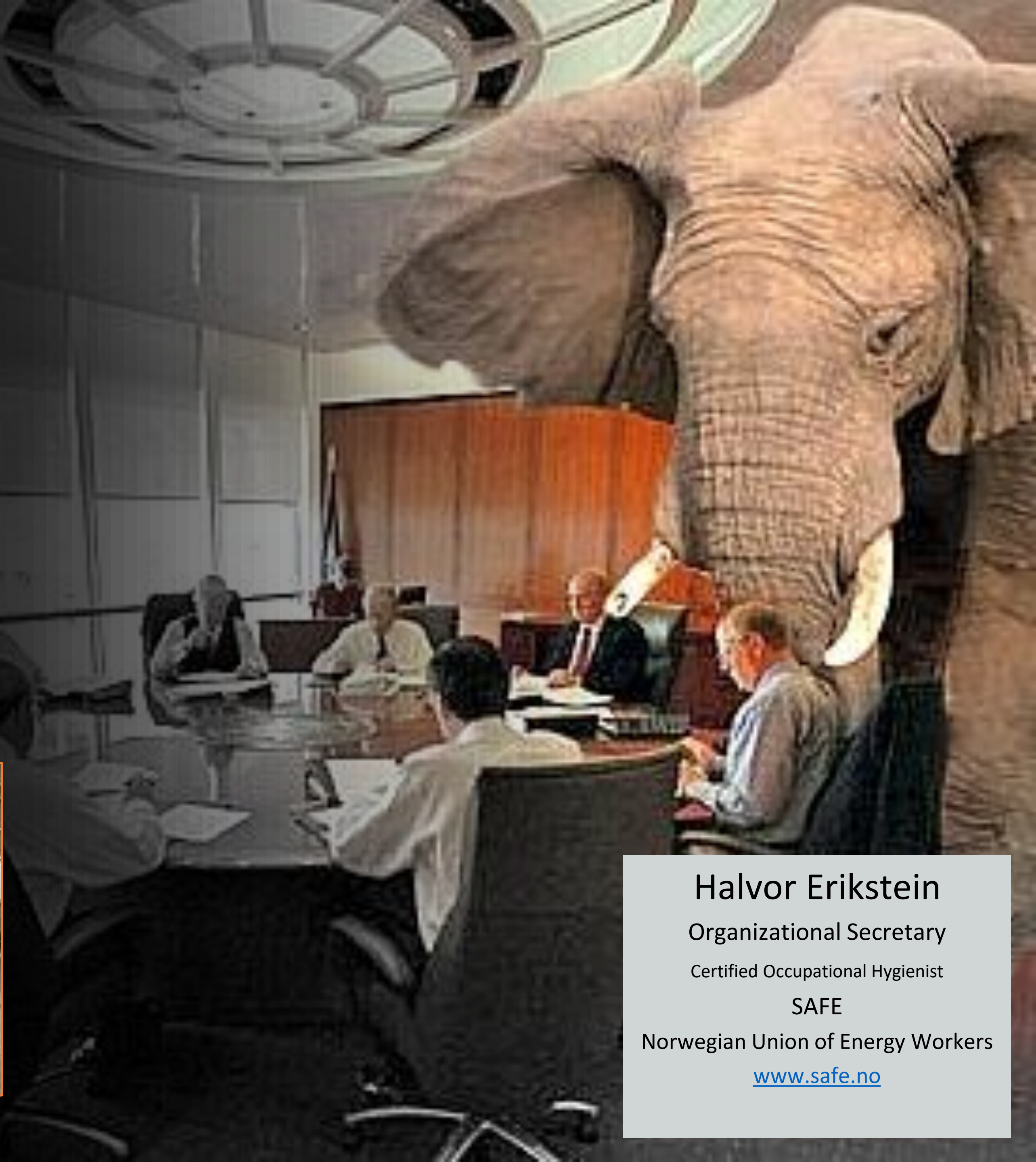
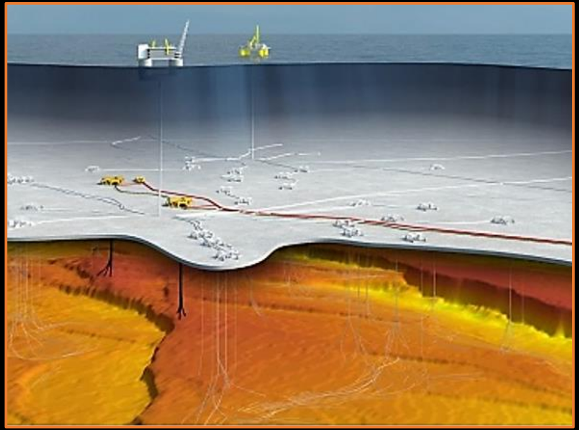
The Elephant in the Room - Benzene in Drilling Mud.





Halvor Erikstein

Organizational Secretary

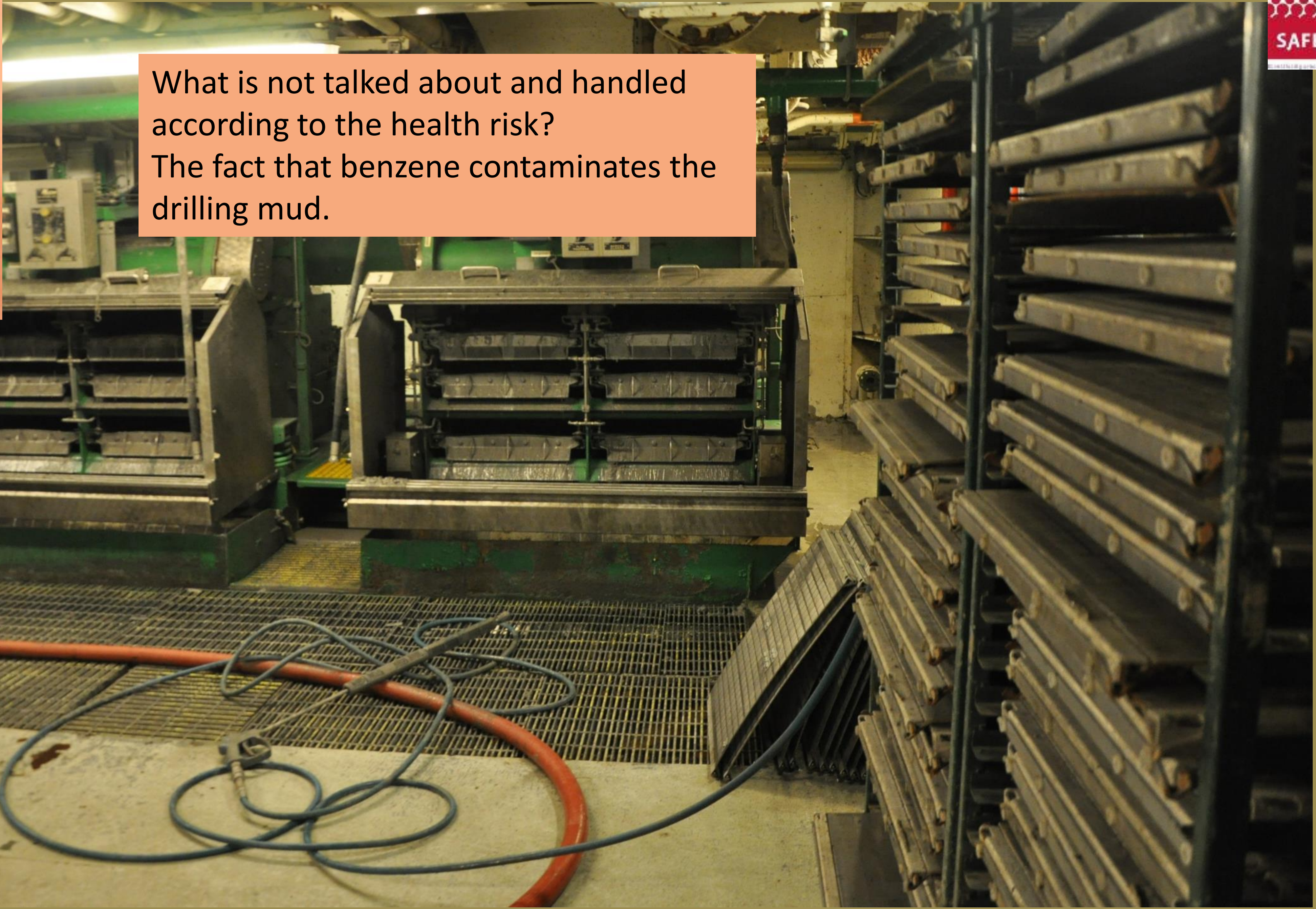
Certified Occupational Hygienist

SAFE

Norwegian Union of Energy Workers

www.safe.no

What is not talked about and handled according to the health risk?
The fact that benzene contaminates the drilling mud.



Respiratory protection based on filter is unsuitable for drilling mud treatment.

Benzene exposure is not taken into account in the drilling mud treatment.

NB! The benzene exposure matrix is incorrect. (2012)

What can be done to reduce the risk?
First: Recognize that benzene is extremely carcinogenic and that benzene can contaminate drilling mud.

