

# Identification, Handling and Disposal of NORM in the Norwegian Petroleum Industry

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# Petroleum Industry NORM Overview (1)



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Oil industry NORM originates as a precipitate of Group II elements. When present as waste it is usually in the form of barium sulphate.

The dominating nuclides are  $^{226}\text{Ra}$  and  $^{228}\text{Ra}$ , and in some cases  $^{210}\text{Pb}$ .

$^{226}\text{Ra}$  is a long-lived alpha emitter (half life 1600 years) originating from the  $^{238}\text{U}$  series.

$^{228}\text{Ra}$  is an beta emitter with a half life of 5.75 years originating from the  $^{232}\text{Th}$  series.



*Sampling of NORM containing sludge.*

Scale type	Main constituent	Main radionuclides	Production type
Sulphate scale	Ba/Sr sulphate	$^{226}\text{Ra}$ , $^{228}\text{Ra}$	Oil
Carbonate scale	Ca carbonate	$^{226}\text{Ra}$ , $^{228}\text{Ra}$	Oil
Lead scale	Steel	$^{210}\text{Pb}$	Gas
Sulphide scale	Iron sulphide	$^{226}\text{Ra}$ , $^{228}\text{Ra}$ , $^{210}\text{Pb}$	Oil and gas

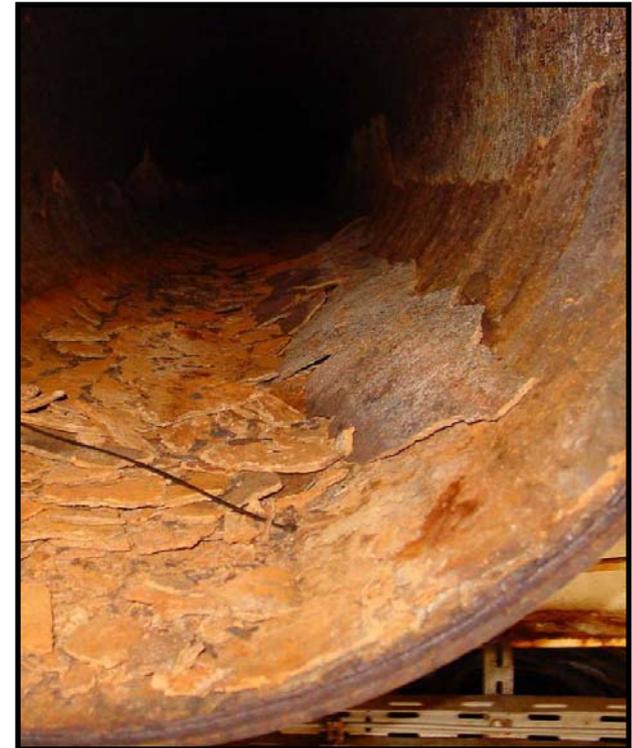
# Petroleum Industry NORM Overview (2)



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Oil company	Mass (tons)	Composition (weight %)				
		Water	Heavy oil components	Sulphates	Corrosion products	Sand/clay
Company A	166	23.6	7.4	45.7	8.5	14.8
Company B	4.1	15.9	1.4	77.9	2.0	2.8
Company C	0.5	11.8	1.5	75.4	6.8	4.5
Company D	17.0	45.4	6.6	39.0	6.1	2.9

Oil company	Activity concentration (Bq/g)		
	<sup>226</sup> Ra	<sup>228</sup> Ra	<sup>210</sup> Pb
Company A	21.5 (9.7 – 74.1)	11.2 (3.3 – 28.9)	2.4 (<0.2 – 11.8)
Company B	19.3 (16.3-23.6)	7.3 (6.4-8.6)	2.7 (2.0-3.7)
Company C	20.8	9.6	1.8
Company D	40.4 (4.9-100)	3.7 (0.4-13.3)	13.8 (2.3-49)

