

Advances in NORM Management in Norway and the Application of the ICRP Publication 103 Recommendations

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First ICRP Symposium, 24-26 October 2011 in
Bethesda, USA



NORM industries in Norway

- **Oil and gas production**
- **TiO₂ pigment production**
- **Production of phosphate fertilisers**
- **Cement production, maintenance of clinker ovens**
- **Primary iron production,**
- **Tin/lead/copper smelting,**
- **Mining of ores (other than uranium)**



Oil and gas industry – discharges and waste I

- Scaling
 - Ra co-precipitates with BaSO_4
 - Pipes cleaned either onshore or offshore
 - Activity concentrations of Ra-226 <1 to ~ 100 Bq/g
- Contaminated equipment other than pipelines



Examples of Heavy Scaling within Oil Production Pipelines (Statoil)

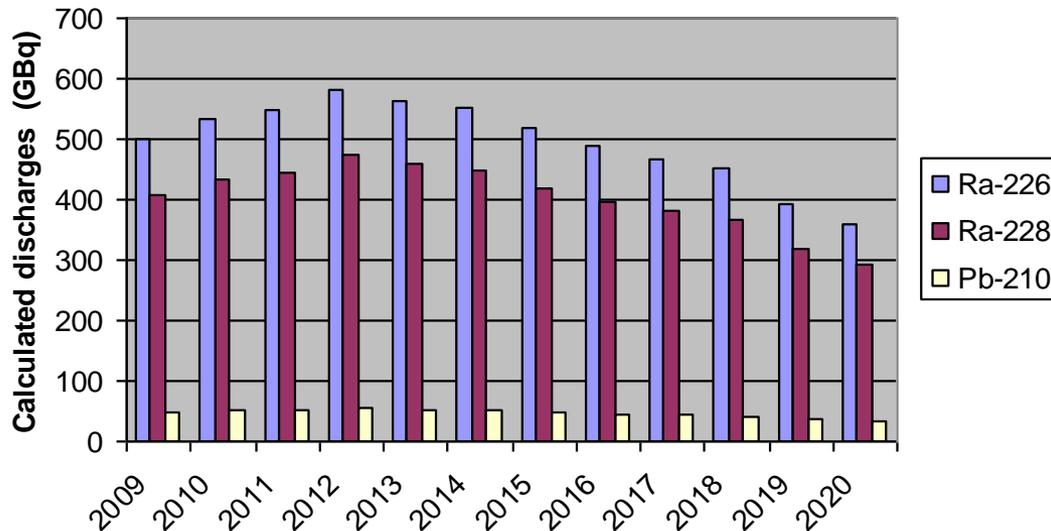
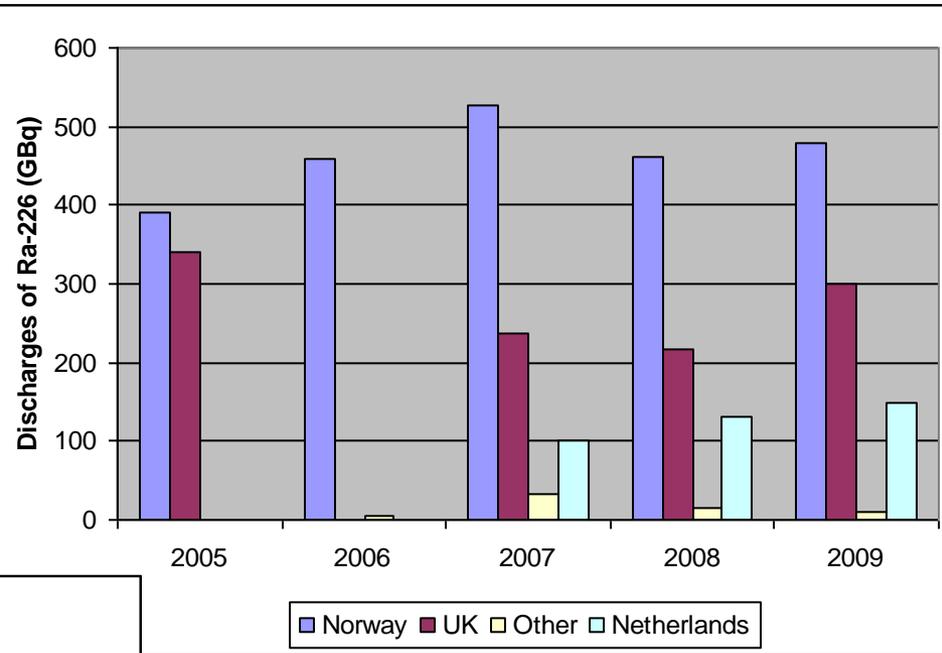


