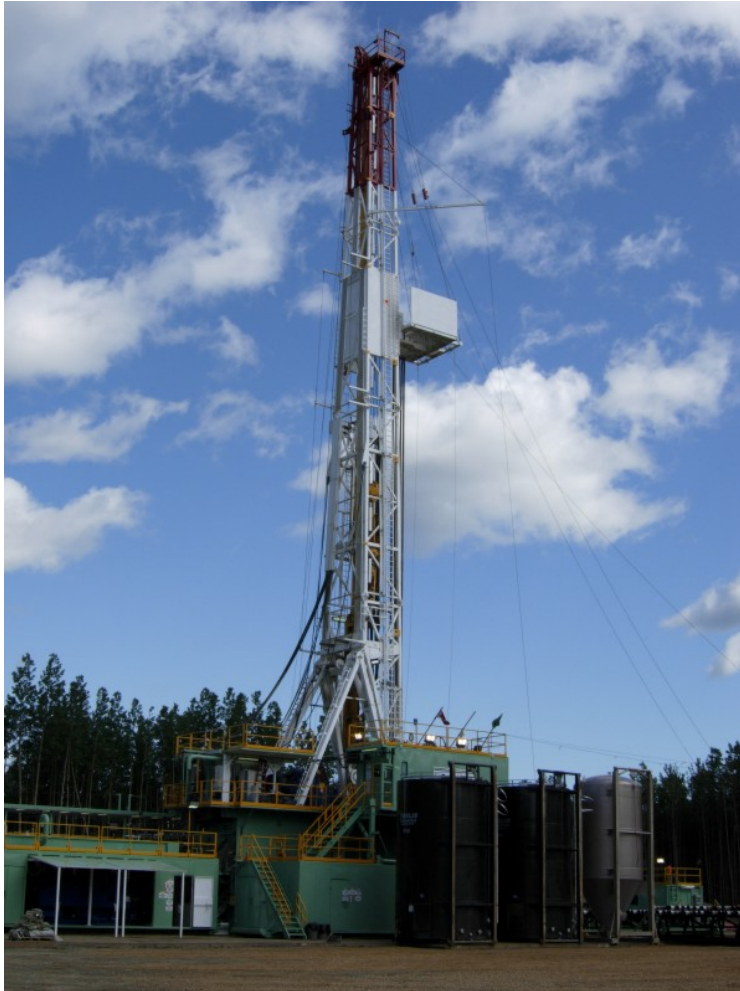


Oil & Gas Industry

Worker Exposure to Drilling Fluids



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Types of Drilling Fluids

- **Water-based** (fresh or seawater; used in off-shore platforms or in environmentally sensitive areas).
- **Oil-based** (diesel oil, mineral oil or synthetic oil; used when drilling through shales).
- **Gas-based** (air, air and water foam, or natural gas; used in very stable formations – speeds drilling).
- Most common types used in B.C. are mineral and synthetic oil-based fluids (little diesel).

Health Effects

- Dizziness (hydrocarbons)
- Headaches (hydrocarbons)
- Drowsiness (hydrocarbons)
- Nausea (hydrocarbons)
- Irritation and inflammation of the respiratory system (oil mist)
- Dermatitis (hydrocarbons)
- Cancer (PAHs, benzene and mildly refined oil mist)
- Skin sensitization (hydrocarbons)

Base Constituents of Concern

Substance	ACGIH TLV (8 hr)	WCB EL (8 hr)	WCB EL (12 hr)
Benzene	0.5 ppm	0.5 ppm	0.25 ppm
Ethyl benzene	100 ppm	100 ppm	50 ppm
Toluene	20 ppm	20 ppm	10 ppm
Xylene	100 ppm	100 ppm	50 ppm
Diesel (as THC)	100 mg/m ³	100 mg/m ³	50 mg/m ³
Oil mist (mildly refined)	5 mg/m ³	0.2 mg/m ³	0.1 mg/m ³
Oil mist (severely refined)	5 mg/m ³	1 mg/m ³	0.5 mg/m ³

The base “oil” makes up 80% to 100% of the drilling fluid.