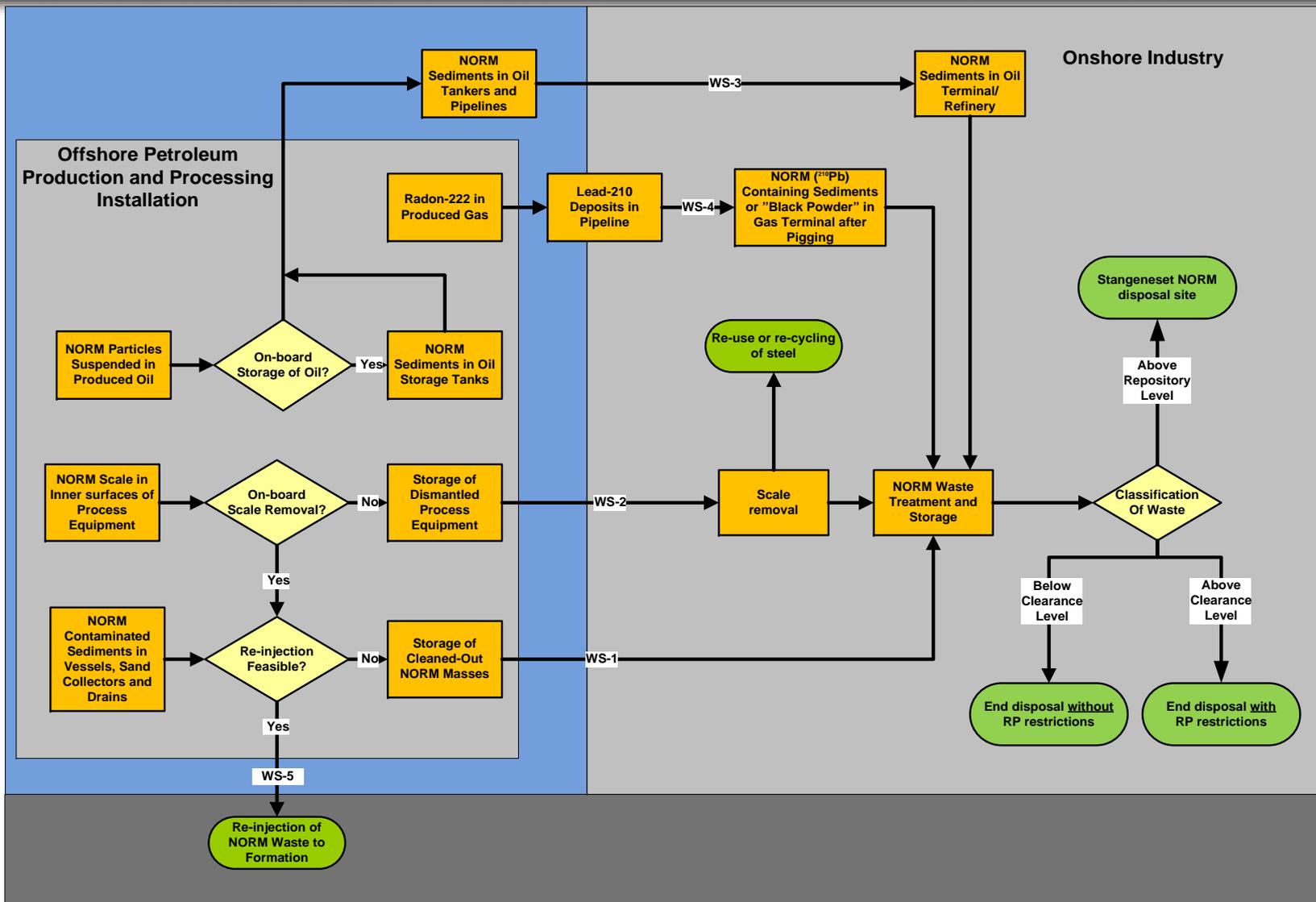


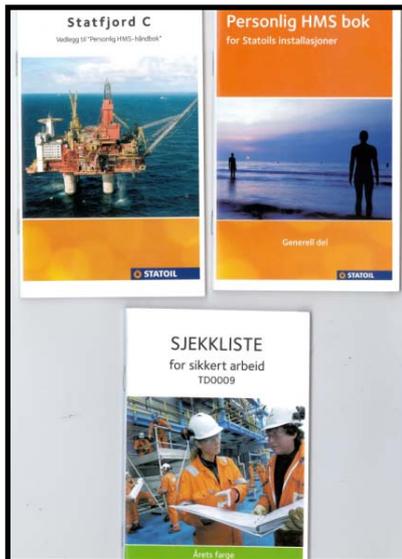
*Ba,Sr sulphate Scale in oil export pipe.*

# Petroleum Industry NORM Waste Stream



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**NORM identification and handling is included in the corporate HSE systems.**

**NORM work is regulated by “Work Permits” and “Safe Job Analyses”.**

**Procedures includes:**

Administrative/legislative issues.