Filters with NORM from gas extraction.
Radioactive and pyrophoric material

Oil and gas industry – discharges and waste II

Produced water

- Discharges (162 mill m³ in 2007)
- Reinjection (27 mill. m³ in 2007)
- Industry obliged to study possible purification technology offshore (BAT)



OSPAR goal:

- Substantial and progressive reduction in discharges
- Concentrations in the environment near background values for NORM

New legislation from 1 January 2011 where radioactive discharges and waste are regulated under the Pollution Control Act

Pollution Control Act (administered originally by the Climate and Pollution agency)

- *Regulations on pollution control*
- *Regulations on the recycling of waste*
- *Regulations on the application of the Pollution Control Act on radioactive pollution and radioactive waste*

The purpose of the Pollution Control Act is to “protect the environment from future pollution, reduce existing pollution, reduce the amount of waste and promote better waste handling”

Implications of the new legislation I

- Radioactive discharges and radioactive waste is regulated under the same legislation as contaminant discharges and hazardous waste
- Situations where the content of NORM has been enhanced due to human activities is included
- Pollution is illegal (both discharges and waste dispersal) and practices must have a licence for discharges
- All hazardous and/or radioactive waste must be handled safely and practices must have a licence for waste handling



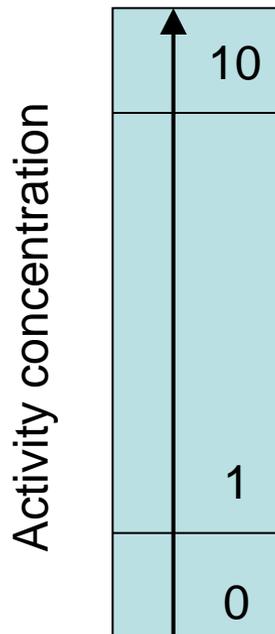
Implications of the new legislation II

- A set of activity levels is defined for when material is considered radioactive waste, when waste is subject to obligatory final disposal and when radioactive discharges require a licence
- Examples for Ra-226:
 - Waste with specific activity < 1 Bq/g is not regulated as radioactive waste
 - Waste with specific activity ≥ 10 Bq/g and total activity $\geq 10\,000$ Bq is subject to obligatory final disposal
 - Discharges requires a licence if the specific activity is ≥ 1 Bq/g or total activity is ≥ 1000 Bq

Radioactive Waste



•Three tier approach



Waste has to be sent to a final repository

- Waste which is only radioactive can be sent for disposal at a facility with a license from NRPA
- Waste which is also classified as hazardous can be sent for disposal at a facility with license for hazardous or radioactive waste

Waste is not regulated as radioactive waste

E.g. Ra-226 (Bq/g)

Radioactive and hazardous waste I



- NORM waste is often also classified as hazardous waste
 - Heavy metals, hydrocarbons, chemicals etc.
- Requirements in the new legislation are similar for hazardous waste and radioactive waste:
 - Duty to declare and a duty to deliver radioactive waste to authorised companies at least once a year
 - License requirement for companies who handle radioactive waste and an annual report to NRPA
 - Requirement of justifiable waste management

Waste Repository Gulen – purpose built for NORM waste from the oil and gas industry, 2008

- Authorized by the [Norwegian Radiation Protection Authority](#) and the [Climate and Pollution Agency](#)
- Authorized for radioactive waste from the petroleum industry at the Norwegian Continental shelf
- Disposal here mandatory when ≥ 10 Bq/g for Ra-226/228, Po-210
- Private company run the repository
 - Fund for closure and post closure remediation
- State guarantee from the Ministry of Petroleum and Energy
 - Fund in case the company is no longer able to run the repository



Waste Repository Gulen

- Waste arrives in HDPE drums in containers
- Excess water removed and void space filled with gravel or oil absorbent material
- Moved to the repository tunnel and grouted into concrete blocks
- Capacity 6000 tons, 570 tons disposed here so far
- Estimated 50 tons/year

