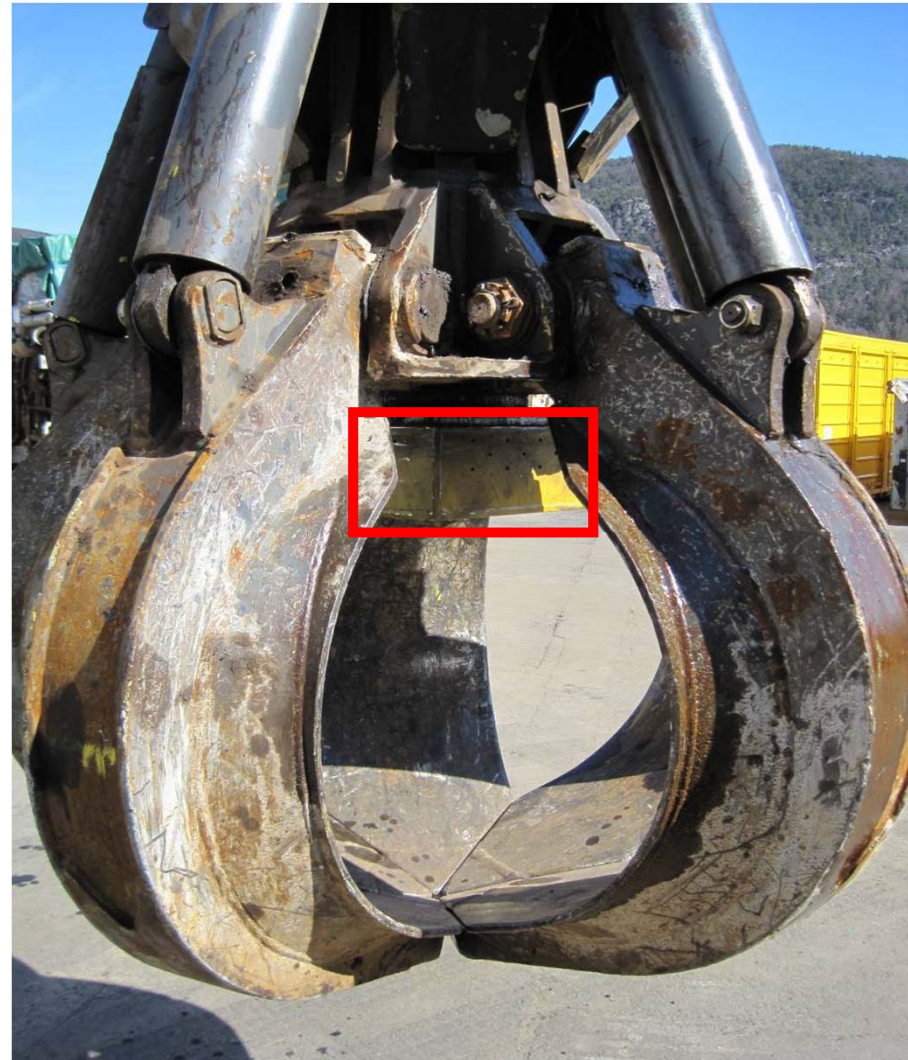
- Activity level after decontamination measured using a contamination monitor
- All decontaminated metals from the production systems (oil and gas systems) go through a radiation portal monitor





# Final material verification

- All steel shipped from the base to recycling/smelting is verified concerning radioactivity
- Grapple mounted radiation detection system
- Detection limit 0,1 Bq/g