Identification and classification.

Use of protective equipment.

Controlled Areas.

Conditioning and Transport.

**The typical doses to workers are low: < 0.05 mSv/year and < 0.5 mSv/year for offshore and onshore workers, respectively.**

**The radiation protection measures are almost entirely focused on avoiding internal exposure through inhalation.**

**Each installation has an appointed RPS, typically the Safety Officer or HSE Officer. All workers who are in contact with NORM has been trained in personal protection measures.**

# Where to find NORM



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## Oil production

Production tubulars

Christmas trees

Risers

Oil-water separators

Topside tubes before  
oil-water separation

Water discharge system

## Gas production

Anywhere in the system  
from risers to flares

# Decommissioning



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**In decommissioning projects NORM is typically included as a part of the tender documentation. (important because of possible trans-boundary issues)**

**Prior to execution of projects surveys are performed to identify all occurrences of NORM (and other hazardous materials).**

**“Front runners” then remove NORM and other hazardous materials leaving the “clean” component and structural steel to be dismantled.**

**Experience data indicate typically up to 4 tons of NORM/installation.**



*Author pretending to monitor for NORM on Ekofisk platform*

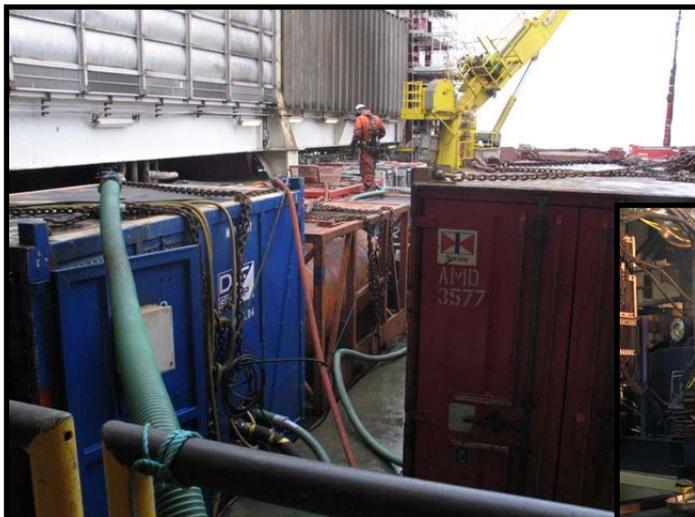


*NORM lay-down area at Stord (Maureen alpha)*

# Re-injection of NORM

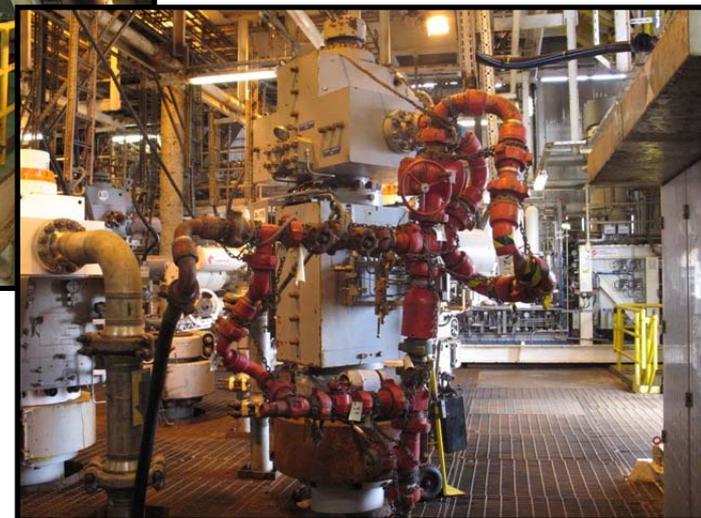


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*Slurrification of NORM through cuttings re-injection unit*

*Pumping NORM material from storage tanks*



*Injection of NORM slurry in waste well*

**Re-injection is the preferred method for NORM disposal, but limited to intra-field material (London Dumping Convention). Therefore availability of waste-wells is crucial.**

# High-Pressure Water-Jetting (Chemtech)



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**HPWJ (> 2000 bar) has been the preferred NORM decontamination method in Norway since 1995. Several specially designed plants perform decontamination on a routine basis. The used water (with NORM) is collected in settling tanks before emission. The NORM material is retrieved and stored. The method works very well on easily accessible components, e.g. production tubulars. HPWJ does not create secondary waste, but releases activity to the environment (activity < 1 Bq Ra-226/litre)**