Common Additives to Drilling Fluid

- Barite
- Bentonite
- Calcium carbonate
- Calcium hydroxide
- Calcium oxide
- Diesel fuel
- Emulsifiers
- Glutaraldehyde
- Glycols & esthers
- Graphite (carbon)
- Gypsum
- Mica
- Recycled newsprint
- Silica (quartz)
- Sodium bicarbonate
- Sodium carbonate
- Canola/peanut/coconut oil
- Water

There are more than 250 chemicals that can be added to drilling fluid.

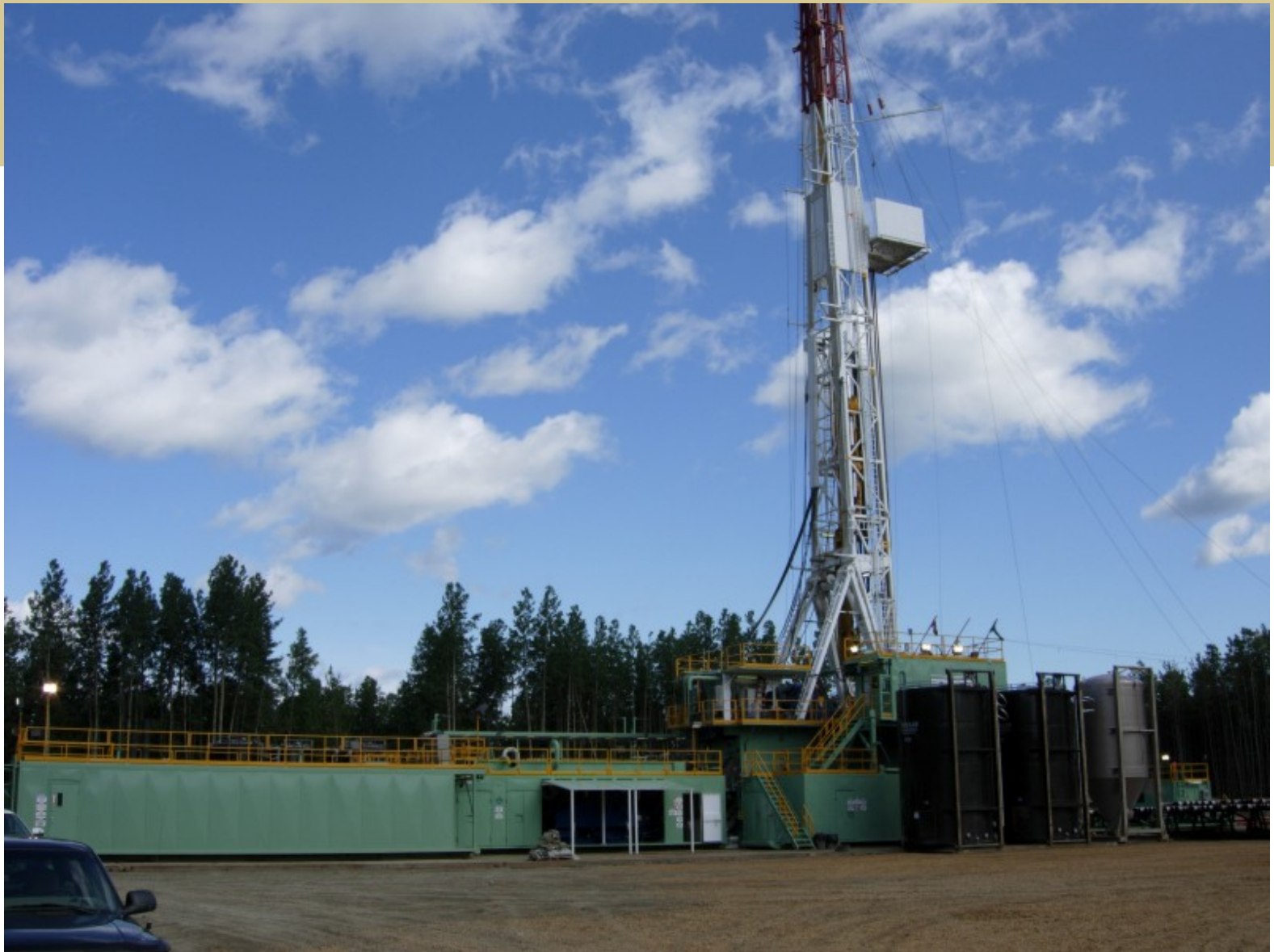
Occupational Sampling Results from Industry