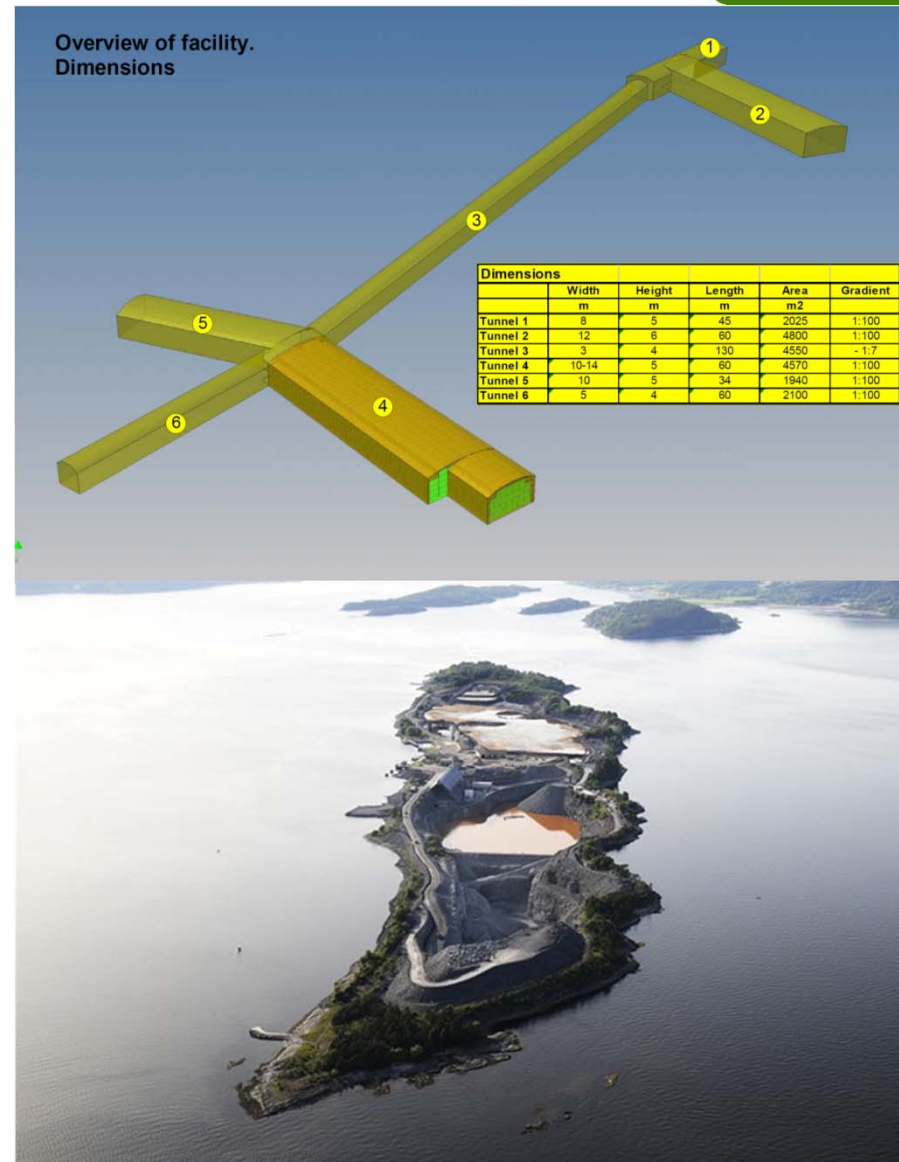


# Disposal of radioactive waste

Radioactive waste with a total activity concentration  $>10 \text{ Bq/g}$  is delivered to Stangeneset NORM Repository at Sløvåg (Wergeland-Halsvik)

Radioactive waste with a total activity concentration  $<10 \text{ Bq/g}$  is delivered to Langøya by Holmestrand (NOAH).

The same type of waste, **Non-radioactive**, is also delivered to Langøya





# Environmental Monitoring

- Sampling and analysis of activity concentrations in process water (every batch)
- Quarterly sampling and analysis of activity concentrations in discharge water from the base
- Annual sampling and analysis of water, sediment and marine biota (environmental monitoring program)
- So far no increased levels of radioactivity in the environment





## Analysis of radionuclides



Order No. 111018-02  
 Contractor: Zpire Limited  
 Address: P.O. Box 41 NO 2027 Kjeller, Norway