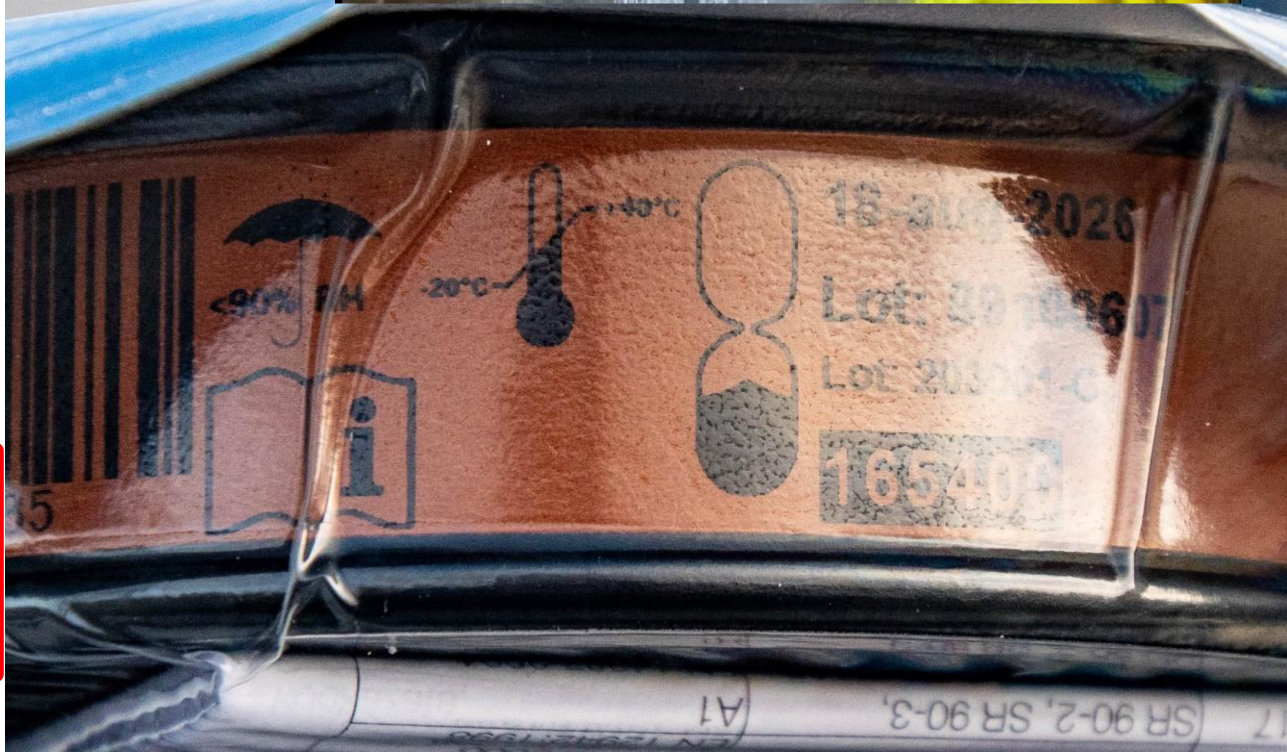
Apply the recognition to the working environment in:
Drilling mud treatment, cuttings treatment, choice of protective equipment.

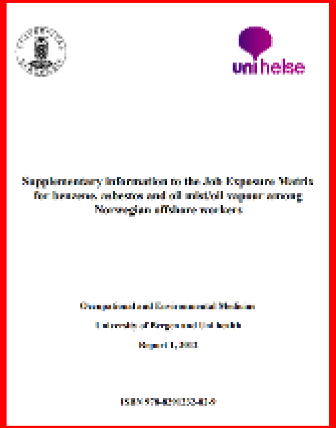
Apply the recognition to drilling: Can new drilling fluid systems reduce the mixing of crude oil in the drilling mud?

Have you seen the filters limitations on humidity?

RH < 90%

Application RH (humidity) less than 90%





Supplementary information to the Job Exposure Matrix for benzene, asbestos and oil mist/oil vapour among Norwegian offshore workers

Table 2.3 Rating of the job categories relative to each other according to exposure burden (exposure intensity x duration x frequency) of performed tasks in four time periods.

Job category	Exposure burden (intensity x frequency x duration)			
	1970-79	1980-89	1990-99	2000 →
Process technicians[a]	2.4	2.4	2.1	1.8
Mechanics	1.9	1.9	1.6	1.4
Industrial cleaners	1.4	1.4	1.3	1.3
Process technicians[b]	1.4	1.4	1.1	0.9
Laboratory engineers	1.3	1.3	1.0	0.7
Deck crew	0.8	0.8	0.7	0.7
Plumbers and piping engineers	0.6	0.6	0.5	0.4
Non-destructive testing	0.5	0.5	0.4	0.4
Machinists	0.4	0.4	0.4	0.4
Electric instrument technicians	0.3	0.3	0.2	0.2
Scaffold crew	0.2	0.2	0.2	0.2
Sheet metal workers and welders	0.2	0.2	0.2	0.2
Insulators	0.2	0.2	0.1	0.1
Mud engineers and shale shaker operations*	*	*	-	-
Drill floor crew*	*	*	-	-
Surface treatment (painters)*	*	*	-	-
Drillers	-	-	-	-
MWD and mud loggers	-	-	-	-
Derrick employees	-	-	-	-
Well service crew	-	-	-	-
Control room operators	-	-	-	-
Electricians	-	-	-	-
Radio employees	-	-	-	-
Turbine operators	-	-	-	-
Hydraulics technicians	-	-	-	-
Chef and catering	-	-	-	-
Health, office and administration personnel	-	-	-	-

[a] : Subgroup of process technicians who perform all tasks in Table 2.2
[b] : Main group of process technicians who perform the most common tasks (task 3, 5, 6, 8 and 9 in Table 2), presumably representing more than 50 % of the process technicians
*: Job categories assumed to have been exposed to benzene prior to 1985, but available exposure information is inadequate to use the rating system
- : Job category estimated to have very low (close to background) exposure to benzene

https://w2.uib.no/filearchive/supplementary-information-to-the-jem-.pdf

The exposure matrix from 2012 has completely omitted exposure from benzene blending into drilling mud.

Similarly, there is a lack of exposure of benzene from the deaeration systems that is neither quantified nor labeled concerning the working environment exposure.

More realistic benzene exposure matrix (SAFE 2022)

- ❑ Vent points
- ❑ Drilling mud

Vent points

https://www.ptil.no/contentassets/c00c2f1eb6434d5e9852edaa06bee9b5/arbeidsmiljoeksponering-helserisiko-og-registrering-av-helseskade---safe.pdf

https://www.ptil.no/contentassets/ab53ee56aeff4b29a238f05df3ea85f0/kontroll-med-avluftingspunkt-prosess-og-roterende-utstyr-halvor-erikstein.pdf

Letter of Concern to the Petroleum Safety Authority

https://safe.no/bekymringsmelding-fra-safe-til-petroleumstilsynet/

SAFE

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Non-destructive testing	0.5	0.5	0.4	0.4
Machinists	0.4	0.4	0.4	0.4
Electric instrument technicians	0.3	0.3	0.2	0.2
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Mud engineers and shale shaker operations*	*	*	-	
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Drillers	-	-	-	
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Derrick employees	-	-	-	
Well service crew	-	-	-	
Control room operators	-	-	-	-
Electricians	-	-	-	-
Radio employees	-	-	-	-
Turbine operators	-	-	-	
Hydraulics technicians	-	-	-	
Chef and catering	-	-	-	-
Health, office and administration personnel	-	-	-	-

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*: Job categories assumed to have been exposed to benzene prior to 1985, but available exposure information is inadequate to use the rating system
- : Job category estimated to have very low (close to background) exposure to benzene

ECHA recommends the benzene TWA = 0.05 ppm

ECHA
EUROPEAN CHEMICALS AGENCY

Committee for Risk Assessment
RAC

Opinion on scientific evaluation of occupational exposure limits for Benzene

ECHA/RAC/ O-000000-1412-86-187/F

Adopted

9 March 2018

Assessment of the Scientific Relevance of OELs for benzene

RECOMMENDATION

The opinion of RAC for the assessment of the scientific relevance of Occupational Exposure Limits (OELs) for benzene is set out in the table below and in the following summary of the evaluation.

SUMMARY TABLE

The table summarises the outcome of the RAC evaluation to derive limit values for the inhalation route and the evaluation of the need for a skin notation to protect against dermal exposure.

Derived Limit Values[5]

OEL as 8-hour TWA[6]:	0.05 ppm (0.16 mg/m^3)[7]
STEL	not established
BLV:	0.7 µg benzene/L urine 2 µg S-phenylmercapturic acid (SPMA)/g creatinine (sampling: end of exposure or end of working shift)
BGV:	0.3 µg benzene/L urine 0.5 µg S-phenylmercapturic acid (SPMA)/g creatinine

Carcinogenicity Classification/Categorisation

CLP Harmonised classification for carcinogenicity	Carc 1A; H350 (May cause cancer)
SCOEL Categorisation of carcinogens[8]	Not assigned by SCOEL[9]

Notations

Notations:	'Skin'

[5] The naming conventions of limit values and notations used here follow the 'Methodology for the Derivation of Occupational Exposure Limits' (SCOEL 2013; version 7) and the Joint ECHA/RAC – SCOEL Task Force (2017b). [https://echa.europa.eu/documents/10162/13579/jtf_opinion_task_2_en.pdf/db8a9a3a-4aa7-601b-bb53-81a5eef93145].

[6] The OEL is based on genotoxicity in workers, specifically: chromosomal damage (aneugenicity and clastogenicity).