Invert Drilling Fluids - Exposure Measurements Summary

Worker/Area	Sample Type	Benzene ppm	Ethylbenzene ppm	Toluene ppm	Xylene ppm	THC mg/m ³	THC mg/m ³	Oil mist mg/m ³	Oil mist mg/m ³
Assistant Derrick	Occ	0	0	0	0	0.85	0.85		
Derrick Man	Occ	0.04	0.08	0.1	0.1	30	30	1	1
Driller	Occ	0.02	0.09	0.1	0.11	8	8		
Lease Hand	Occ	0.01	0.08	0.1	0.09	7	7		
Motor Man	Occ	0.03	0.09	0.1	0.1	11.1	11.1	0.3	0.3
Rig Manager	Occ	0.02	0.29	0.01	0.1	8	8		
Roughneck	Occ	0.2	0.4	0.73	5	24	24	1.4	1.4
Agitator	Area	0.025	0.11	0.12	0.6	75.4	75.4	2.7	2.7
Chemical Mixing Room	Area					26.8	26.8		
Doghouse	Area	0.001	0.001	0.001	0.001				
Drilling Floor	Area	0.5	0.04	0.04	0.11	30.5	30.5	0.42	0.42
Flare Tank and Flare Stack	Area					14.8	14.8		
Mixing Station	Area	0	0	0	0.23	1.9	1.9	1.5	1.5
Mud Pit/Tanks	Area	0.6	0.08	0.1	0.2	137	137	1	1
Shakers	Area	0.6	0.43	0.5	2.7	240	240	3.2	3.2

Assume diesel Assume kerosene Assume mildly refined Assume severely refined

 Exceeds 12 hr OEL
 Exceeds 50% of 12 hr OEL













WorkSafeBC Sampling Results

Rig	Sample Type	Worker or Location	Oil Mist (mg/m ³)	WCB 12hr EL Mildly Refined (mg/m ³)	WCB 12hr EL Severely Refined (mg/m ³)
Rig 1	Occupational	Derrickhand	< 0.05	0.1	0.5
	Occupational	Roughneck	< 0.05		
	Occupational	Roughneck	< 0.05		
	Area	Shaker	< 0.08		
	Area	Drill Floor	< 0.05		
Rig 2	Occupational	Roughneck	< 0.07		
	Occupational	Roughneck	< 0.08		
	Occupational	Derrickhand	0.80		
	Area	Shaker	0.29		
	Area	Drill Floor	< 0.05		

How Do You Control Exposure?