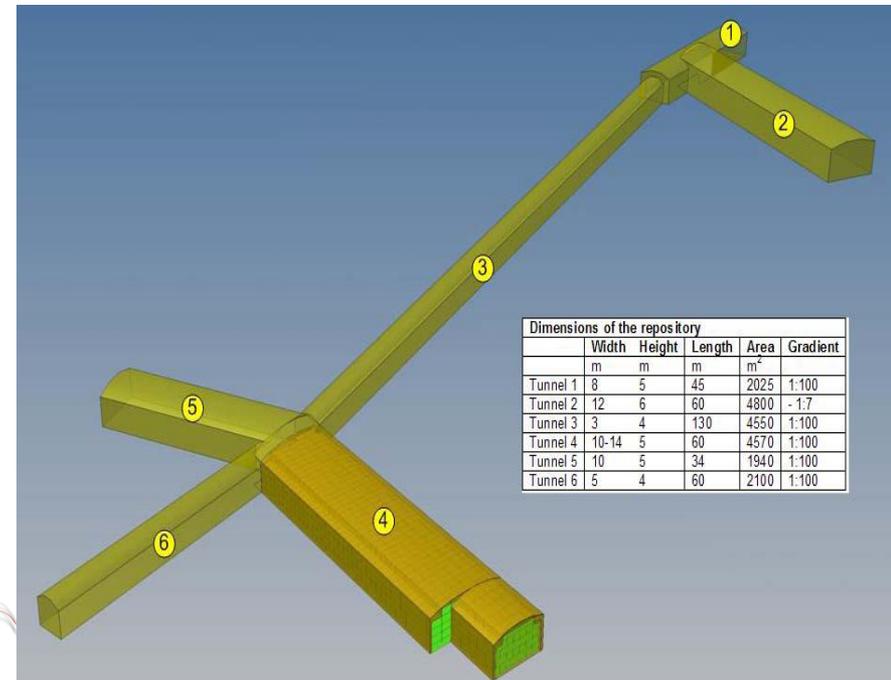


Storage tunnel

Overview of facility



Repository tunnel



Dimensions of the repository					
	Width	Height	Length	Area	Gradient
	m	m	m	m ²	
Tunnel 1	8	5	45	2025	1:100
Tunnel 2	12	6	60	4800	- 1:7
Tunnel 3	3	4	130	4550	1:100
Tunnel 4	10-14	5	60	4570	1:100
Tunnel 5	10	5	34	1940	1:100
Tunnel 6	5	4	60	2100	1:100

Waste Repository NOAH - receives NORM waste and Hazardous waste

- Authorized by the [Climate and Pollution Agency](#) and the [Norwegian Radiation Protection Authority](#)
- Main repository for hazardous waste in Norway
- Receives and treats NORM waste (1-10 Bq/g), hazardous waste and contaminated soil.
- All waste material is stabilized before being deposited below sea level in a former limestone quarry.
- Private company run the repository
 - Fund for closure and post closure remediation



The repository today and plans for the area after remediation



Application of the ICRP Publication 103 Recommendations to NORM industries in Norway

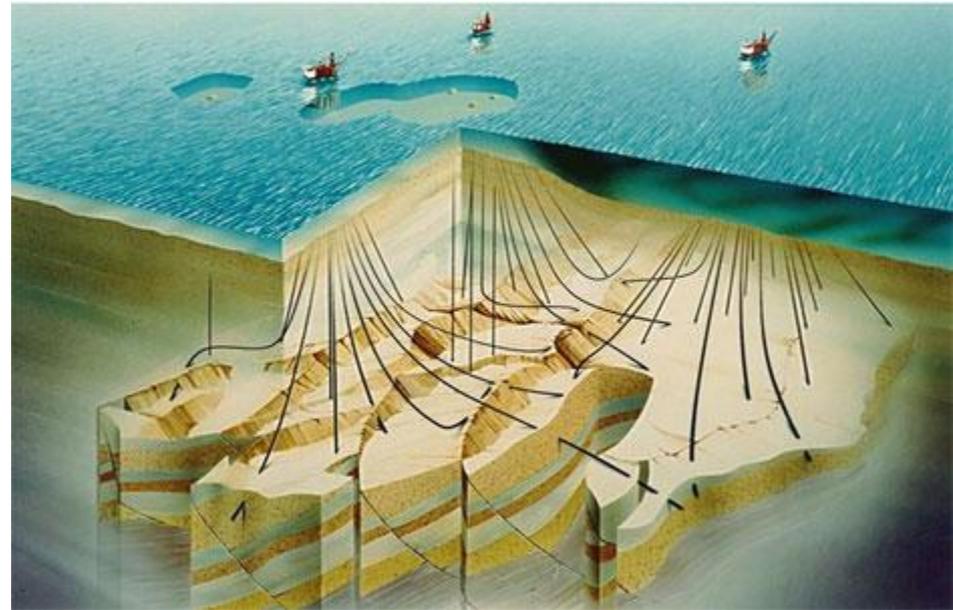


Planned vs existing exposure situation for petroleum industry?