[7] To facilitate comparison with the SCOEL (1991) opinion and the current Binding OEL on benzene, ppm was maintained as the leading unit.

[8] See Appendix 1 of the ECHA BD for details on the "SCOEL classification of carcinogens".

[9] In 1991, when SCOEL evaluated benzene, the scheme was not yet in place.

https://echa.europa.eu/documents/10162/4fec9aac-9ed5-2aae-7b70-5226705358c7

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The limit values must not be perceived as sharp boundaries between harmless and dangerous concentrations;

Such sharp boundaries do not exist. This is partly due to the biological differences between humans.

Two people can react differently even if they are exposed to the same influence of a chemical.

This is especially true in those cases where there is an impact of several different pollutants at the same time, or where hard physical work occurs at the same time as the impact.

Uptake of chemicals into the body can increase significantly as the workload increases.

https://www.arbeidstilsynet.no/regelverk/forskrifter/forskrift-om-tiltaks--og-grenseverdier/

The Norwegian TLW set to 0.2 ppm (July 2021).

PETROLEUM SAFETY AUTHORITY NORWAY

Norsk

To The activities regulations § 36

§ Regulations

§ 36 Chemical health hazard

Section

Hide

The employer shall ensure that hazardous chemical exposure during storage, use, handling and disposal of chemicals, and during operations and processes that produce chemical components, is avoided.

The action values and threshold values in Regulations relating to action values and threshold values (in Norwegian only) shall be corrected by means of a safety factor of 0.6 for a working period of twelve hours, and for persons found to be working under heightened pressure, a safety factor of 0.2 shall apply, except for CO and CO2.

Section last changed: 01 January 2018

Guideline

Show

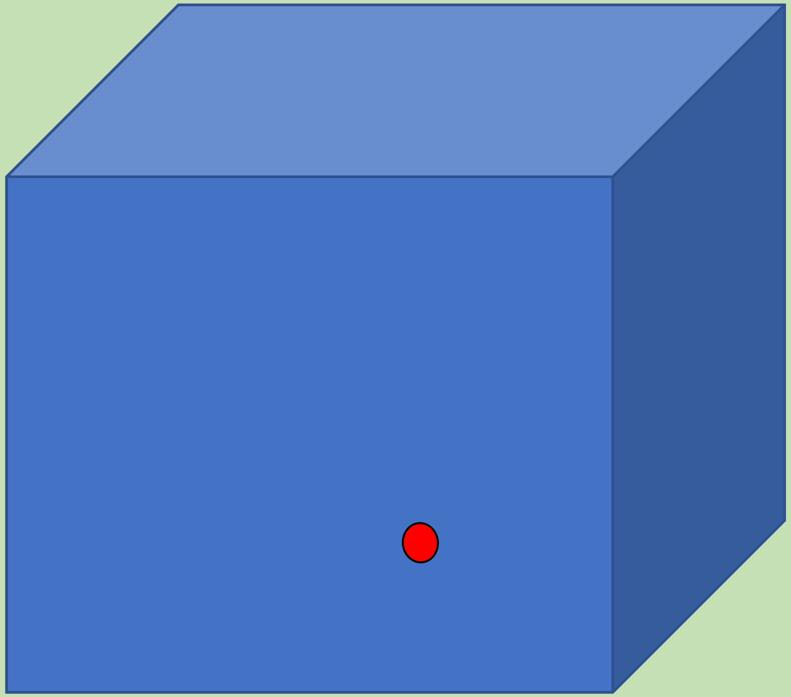
https://www.ptil.no/en/regulations/all-acts/the-activities-regulations3/VIII/36/

71-43-2	Benzen	0,2	0,66	HK M	2020

https://lovdata.no/dokument/SF/forskrift/2011-12-06-1358#KAPITTEL_5

Concentrations of Chemical Exposure

1 cubic meters (m^3) = 1000 litrers



Limit values are stated in parts pr. million (ppm) or in milligrams pr. cubic meters (mg/m^3)
1 ppm is a gas bubble on 1 cm^3 (1 milliliters) diluted in 1m^3.

Fire and explosion limits are stated in
100 parts (% - percent).

Health risk stated in
1000.000 parts (ppm)
1volum% = 10.000 ppm

The Hazard Ladder

Cincentration		Compound
parts pr. million (ppm)	Volume%	
1.000.000	100	LEL - Lower Expl. Level)
100.000	10	
10.000	1	
1.000	0,1	
100	0,01	
10	0,001	Occupational exposure levels
1	0,0001	
0,1	0,00001	
0,01	0,000001	
0,001	0,0000001	

LEL - Lower Expl. Level)

Methanol (6,0 LEL)
Methan (5,0 LEL)
<u>Ethanol (3,3% LEL)</u>
<u>Isopropanol (2 % LEL)</u>
Propane (2,1 LEL)
Benzene (1,3 LEL)
Xylene (1,0 LEL)

Occupational exposure levels

<u>Ethanol (500 ppm)</u>
Methanol (100 ppm) HE
Carbonmonoxide 20 ppm RE
Ammonia 15 ppm E^{2}
H_2S 5 ppm E
Hydrogencyanid 0,9 ppm) HE
Benzene (1,0 ppm) HKG **(OLD)**
Nitrogendioxide 0,5 ppm E^{13}
BENZENE (0.2 ppm) HKG (NEW)
Diisocyanates (0,005 ppm) A^{4}

1 volume% = 10000 ppm

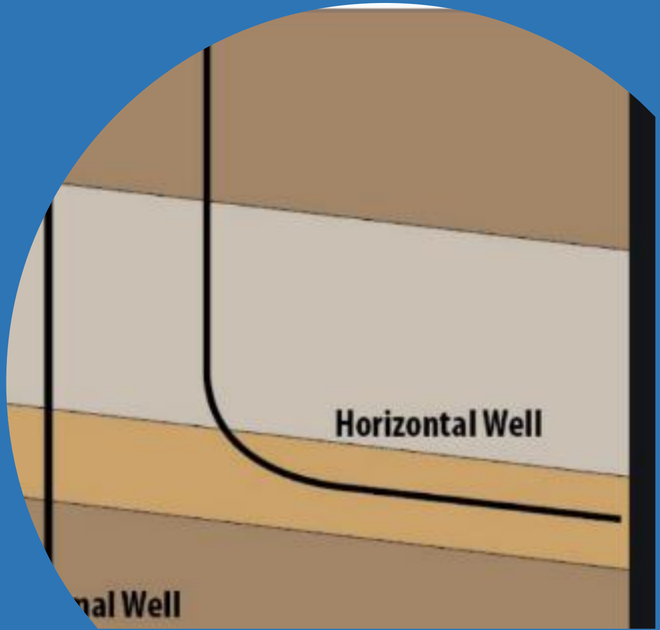
NB!
If you measure 20.0% oxygen (O_2), you have 0.9% (9000 ppm) of something else.....

Ref; “Forskrift om tiltaks og Grenseverdier 2020. Eksplosjonsgrenser hentet fra “NIOSH Pocket Guide to Chemical Hazards (1990) og “Sources of Ingition” (J.Bond 1991)