Kind of samples: Water samples

Analysis results			Sample 1	Sample 2		
Name of the sample			0652	0653		
Specified description			Vann 3.kv2011 AFMBV	Vann Raunesbecken		
Nuclide	Units	Method				
U-238-series						
C <sub>U-238</sub>	[mBq/l]	α	24 ± 4	6 ± 2		
C <sub>U-234</sub>	[mBq/l]	α	30 ± 5	6 ± 2		
C <sub>Ra-226</sub>	[mBq/l]	γ	< 6	< 6		
C <sub>Pb-210</sub>	[mBq/l]	γ	< 10	14 ± 6		
C <sub>Po-210</sub>	[mBq/l]	α	2 ± 1	9 ± 2		
C <sub>U-nat</sub>	[µg/l]		1,94 ± 0,32	0,49 ± 0,16		
Th-232-series						
C <sub>Ra-228</sub>	[mBq/l]	γ	< 4	< 4		
Dose calculation with age-specific consumption rates (German Radiation Protection Ordinance)						
D <sub>0</sub> (< 1 a)	[mSv/a]		0,012	0,060		
D (< 1 a)	[mSv/a]		0,052	0,086		
D (> 17 a)	[mSv/a]		0,006	0,009		
Dose calculation according to WHO						
Adult D (> 17 a)	[mSv/a]		0,012	0,019		

γ: Gamma-ray spectrometry

α: Alpha-particle spectrometry



# Approval/permit from NRPA



- AF Decom Offshore approved by NRPA since 2005
- Removal of petroleum installations require consent from Norwegian Authorities



Approval for the handling and storage of radioactive waste and release from the same plant for AF Decom

Approval for the use of the plant for the treatment and storage of radioactive waste, and release into the environment from the same plant, for AF Decom AS.

Issued pursuant to the Regulations of 21st November 2003 No. 1362 on Radiation Protection and the use of Radiation (Regulations on radiation protection and the use of radiation) § 5. The approval is issued on the basis of information supplied in the application dated 14<sup>th</sup> December 2004 and other information that was presented during the handling of the application. Note that this approval does not constitute an approval of the submitted documents or the enterprise's Internal Control System.

The approval applies to the handling and storage of radioactive materials pursuant to The regulations on radiation protection and the use of radiation § 5 Litra p, and release pursuant to § 5 Litra o. The approval has been issued after an assessment of the circumstances around the waste disposal as described in the application. Further, reference is made to the current principles applicable to the use of radiation, inspection/supervision, and risk assessment.

The approval is valid from today's date and to and including 31st December 2010. If all or major parts of the approval is/are not implemented, the enterprise shall submit a report to The Norwegian Radiation Protection Authority describing the scope of the enterprise's activities so that The Radiation Protection Authority can evaluate any changes it may wish to make to the approval.

If the enterprise wishes to implement major changes that may effect the storage and operational conditions, The Norwegian Radiation Protection Authority must be contacted so that the said Radiation Protection Authority can assess whether it is necessary to alter the approval, cf. The act on radiation protection and the use of radiation § 6 second part and the Regulations on radiation protection and the use of radiation § 5 fourth part. The enterprise cannot implement changes until a ruling pertaining to the altered approval has been adopted.

The Norwegian Radiation Protection Authority emphasises the importance of that it is not only the health and safety of human life but also that the protection of the environment is accommodated. This approval applies only to matters and circumstances regulated by The Act on Radiation Protection and the Use of Radiation and accompanying Regulations. The Norwegian Radiation Protection Authority draws attention to that other relevant legislation regulates the handling of waste applies to the enterprise independently of this approval for the handling and storage of radioactive waste.

**Enterprise data:**

Enterprise: A F Decom	Location: Raunes
Branch: De-commissioning.	UTM: 315550. 6593500
Petroleum industry	
Enterprise Reg. No.: 971 700 912	Municipality: Vindafjord
Postal address: Post box 34 Grefsen, 0409 Oslo	County: Rogaland

# Procedures



- AFDO-50-P-008  
Measuring and Handling of NORM
- AFDO-50-W-005  
Work with NORM (work instruction)
- AFDOV-50-P-001  
HSE Measurements
- AFDO-50-M-001  
Preparedness Plan for AFEBV

	<b>PROCEDURE</b> AFDO-50-P-008 Measuring and handling of NORM
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	<b>ARBEIDSSINSTRUKS</b>	<b>WORK INSTRUCTION</b>
	AFDO-50-W-005 Arbeid med NORM	AFDO-50-W-005 Work with NORM