# Reuse and recycling



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*Cleaned production tubulars at Chemtech yard*



*Cleaned process equipment (stainless steel) from Frøy.*

**Decontaminated components can be reused but are most often recycled.  
To improve reuse it is important that harmonized cleanliness criteria is implemented internationally.**

# End disposal of Exempted Waste



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*Fly ash repository.*



*Monitoring of radioactivity at fly ash repository.*

**Handling, treatment and end disposal of exempted materials will be regulated in the new legislation.**

**Companies involved in these activities will work under regulatory control.**

**End disposal options will have to be approved.**

**The main challenge for the waste industry is the fact that NORM waste almost always includes additional hazardous components, e.g. oil/wax and heavy metals incl. Hg and As.**

# NORM Temporary Storage



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*NORM temporary storage at CCB base.*



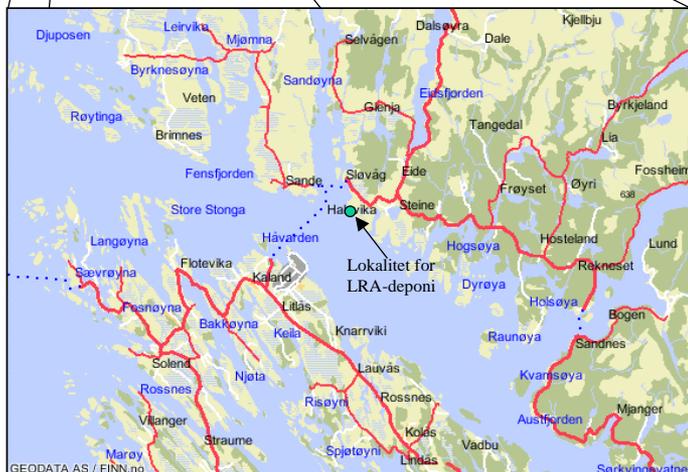
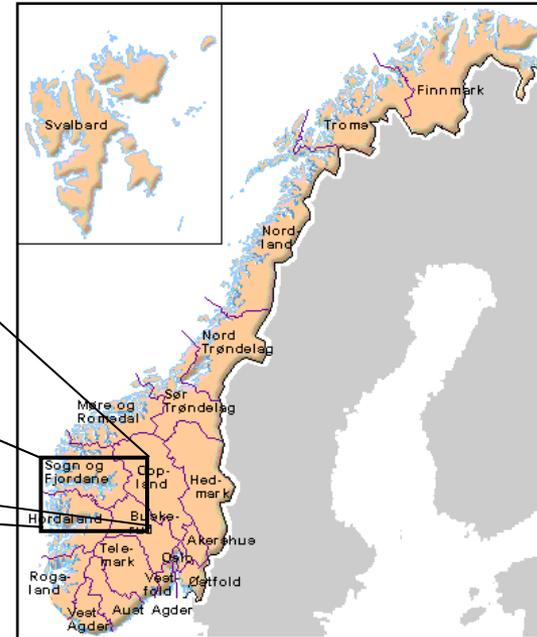
*Typical separator mass NORM.*

**NORM from the offshore oil and gas installations are stored in HDPE drums in steel containers in secured areas on the service bases.**