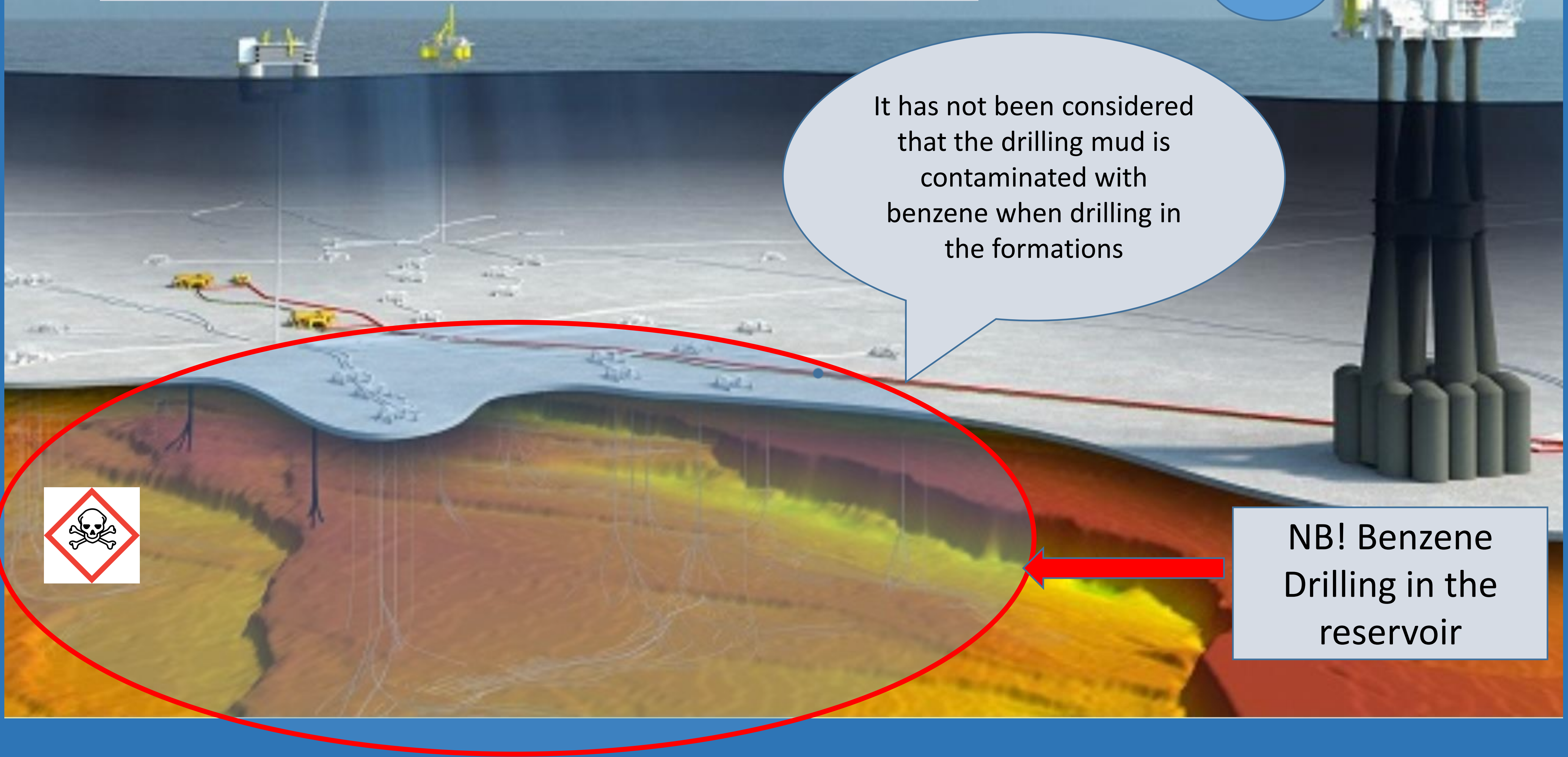
Drilling mud treatment equipment

When drilling in hydrocarbon containing formations, crude oil with benzene will contaminate the drilling mud.

What significance does the influx of hydrocarbons from the formation have on chemical health hazard?



Drilling in Hydrocarbon Containing Formations



Influx of crude oil into the drilling mud has been reported, but not emphasized...

10%


ACONA

RAPPORT

Bruk av borevæsker på norsk kontinentalsokkel

Utviklingstrekk knyttet til helsefare

Report Page 45.

- **4.5**
- The project group wants to shed light on the following challenges in connection with reducing health risks after talks with the companies: Benzene is an organic solvent that is found naturally in oil and gas reservoirs. It is classified as a carcinogen and harmful substance. During a meeting with the company, the project group was informed that up to 10% of crude oil in the drilling fluid has been detected by drilling through a reservoir. In such situations, operators, especially in shaker areas, could be exposed to benzene. (*Report in Norwegian. Google translator*)

https://www.ptil.no/fagstoff/utforsk-fagstoff/prosjektrapporter/2020/bruk-av-borevasker-pa-norsk-kontinentalsokkel---utviklingstrekk-knyttet-til-helsefare/

Environmental Report. Troll 2019

Tabell 2.2 Disponering av kaks ved boring med vannbasert borevæske på Troll 2019 (EEH tabell 2.2)

Brønnbane	Lengde [m]	Teoretisk hullvolum [m3]	Total mengde kaks generert [tonn]	Utslipp av kaks til sjø [tonn]	Kaks injisert [tonn]	Kaks sendt til land [tonn]	Importert kaks fra annet felt [tonn]	Eksportert kaks til annet felt [tonn]
31/2-D-7 BY1H	7 254	404,25	1 200,63	1 200,63				
31/2-D-7 BY2H	4 499	164,71	489,18	489,18				
31/2-D-7 BY3H	5 383	197,05	585,24	585,24				
31/2-E-3 AY1H	1 369	174,77	519,05	519,05				
31/2-G-6 BY1H	6 325	350,15	1 035,28	1 035,28				
31/2-G-6 BY2H	4 490	164,36	488,15	488,15				
31/2-G-6 BY3H	6 394	234,08	695,22	695,22				
31/2-K-11 AY1H	7 911	435,81	1 294,35	1 294,35				
31/2-K-11 AY2H	5 961	218,23	648,14	648,14				
31/2-K-11 AY3H	5 892	215,70	640,64	640,64				
31/2-M-23 CY1H	7 415	313,18	930,14	930,14				
31/2-M-23 CY2H	6 397	234,19	695,55	695,55				
31/2-M-23 CY3H	5 907	216,25	642,27	642,27				
31/2-P-24 CY1H	7 155	382,41	1 135,69	1 135,69				
31/2-P-24 CY2H	5 545	203,00	602,91	602,91				
31/2-W-11 H	1 095	270,15	802,35	802,35				
31/2-W-12 H	1 245	281,50	836,06	836,06				
31/2-W-13 H	1 100	270,61	803,72	803,72				
31/2-W-14 H	1 266	283,30	841,39	841,39				
31/2-W-21 H	1 082	272,06	808,03	808,03				
31/2-W-22 H	1 040	266,79	792,37	792,37				
31/2-W-23 H	1 198	285,75	852,78	852,78				
31/2-W-24 H	1 179	283,98	843,41	843,41				
31/2-Y-12 BY1H	8 658	502,07	1 441,60	1 441,60				
31/2-Y-12 BY2H	5 736	209,99	623,68	623,68				
31/2-Y-12 BY3H	6 329	231,70	688,16	688,16				
31/5-H-1 BY1H	5 170	317,00	941,46	941,46				
31/5-H-1 BY2H	4 405	161,27	478,96	478,96				
31/5-H-1 BY3H	4 075	149,18	443,08	443,08				
31/5-H-1 BY4H	3 906	143,00	424,70	424,70				
31/5-I-11 BY1H	6 297	352,60	1 047,23	1 047,23				
31/5-I-13 BY1H	5 739	222,56	661,01	661,01				
31/5-I-13 BY2H	5 820	213,07	575,28	575,28				
31/5-I-23 BY1H	4 730	279,85	831,15	831,15				
31/5-I-23 BY2H	3 375	123,56	366,97	366,97				
31/5-I-23 BY3H	4 789	175,32	520,70	520,70				
SUM	166 130	9 203,45	27 226,53	27 226,53		0,00		

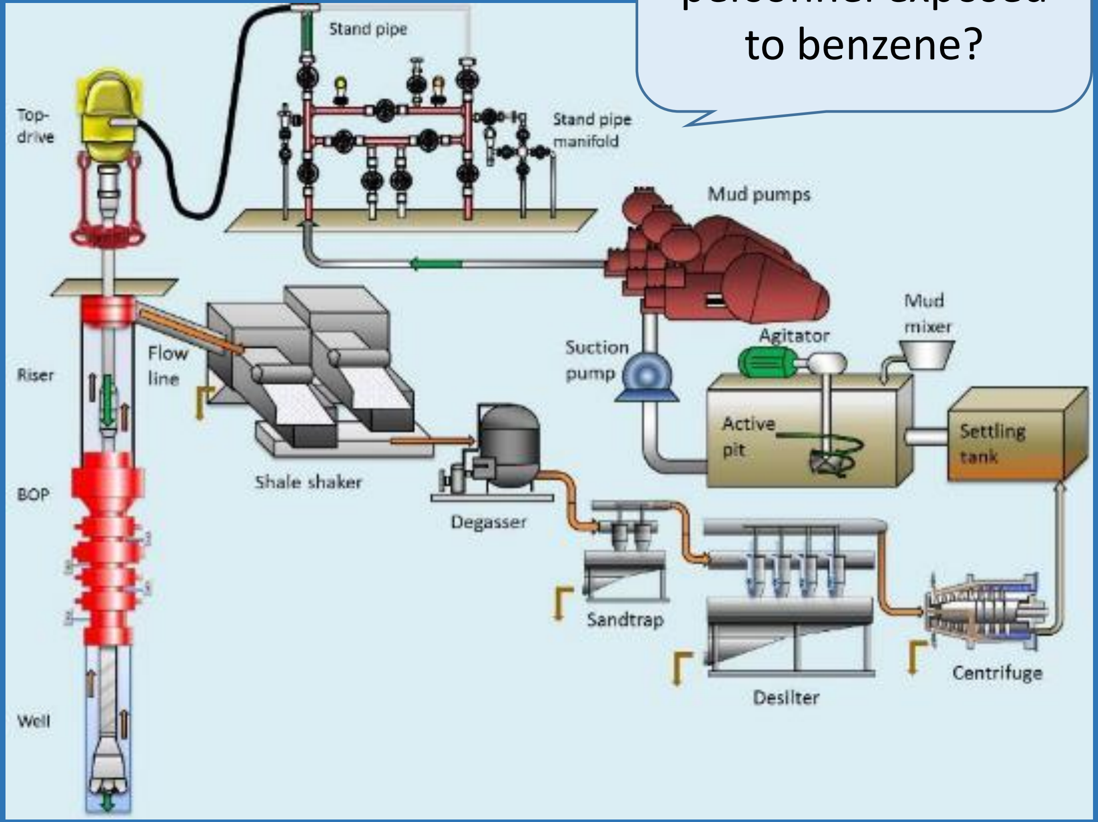
Samlet boret lengde er noe lavere i 2019 enn i 2018 (166129,8 m i 2019 vs. 175 716 m i 2018).
Mengde kaks generert (27 226,53 tonn i 2019 versus 20 764,38 tonn i 2018) er noe høyere enn i 2018.

Overall drilled length is somewhat lower in 2019 than in 2018 (166129.8 meters in 2019 vs. 175 716m in 2018).
The total of cuttings generated (27,226.53 tons in 2019 versus 20,764.38 tons in 2018) is somewhat higher than in 2018.