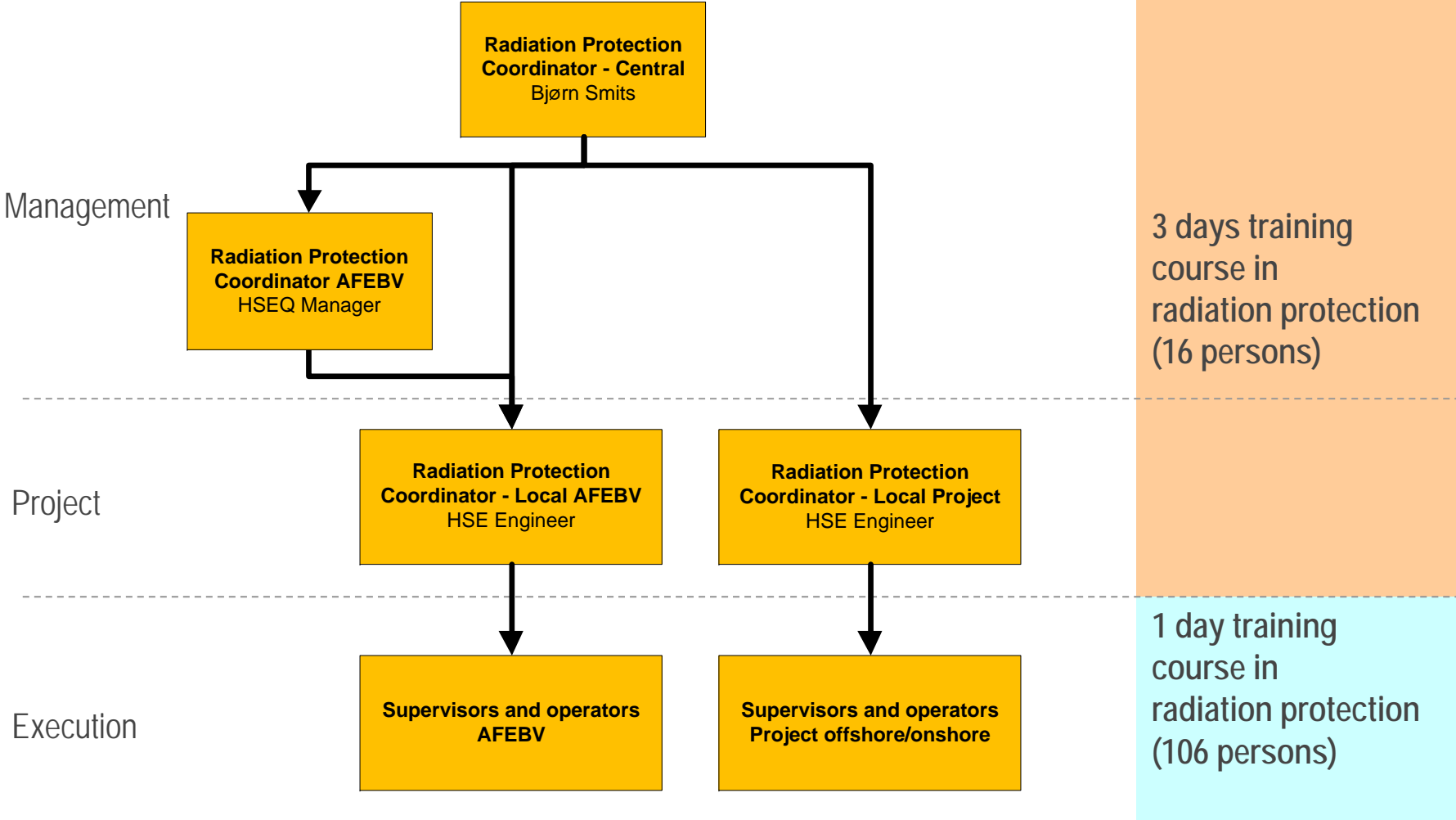
<p><b>1 GENERELT</b></p> <p><b>1.1 Formål og virkeområde</b></p> <p>Instruksen gjelder riving og rengjøring av NORM-kontaminerte objekter, fylling av fat samt lagring og transport av naturlig forekommende radioaktive materialer (NORM).</p> <p>Instruksen skal sikre at NORM, blir håndtert på en måte som ikke fører til risiko for skade på personer og miljø. Instruksen skal sikre at NORM blir behandlet i henhold til gjeldende myndighetskrav og godkjenninger.</p> <p><b>1.2 Ansvar</b></p> <p>Formann med delegert fullmakt fra plasssjef har ansvaret for:</p> <ul style="list-style-type: none"> <li>- at arbeidet gjennomføres som beskrevet i denne arbeidsinstruksen</li> <li>- at ferdig merket prosess-stål fortløpende blir flyttet fra demonteringsområdet til lagerområdene for prosess-stål.</li> <li>- at demonteringsområdet holdes rent og ryddig både under og etter arbeidet.</li> <li>- at ferdig rengjort prosess-stål fortløpende blir flyttet fra rengjøringsområdet etter gjennomført kontroll av rengjøring (V-4).</li> </ul> <p>Strålevernkoordinator-Plass (RPS-L) er ansvarlig for:</p> <ul style="list-style-type: none"> <li>- gjennomføring av merking av sortert prosess-stål (V-1), og gjennomføring av NORM-screening og merking (V-2).</li> <li>- å gjennomføre kontaminasjonskontroll etter behov.