# Stangeneset NORM Disposal Site Location



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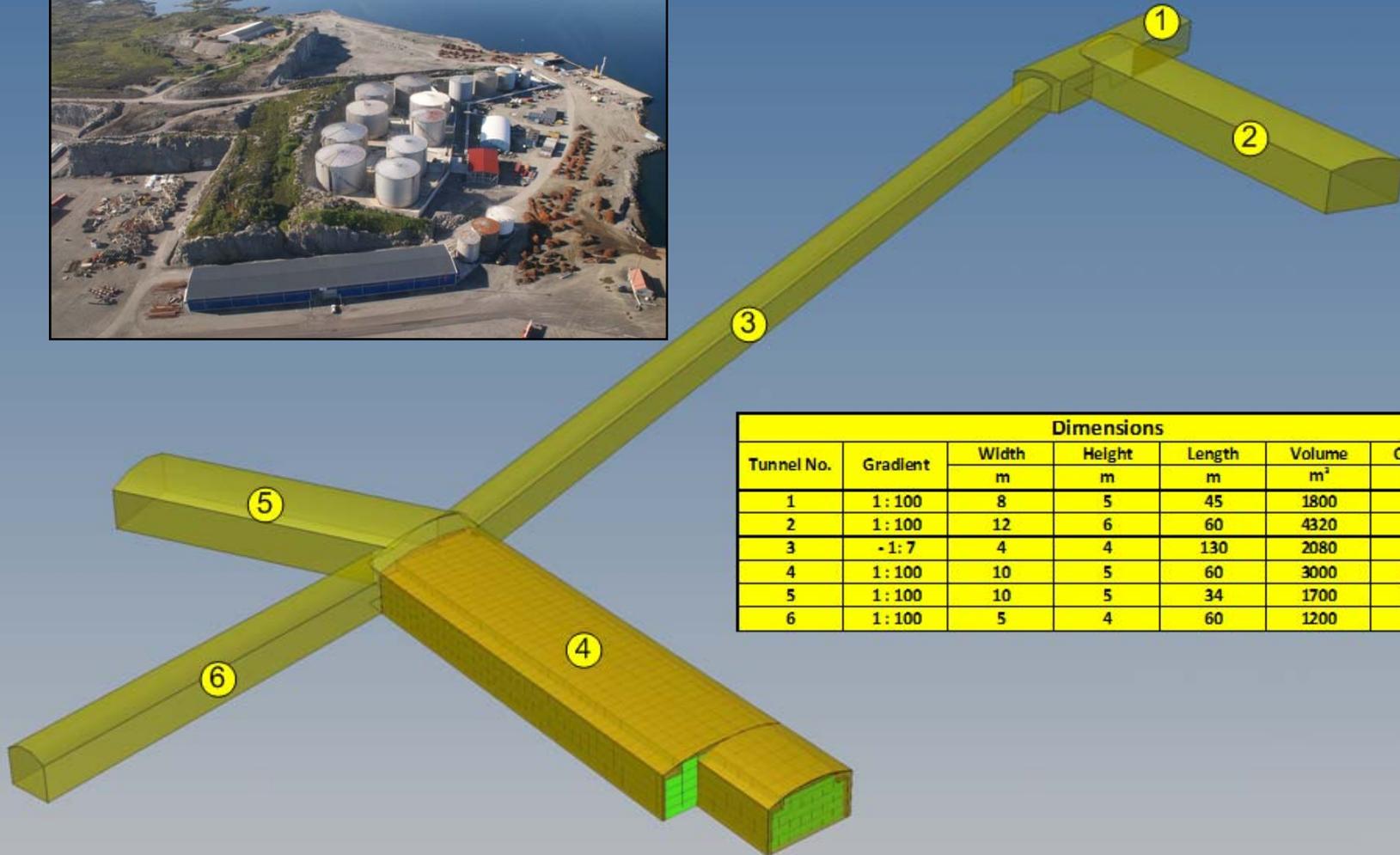


**The disposal site is located at Sløvåg in Sogn og Fjordane County, Norway.**  
**The facility was opened in October 2008.**  
**Capacity to receive all European oil and gas industry generated NORM.**

# Stangeneset NORM Disposal Site Overview



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Dimensions						
Tunnel No.	Gradient	Width	Height	Length	Volume	Capacity
		m	m	m	m <sup>3</sup>	tons
1	1 : 100	8	5	45	1800	
2	1 : 100	12	6	60	4320	
3	- 1 : 7	4	4	130	2080	
4	1 : 100	10	5	60	3000	4500
5	1 : 100	10	5	34	1700	2550
6	1 : 100	5	4	60	1200	

# Stangeneset NORM Disposal Site Operation



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**Containers with NORM drums are received at quayside and transported unopened to the Storage & Conditioning Tunnel.**

**The drums are registered, weighed and conditioned (if necessary).**

**Disposal-ready drums are transferred to the Repository Tunnel and grouted into concrete blocks (30 – 100 drums per block).**

**Total capacity approx 7 000 tons. Currently processed approx 200 tons NORM from ConocoPhillips, Shell, Total and Statoil.**



# Summary



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**Question:** Is there a complete cradle-to-grave solution for petroleum NORM waste in Norway?

**Answer:**

NORM above Repository Level, low oil content: Yes.

NORM below Repository Level, low oil content: Yes.

NORM above Repository Level, high oil content: No, currently stored at oil bases.  
Amounts are increasing due to decreased Repository Level.

NORM below Repository Level, high oil content: Yes, but currently with no regulatory control.



*Repository tunnel.*