Length of oil well drilled:
166 kilometers in 2019
176 kilometers in 2018

https://www.norskoljeoggass.no/contentassets/500573d7546748b888327ffd5e4ab519/troll.pdf

Example of benzene exposure when crude oil has contaminated the drilling mud



Where are personnel exposed to benzene?

https://ndla.no/en/subject:1:01c27030-e8f8-4a7c-a5b3-489fdb8fea30/topic:2:182849/topic:2:147173/resource:1:145316

The limit value for benzene is 0.2 ppm = 0.66 mg/m^3

As an example, the assumption is that crude oil contains about 1% benzene.

What does mixing 1 kilogram of crude oil mean?

1 kg = 1000 grams. Total amount of benzene will be:

1% of 1000 grams = 10 grams = 10.000 mg

Assumption; 10% of 10000 mg = 1000 mg is released into the work environment.

How much air for 1000 mg to be diluted to the limit value?

1000mg/(0.66 mg/m^3) = **1510 m^3**

Who considers benzene when drilling in hydrocarbon containing formations?

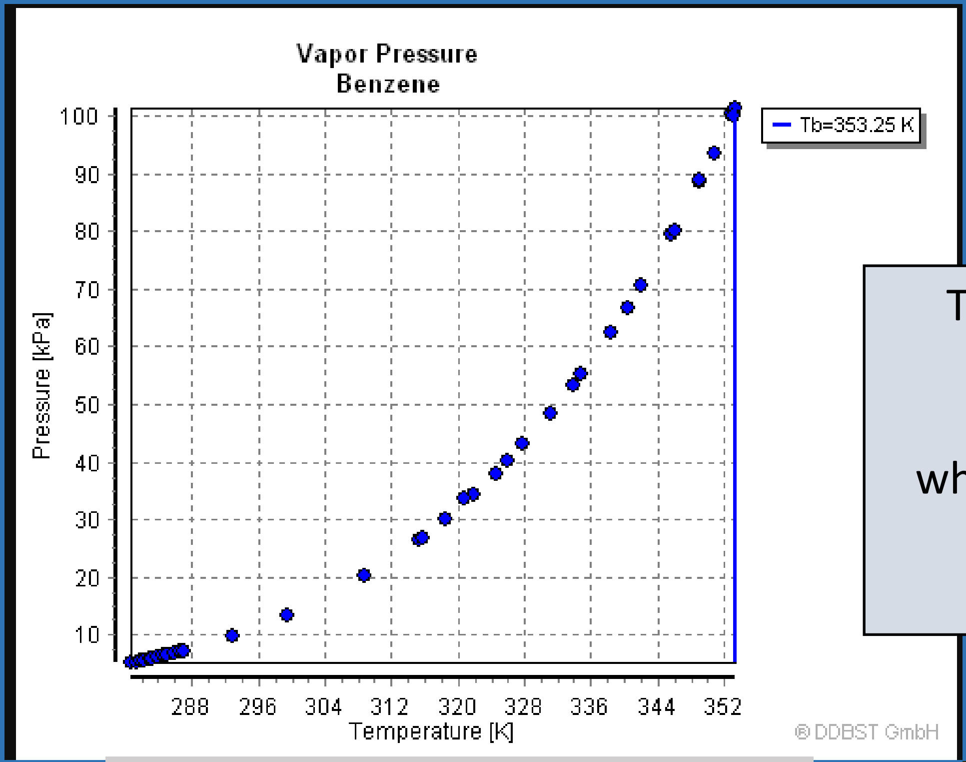
Temperature has a significant effect on chemical exposure

In the accompanying chart are approximate vapor pre
temperatures.

Temp (°C)	mmHg	Temp (°C)	mmHg
Benzene 30	120	Toluene 30	37
40	180	40	60
50	270	50	95
60	390	60	140
70	550	70	200
80	760	80	290
90	1010	90	405
100	1340	100	560
		110	760

https://www.chegg.com/homework-help/questions-and-answers/accompanying-chart-approximate-vapor-pressures-benzene-toluene-various-temperatures-1a-mol-q23996764

https://www.convertunits.com/from/mm%20Hg/to/kPa



http://www.ddbst.com/en/EED/PCP/VAP_C31.php

Celcius (°C)	Kelvin (K)	kPa	mmHG
20	293	10	75
30	303	16	120
40	313	24	180
50	323	36	270
60	333	52,3	390

https://www.sensorsone.com/kpa-to-mmhg-conversion-table/

The vapor pressure of benzene increases from
75 mmHg to 390 mmHg
when temperature increases from
20 C° to 60 C°
A factor of 5.2!

High source strength and high temperature result in heavy degassing of chemical compounds

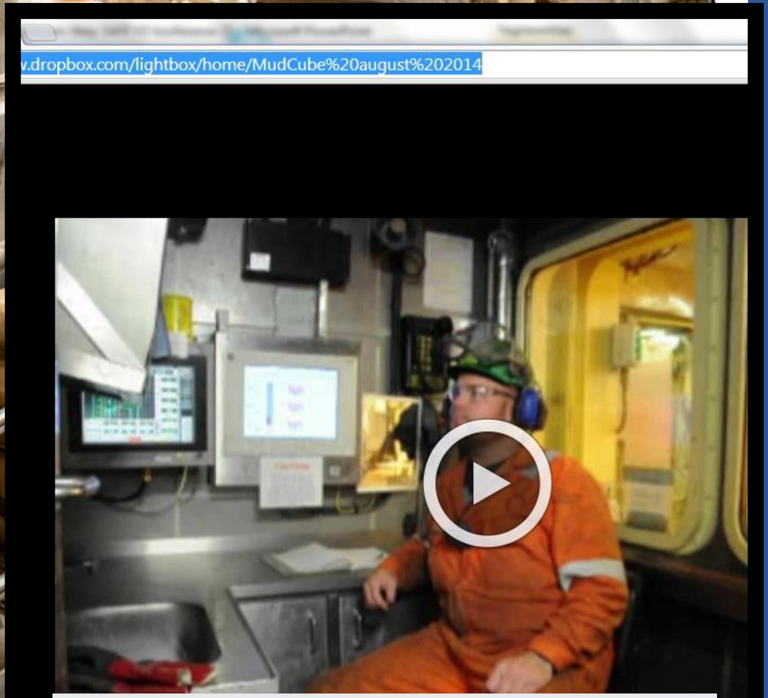
The short jobs with high exposure can cost you your health!

- The limit value for benzene is 0.2 ppm
- If you inhale 20 ppm unsuspectingly for 1 minute, you get the same dose as a stay of 0.2 ppm in 100 minutes
- (20 ppm minutes/0.2 ppm = 100 minutes)
- If you perform the job for 30 minutes without respiratory protection, the total exposure will correspond to (20ppm / 0.2ppm) x30 minutes = 3000 minutes
- This means that you have been exposed to an amount of benzene equivalent to exposure to 0.2ppm for

  3000 minutes/60 minutes
- *20 ppm for 30 minutes equals 50 hours at 0.2 ppm*

Norwegian Invention: MudCube – Closed Vacum Based Roating Filter Belt.

https://cubility.com/



https://www.dropbox.com/s/j0eh5iszbhfue75/Intervju-Roughneck-August2014.mp4?dl=0

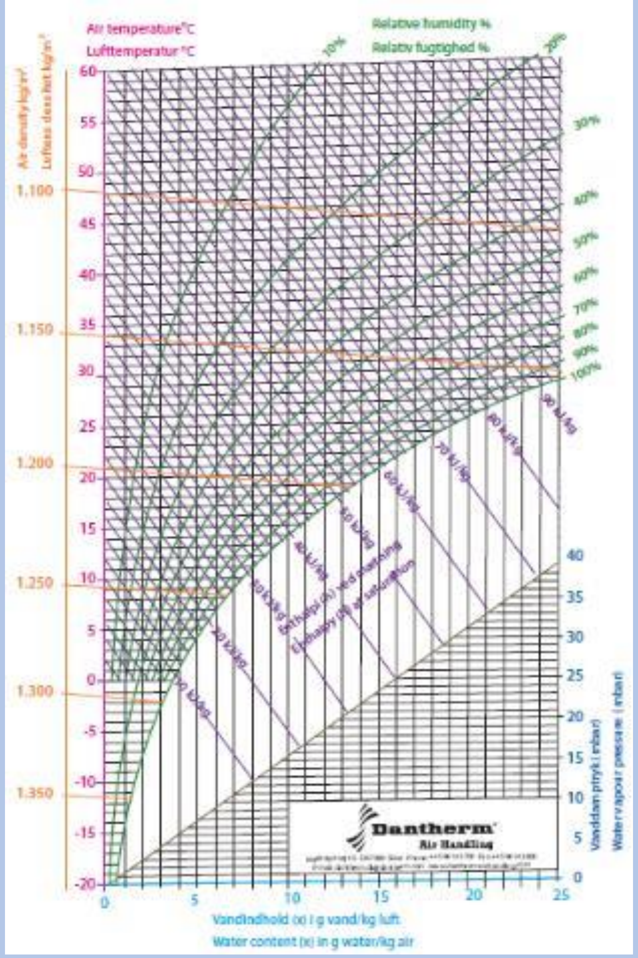
Respiratory Protection - use and restrictions.