</li> <li>- at arbeidet foregår med minst mulig eksponering av personell, uten utslipp til det ytre miljø og gjennomføring av kontroll av rengjøring (V-3).</li> <li>- kontroll av materialenes renhet med hensyn til NORM (V-7 og V-8).</li> </ul> <p>HMS-ingeniør er ansvarlig for gjennomføring av kontroll av rengjøring (V-4).</p> <p><b>1.3 Definisjoner</b></p> <p><b>AFMBV - AF Miljøbase Vats</b></p> <p><b>Kontaminasjonskontroll - Måling utført for å avgjøre om en gjenstand er radioaktiv kontaminert eller ikke.</b></p>	<p><b>1 GENERAL</b></p> <p><b>1.1 Purpose and scope</b></p> <p>The instructions apply during dismantling and cleaning of NORM-contaminated objects, filling of collection units, storage and transportation of naturally occurring radioactive materials (NORM).</p> <p>The instruction shall ensure that NORM is handled in a manner that ensures the safety of personnel and environment. The instruction shall ensure that NORM is treated in accordance with applicable regulatory requirements and approvals.</p> <p><b>1.2 Responsibilities</b></p> <p>The Foreman as delegated by the Site Manager is responsible for</p> <ul style="list-style-type: none"> <li>- the implementation of this work instruction.</li> <li>- the labeled process steel continuously being moved from the Dismantling areas to the storage areas for process steel.</li> <li>- keeping the Dismantling areas clean and orderly, both during and after work.