- (31) "The system has to deal with a number of sources of exposure, some already being in place, and others introduced deliberately as a matter of choice by society or as a result of emergencies."
- (39) "In protecting individuals from the harmful effects of ionising radiation, it is the control (in the sense of restriction) of radiation doses that is important, no matter what the source."
- (44) "The term '*source*' is used to indicate the cause of an exposure, and not necessarily a physical source of radiation. [...] A source is an entity for which radiological protection can be optimised as an integral whole."
- (48) "The term '*practice*' [...] denote an activity that causes an increase in exposure to radiation [...]"
- (49) "It is implicit in the concept of practice that the radiation sources that it introduces or maintains can be controlled directly by action on the source."
- (176) "Planned exposure situations are situations involving the deliberate introduction and operation of sources."

Oil and gas industry is a planned exposure situation

- Deliberate extraction for the benefit of the society
- No exposure of humans or the environment would have occurred without human activities
- Source modified and controllable
- Optimisation in the industrial process is possible, both for discharges and waste



Planned exposure situations implies

- Dose constraints applies, ALARA applies
- (239) "The first band, 1 mSv or less, applies to exposure situations where individuals receive exposures – usually planned – that may be of no direct benefit to them but the exposure situation may be of benefit to the society."
- (260) "For the control of public exposure from waste disposal, the Commission has previously recommended that a value for the dose constraint for members of the public of no more than about 0.3 mSv in a year would be appropriate." See also Table 8.
- (261) "Some flexibility may be required for particular situations involving long-lived natural radionuclides [...]."

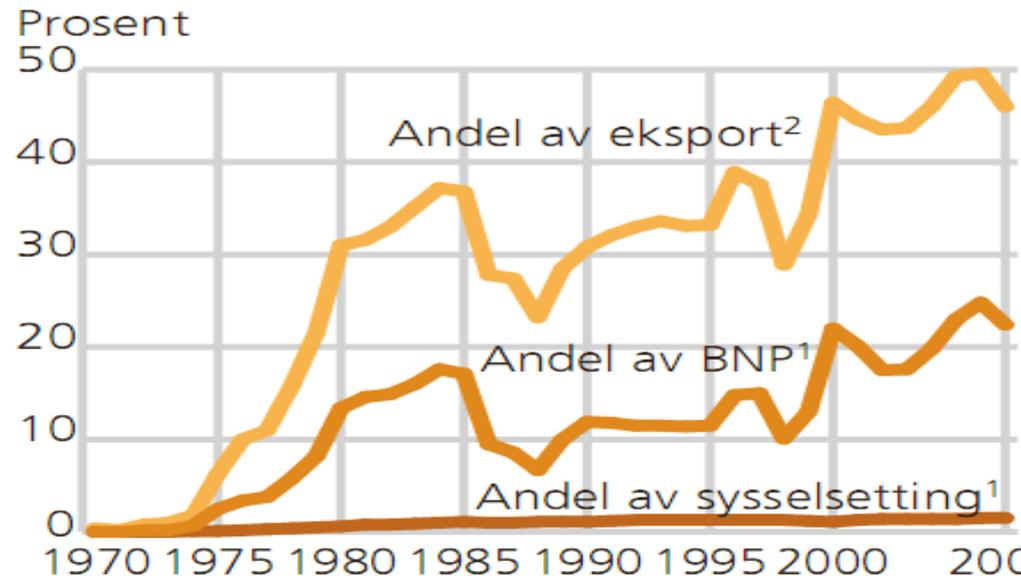
Other relevant paragraphs

- (26) "[...] an appropriate level of protection for people and the environment against the detrimental effects of radiation without unduly limiting the desirable human actions that may be associated with such exposures."
- (27) "[...] balancing the risks and benefits."
- (30) "[...] 'environmental protection' [...] aim is now that of preventing or reducing the frequency of deleterious radiation effects to a level where they would have a negligible impact on the maintenance of biological diversity, the conservation of species, or the health and status of natural habitats, communities and ecosystems."
- (36) "[...] the LNT model remains a prudent basis for radiological protection at low doses and low dose rates."
- (51) "[....] a graded burden of obligation [...]"

Oil and gas – optimisation should be easy

Largest oil producers, million barrels/day (2007)

Saudi Arabia	10,4
Russland	10,0
USA	6,9
Iran	4,4
Kina	3,7
Mexico	3,5
Canada	3,3
De forente arabiske emirater	2,9
Kuwait	2,6
Venezuela	2,6
Norge	2,6



In Norway:

% of export (top)

% of GDP (middle)

% of employment (bottom)

Current oil price ~ 111 USD/barrel