<u>Compressed air respirators must be worn when:</u>

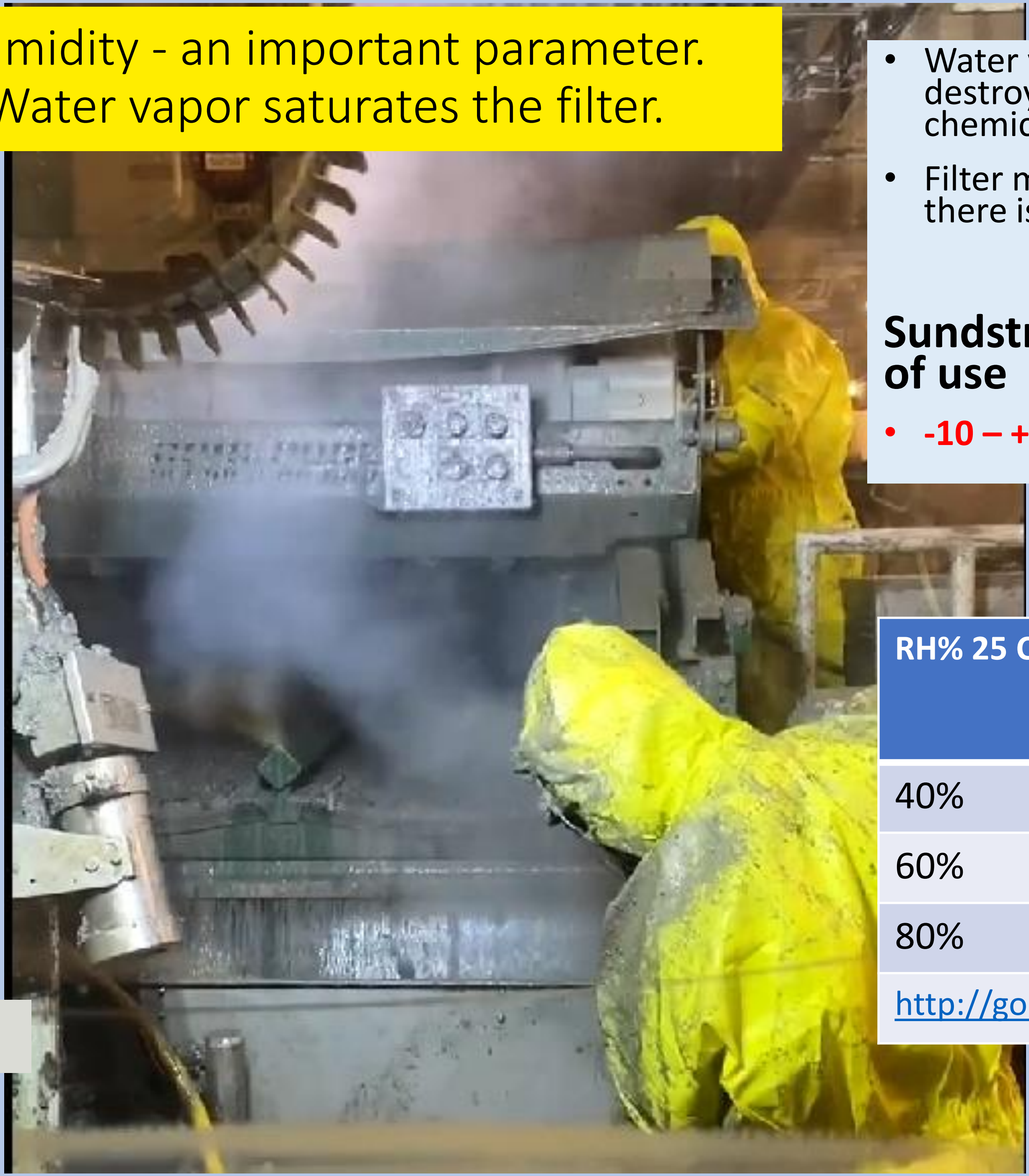
- One does not know the concentration of the pollutants.
- The humidity is higher than the respirator is specified for.
- There are beards or other conditions that cause mask leakage.
- Mask fitting testing is not performed.
- Filter breakthrough time can not be estimated.

Humidity - an important parameter.
Water vapor saturates the filter.

Mollier diagram



https://www.dantherm.com/gb/technologies/mobile-dehumidification/the-theory-behind-dehumidification/



- Water vapor saturates the filter and destroys the filters' uptake of other chemical compounds
- Filter masks are unsuitable where there is high humidity.

NB

Sundstrøm indicates area of use

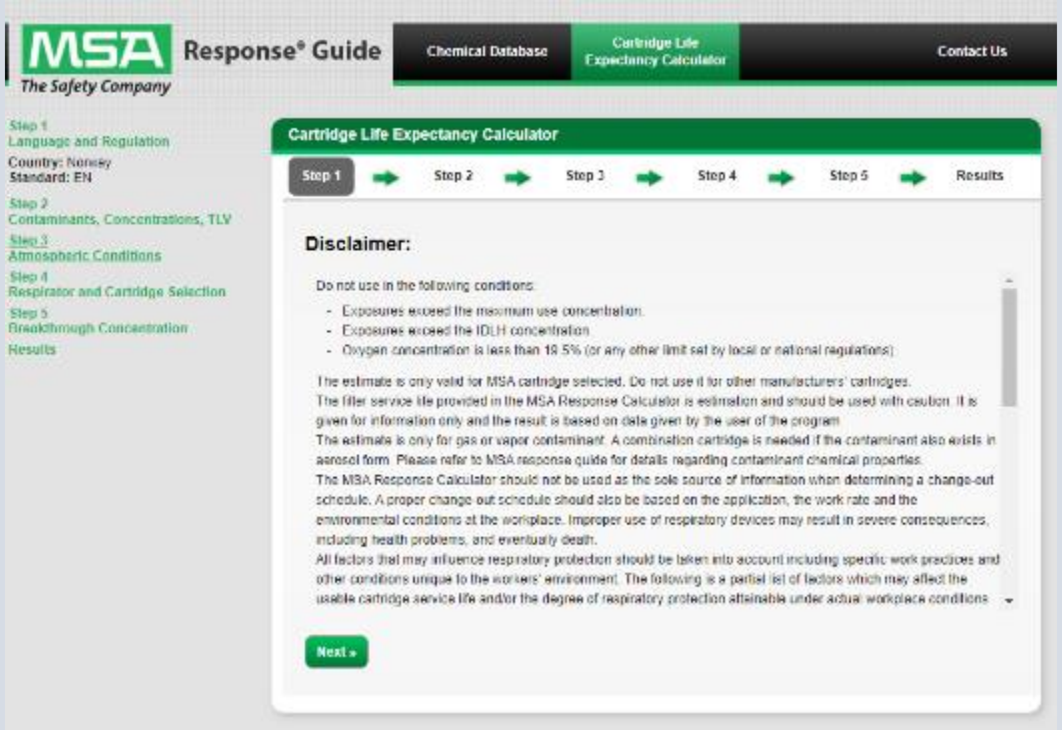
- **-10 – +55 °C, < 90 % RH**

RH% 25 C°	Water vapor gram/m^3	Parts pr. million (ppm)
40%	10,1	ca. 7900
60%	15,1	ca. 12000
80%	126,8	ca. 16000

http://go.vaisala.com/humiditycalculator/

Cartridge Life Expectancy Calculator

http://webapps.msasafety.com/ResponseGuide/Home.aspx



http://webapps.msasafety.com/responseguide/Home.aspx

The importance of knowing the humidity

MSA *The Safety Company*

Cartridge Life Expectancy Calculator Results

Country:
Norway

Breakthrough Chemical PEL:
n-Hexane
1 hours and 1 minutes at a breathing rate of 60 lpm

Contaminants & Concentrations
n-Hexane, 500 ppm (500 OSHA PEL)

Atmospheric Conditions
Temperature: **20 C**
Humidity: **80 %**
Pressure: **760 mm Hg**

Respirator & Cartridge
Mask: **Full Face Mask EN 148-1 thread**
Cartridge: **90 A1B1E1**

Breakthrough Concentration
Breakthrough Concentration: **10 % of TLV**
Breakthrough Time: **1 hours and 1 minutes**

Humidity (RH%): 80%
Breakthrough Time: 61 minutes

MSA *The Safety Company*

Cartridge Life Expectancy Calculator Results

Country:
Norway

Breakthrough Chemical PEL:
n-Hexane
0 hours and 22 minutes at a breathing rate of 60 lpm

Contaminants & Concentrations
n-Hexane, 500 ppm (500 OSHA PEL)

Atmospheric Conditions
Temperature: **20 C**
Humidity: **100 %**
Pressure: **760 mm Hg**

Respirator & Cartridge
Mask: **Full Face Mask EN 148-1 thread**
Cartridge: **90 A1B1E1**

Breakthrough Concentration
Breakthrough Concentration: **10 % of TLV**
Breakthrough Time: **0 hours and 22 minutes**

Humidity (RH%): 100%
Breakthrough Time: 22 minutes

SAFE

Airline respirators – use of compressed air systems

- When you do not know the concentration of the contaminant,
- It is high humidity,
- Has a beard or other condition that causes a mask leak
- When you can not calculate filter breakthrough time

Breathing Air and Respiratory Protective Equipment

Breathing Air and Respiratory Protective Equipment

Working Together for Safety Recommendation 009E/2017

SfS
Samarbeid for Sikkerhet

Prepared by the Working Together for Safety Working Group: December 2016	Version: Version 01	Working Together for Safety Project Manager: Hugo Halvorsen
Applies from: 1 May 2017		Approved by the Working Together for Safety Board, Chairman: Odd Rune Malterud

Contents

https://samarbeidforsikkerhet.no/wp-content/uploads/2021/04/Recommendation-009E-Breathing-Air-and-Respiratory-Protective-Equipment.pdf

Assigned Protection Factor

Appendix 3: Assigned protection factors for various types of respiratory protective equipment

Type of respiratory protective equipment	Assigned protection factor (OSHA)[10]
Filtering respiratory protective equipment (negative pressure)	
Half mask	10
Full facepiece	50
Fan-assisted filtering respiratory protective equipment	
Half mask	50
Full facepiece	250
Helmet or hood	25-1,000*
Respiratory protective equipment with compressed air supply	
Half mask with continuous airflow	50
Full facepiece with continuous airflow	250
Helmet or hood	25-1,000*
Half mask respirator	1,000
Full facepiece respirator without positive pressure	1,000
Full facepiece respirator with positive pressure**	2,000

OSHA: Occupational Safety and Health Administration (American equivalent of the Norwegian Labour Inspection Authority)

NB: Several overviews of protection factors for various types of respiratory protective equipment are available. We have chosen to refer to OHSA's overview, which we regard as the most recognised within this area.