</li> <li>- cleaned process steel continuously being moved from the cleaning area after completion of inspection of cleaning (V-4).</li> </ul> <p>On-site Radiation Protection Manager (RPS-L) is responsible for</p> <ul style="list-style-type: none"> <li>- implementing the labeling of sorted process steel (V-1), and implementation of NORM screening and labeling (V-2).</li> <li>- implementing contamination control as needed.</li> <li>- ensuring that the work is done with minimum exposure of personnel, with no emissions to the external environment and the implementation of the control of cleaning (V-3).</li> <li>- checking the purity of the materials with respect to NORM (V-7 and V-8).</li> </ul> <p>HSE engineer is responsible for implementing the control of cleaning (V-4).</p> <p><b>1.3 Definitions</b></p> <p><b>AFEBV - AF Environmental Base Vats</b></p> <p><b>Contamination control - Measurements performed to determine if an object is NORM contaminated or not.</b></p>
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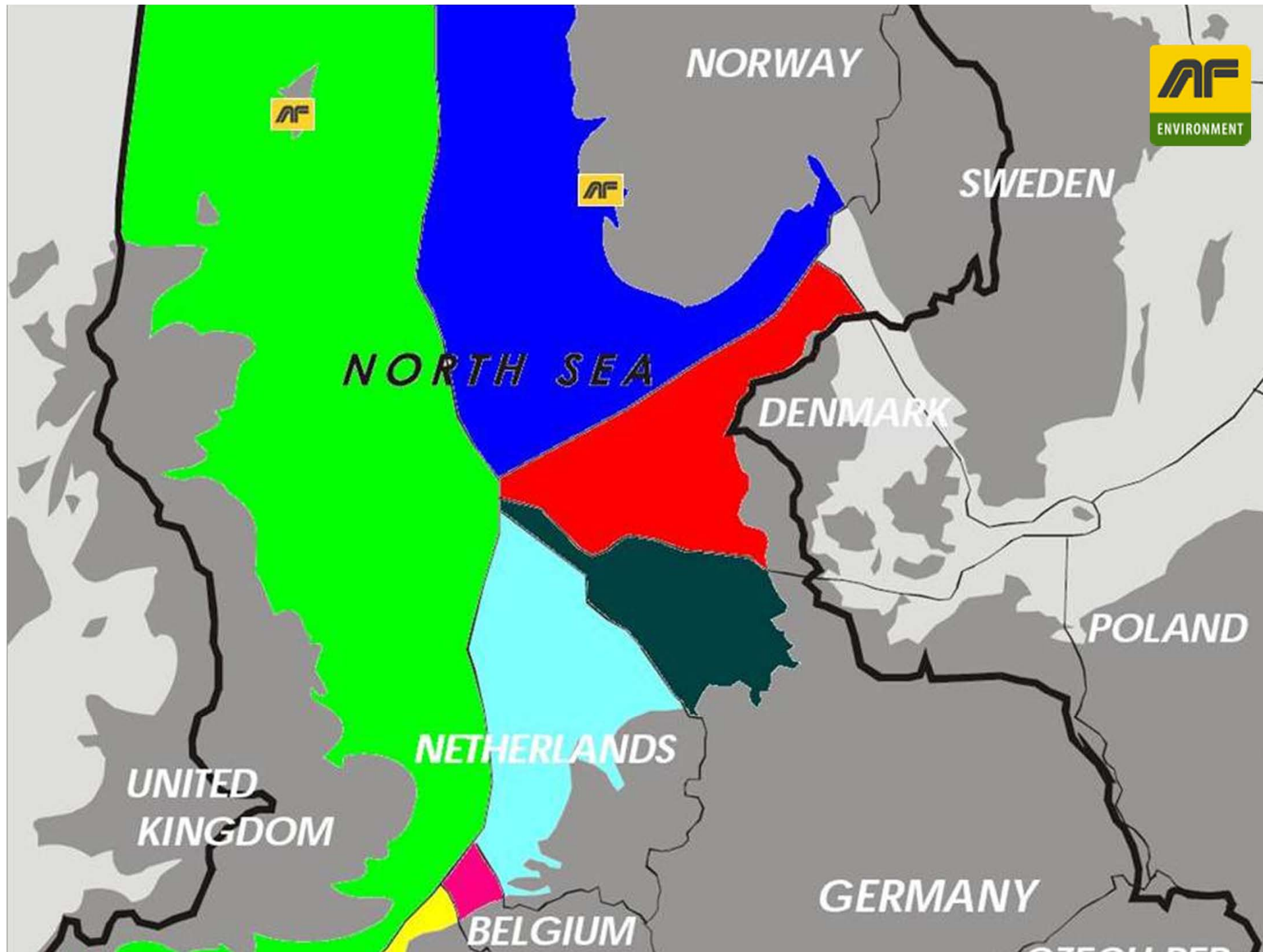
Identification	PI
AFDO-50-P-008 Measuring and handling of NORM	DI

Identification	Prepared by:	Verified by:	Approved by:	Rev / Date:	Page
AFDO-50-W-005 Arbeid med NORM / Work with NORM	JOS	JOS	JOS	07/15.06.11	1 of 12



# Radiation Protection Organisation









Thank you for your attention