* Some suppliers are able to document tests which show that it is possible to achieve a protection factor of 1,000 or more. If no such tests have been documented, you should assume that the protection factor is only 25[10].

** Added to the table, since this type of equipment is not listed by OSHA

Checklist for Breathing Air System

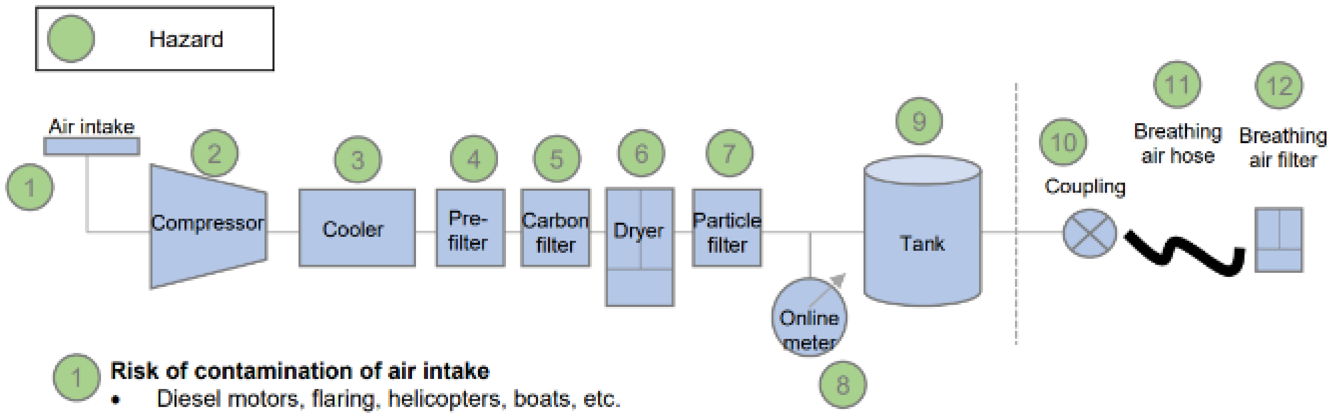
Appendix 2: Sample checklist for breathing air system

	Sample checklist for approval of breathing air system / Operation of mobile compressor system checklist		
	Parts of this list are not relevant to all types of breathing air system. The order of the equipment components may vary from system to system. A risk assessment must be carried out before using the instrument air system for breathing air purposes. The checklist must be completed, and details of any points that the breathing air system does not comply with should be inserted in the comments field.		
	Equipment components	**Checked**	**Actions/Comments**
1	**Air intake**	**Signed:**	
	Is the location of the air intake OK with regard to possible contamination of the air entering the compressor? Possible sources of contamination include diesel motors, flaring, helicopters, boats, hydrocarbons, aspiration of chemicals, painting, washing, leaks, etc.		
2	**Pre-filter**		
	Verify that the correct filter is installed and that maintenance routines have been adhered to.		
3	**Compressor**		
	Is the compressor oil-free? If not (synthetic oil should be used): - Can the oil content be measured using system testing equipment? - Is the oiled compressor equipped with a CO and high-temperature alarm?		
	When using mobile compressors, these must be designed for the supply of breathing air, and the following measurements taken: Minimum monthly: Check the quality of the breathing air (O_2, oil, water, CO and CO_2) at the end user (after the filter unit). Instead of performing this check of the breathing air quality, an online meter may be used. Note: An online meter will not usually feature an oil content detector. Routines must therefore be established for periodic checks – at least twice per year and preferably once per month for systems in continuous use. Logging of the measurements is also recommended in order to monitor any developments and the need to adjust the interval of the periodic checks. Measurements shall be performed by competent personnel. The results shall be logged, and the metering equipment calibrated in accordance with supplier recommendations. Have the measurements been taken in accordance with these? Mobile compressors/systems shall be operated in accordance with the manufacturer's operation and servicing requirements, unless otherwise agreed.		
	Maintenance of compressors: Compressors for breathing air shall be subject to a preventive maintenance programme, including checks of the quality of the breathing air. With regard to maintenance of the breathing air system, the following shall be documented: • Oil change / compressor oil consumption • Checking and replacement of compressor filter • Functional checks of draining and safety valves • Repairs / service performed on the system • System irregularities • Compressor operating instructions must be available		

https://samarbeidforsikkerhet.no/wp-content/uploads/2021/04/Recommendation-009E-Breathing-Air-and-Respiratory-Protective-Equipment.pdf

Breathing Air – Input for Risk Analysis

Appendix 1: Breathing air – input for risk analysis



1 **Risk of contamination of air intake**
- Diesel motors, flaring, helicopters, boats, etc.
- Aspiration of chemicals; painting, washing, leaks, etc.

1 **Risk of contamination of air intake**
- Diesel motors, flaring, helicopters, boats, etc.
- Aspiration of chemicals; painting, washing, leaks, etc.

2 **Compressor**
- Heating of oil releases CO and gases
- Selection of oil type – must be synthetic
- Risk of technical faults on the compressor

3 **Mechanical cooler**
- Possibility of contamination/infiltration

4 **Pre-filter (if applicable)**
- Insufficient maintenance – changing of filter

5 **Carbon filter (if applicable)**
- Insufficient maintenance – changing of filter

6 **Dryer – maintenance routines**
- Electrical heating when regenerating; smouldering (CO), short circuit
- Contamination of oil/water
- Pneumatic failure of regeneration

7 **Afterfilter**
- Maintenance – changing of filter

8 **Online quality metering / breathing air (and dew point meter)**
- Alarms for CO/CO_2 and O_2

9 **Air tank**
- Insufficient cleaning of tank
- Incorrect cleaning agent

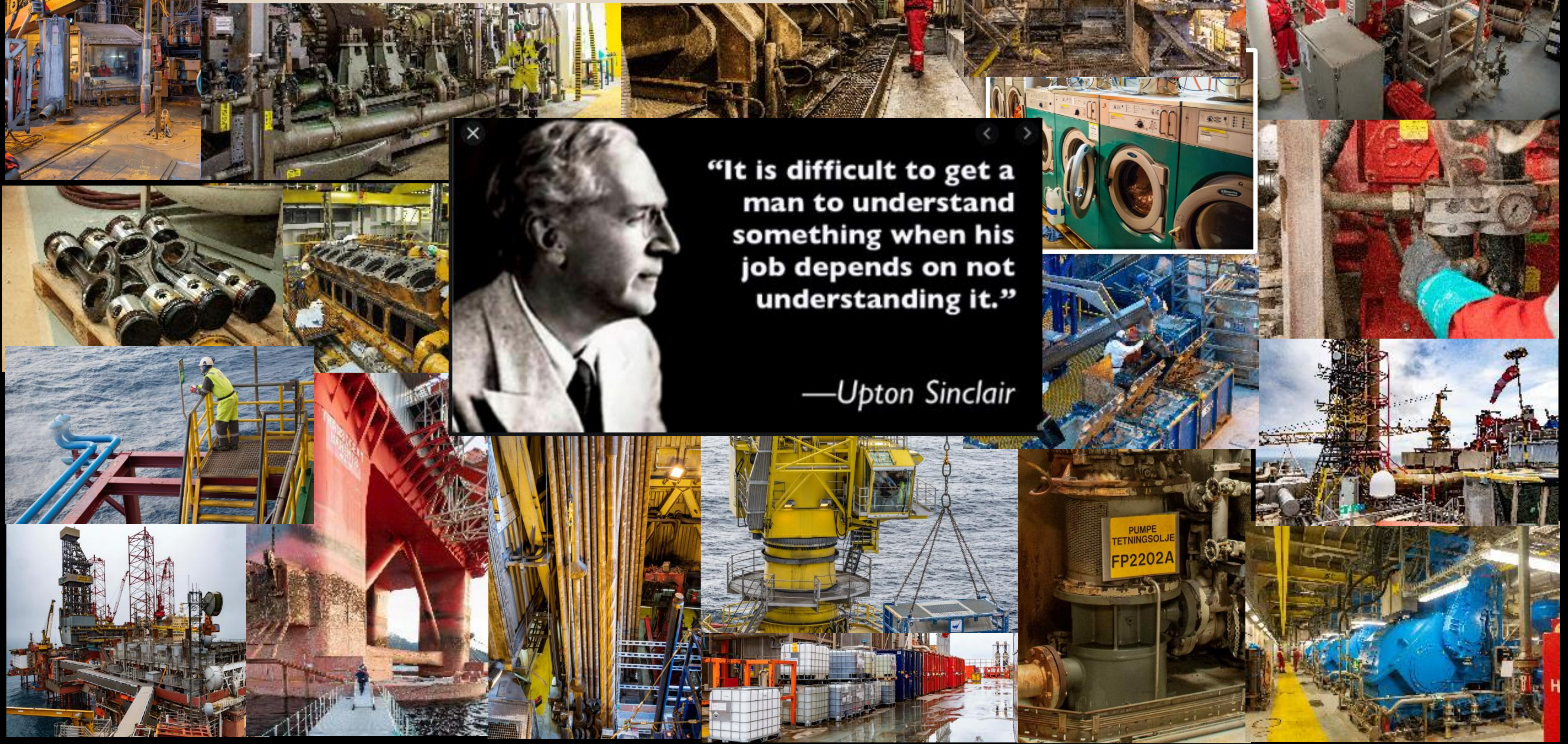
10 **Couplings**
- Risk of contamination from other systems (working air system, etc.)?
- Possible to connect wrong hose types (unique couplings, labelling)?
- Risk of couplings loosening?

11 **Breathing air hose**
- Risk of the hose being used for purposes other than breathing air?
- Does the hose fulfil the requirements of the environment in which it shall be used (heat resistance, anti-static, etc.)?

12 **Breathing air filter**
- Preventive maintenance programme established?
- Must have two-stage filter: pre-filter (removes particles) and carbon filter (removes oils and oil vapour)

NB! Very few of the incredibly many work operations have been mapped with regard to exposure. In the case of occupational disease investigations, missing data will be interpreted as little exposed and not documented.





What can be done to reduce the risk?

- ✓ First: Recognize that benzene is extremely carcinogenic.
- ✓ Apply the recognition to the working environment by: Drilling mud treatment, cuttings treatment, choice of protective equipment.
- ✓ Apply the recognition to drilling: Can new drilling fluid systems reduce the mixing of crude oil in the drilling mud?

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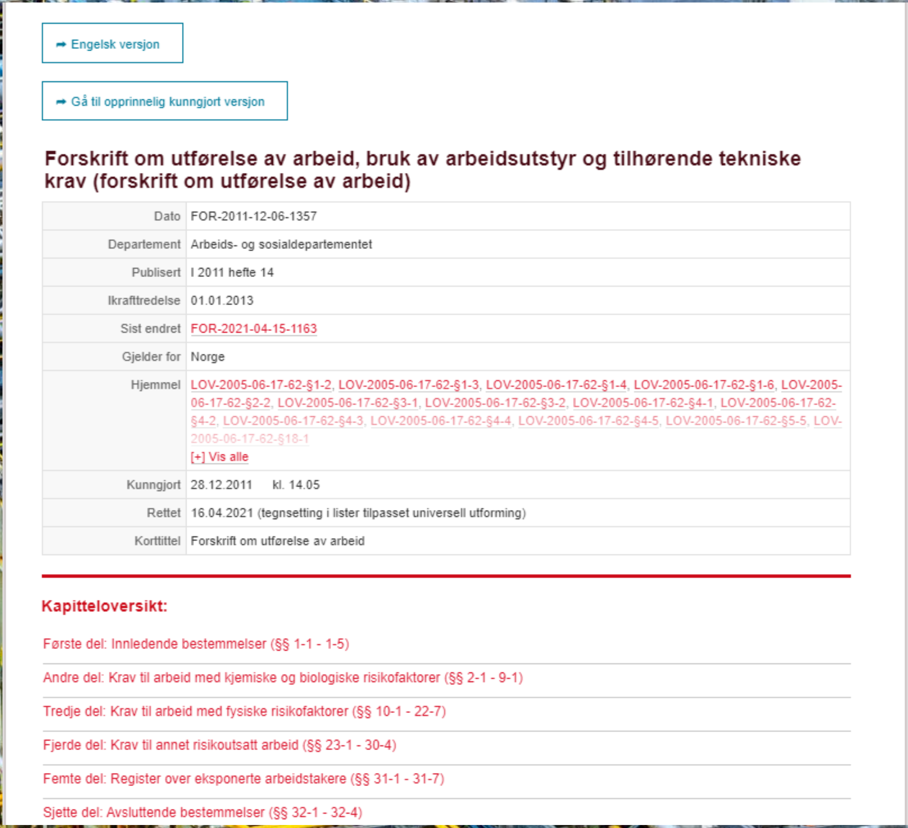
SAFE

Norwegian Union of Energy Workers

www.safe.no

Arbeidsmiljøloven.
Forskrift om utførelse av arbeid, bruk av arbeidsutstyr og tilhørende tekniske krav (forskrift om utførelse av arbeid)



➡ Engelsk versjon

➡ Gå til opprinnelig kunngjort versjon

Forskrift om utførelse av arbeid, bruk av arbeidsutstyr og tilhørende tekniske krav (forskrift om utførelse av arbeid)

Dato	FOR-2011-12-06-1357
Departement	Arbeids- og sosialdepartementet
Publisert	I 2011 hefte 14
Ikrafttredelse	01.01.2013
Sist endret	FOR-2021-04-15-1163
Gjelder for	Norge
Hjemmel	LOV-2005-06-17-62-§1-2, LOV-2005-06-17-62-§1-3, LOV-2005-06-17-62-§1-4, LOV-2005-06-17-62-§1-6, LOV-2005-06-17-62-§2-2, LOV-2005-06-17-62-§3-1, LOV-2005-06-17-62-§3-2, LOV-2005-06-17-62-§4-1, LOV-2005-06-17-62-§4-2, LOV-2005-06-17-62-§4-3, LOV-2005-06-17-62-§4-4, LOV-2005-06-17-62-§4-5, LOV-2005-06-17-62-§5-5, LOV-2005-06-17-62-§18-1 [+] Vis alle
Kunngjort	28.12.2011 kl. 14.05
Rettet	16.04.2021 (tegnsetting i lister tilpasset universell utforming)
Korttittel	Forskrift om utførelse av arbeid

Kapitteloversikt:

https://lovdata.no/dokument/LTI/forskrift/2015-06-26-806

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Benzene and worker cancers: 'An American tragedy'

by Kristen Lombardi December 4, 2014

Shutterstock; Courtesy of the Bowers, Boley, Milward and Wright families

Reading Time: 2 minutes

Key findings:

- For decades, the petrochemical industry spent millions on science seeking to minimize the dangers of benzene, a carcinogen tied to leukemia and other cancers.
- Benzene, a sweet-smelling component of crude oil, is used to make plastics, lubricants, dyes, adhesives and pesticides. It's also a key ingredient in gasoline and cigarettes, and it's the 17th most produced chemical in the U.S.
- A 2004 National Cancer Institute study suggested there's no safe threshold for people working with the chemical.
- Our review of some 20,000 pages of internal records reveals the petrochemical industry went to great lengths to rebut studies showing harmful effects of benzene in low doses.
- While seeking funding, the industry's lobby touted how the expected results of a proposed study in China could be used to reduce liability and combat stricter regulation.

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Bloated and bed-ridden, his skin browned by blood transfusions, John Thompson succumbed to leukemia on November 11, 2009.

A carpenter by trade, Thompson, then 70, had spent much of his life building infrastructure for the petrochemical industry in his native Texas — synthetic rubber plants in Port Neches, chemical facilities in Orange. Throughout the 1960s and early 1970s, he often encountered benzene, stored on job sites in 55-gallon drums, which he used as a cleaning solvent. He dipped hammers and cutters into buckets full of the sweet-smelling liquid; to expunge tar, he soaked gloves and boots in it.

Thompson never figured the chemical could do him harm. Not when it stung his hands or turned his skin chalky white. Not even when it made him faint. But after being diagnosed with a rare form of leukemia in 2006, relatives say, he came to believe his exposure to benzene had amounted to a death sentence. Oil and chemical companies knew about the hazard, Thompson felt, but said nothing to him and countless other workers.

"They put poison on his skin and in the air he breathed," said Chase Bowers, Thompson's nephew. "He died because of it."

Thompson died before a lawsuit filed by his family against benzene suppliers could play out in court, where science linking the chemical to cancer could be put on display. Over the past 10 years, however, scores of other lawsuits, most filed by sick and dying workers like Thompson, have uncovered tens of thousands of pages of previously secret documents detailing the petrochemical industry's campaign to undercut that science.

Internal memorandums, emails, letters and meeting minutes obtained by the Center for Public Integrity over the past year suggest that America's oil and chemical titans, coordinated by their trade association, the American Petroleum Institute, spent at least $36 million on research "designed to protect member company interests," as one 2000 API summary put it. Many of the documents chronicle an unparalleled effort by five major petrochemical companies to finance benzene research in Shanghai, China, where the pollutant persists in workplaces. Others attest to the industry's longstanding interest in such "concerns" as childhood leukemia.

Exposed: Decades of denial on poisons

Search this archive of previously secret oil and chemical industry communications showing the extent of corporate knowledge about toxic substances that have killed or impaired millions. Read more

LIMIT TO: vinyl chloride | benzene

Search for a word or phrase in the collection | SEARCH

https://publicintegrity.org/environment/benzene-and-worker-cancers-an-american-tragedy/