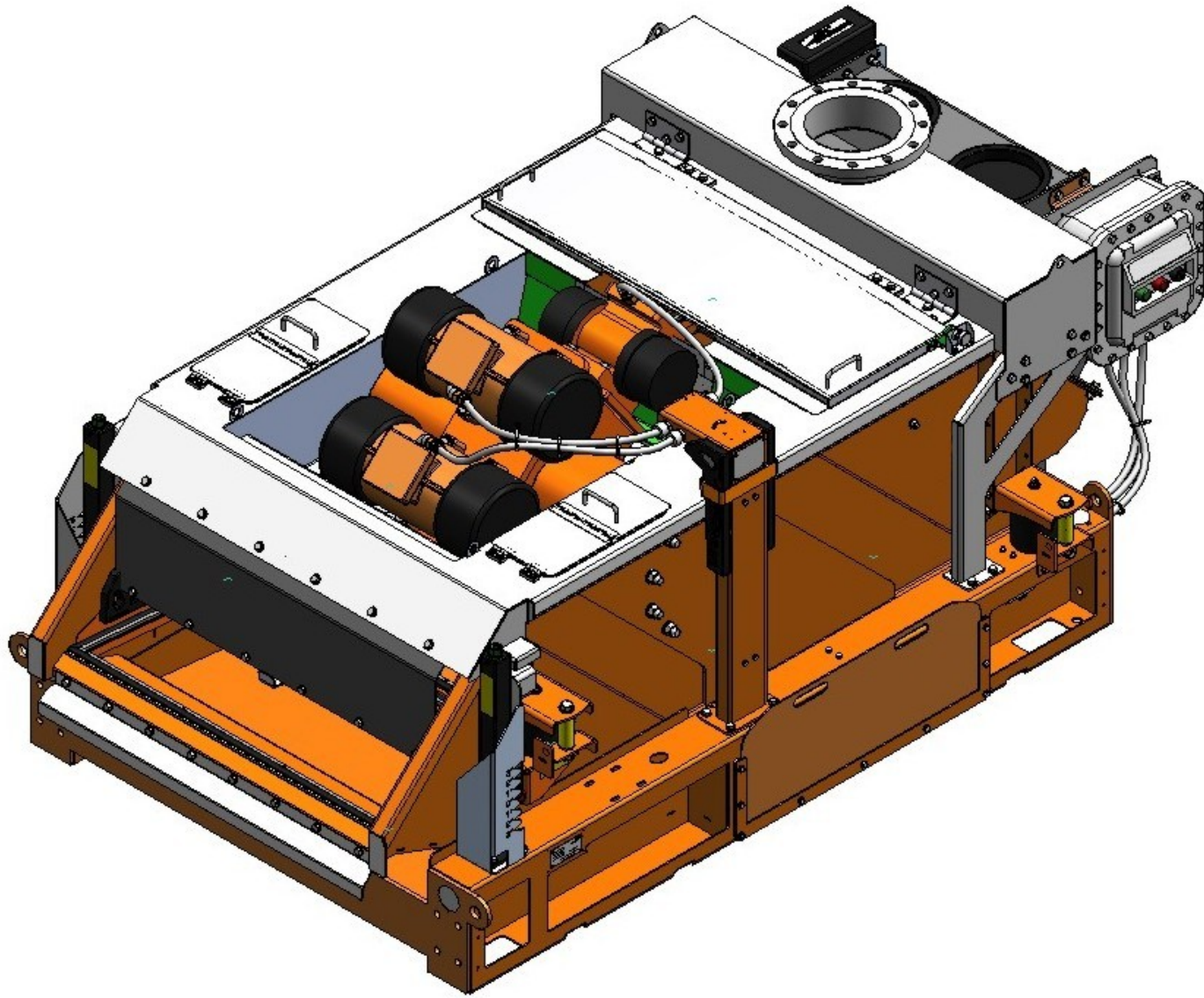
1. Substitute to produce a less hazardous situation
2. Provide engineering controls
3. Apply administrative controls
4. Provide personal protective equipment

Substitution Considerations

- Do not use diesel-based drilling fluids (health issues, fires & explosions).
- Oil in oil-based fluids should be “severely” refined (to remove aromatic hydrocarbons).
- Synthetic fluids have fewer (or no) aromatics.
- Low viscosity synthetic fluids may release more hydrocarbons.
- Health effects from “additives”.
- All fluids may become contaminated while in the drill hole.

Engineering Control Considerations

- Exhaust ventilation (e.g., canopies) for Shakers and other areas where fluid is agitated; should be equipped with condensers.
- More ventilation may be required in “enclosed” areas (e.g., partially covered or completely enclosed rigs).
- Enclose Mud Tanks and use remote sensors for inspection.
- Use automatic mud sampling devices.
- Remote handling for solid and liquid “additives” (e.g., pump liquids into the mixing system; handle solids in bulk form from pre-loaded containers).
- Place barriers between travel pathways (decking and stairwells) and Shakers.





Administrative Control Considerations

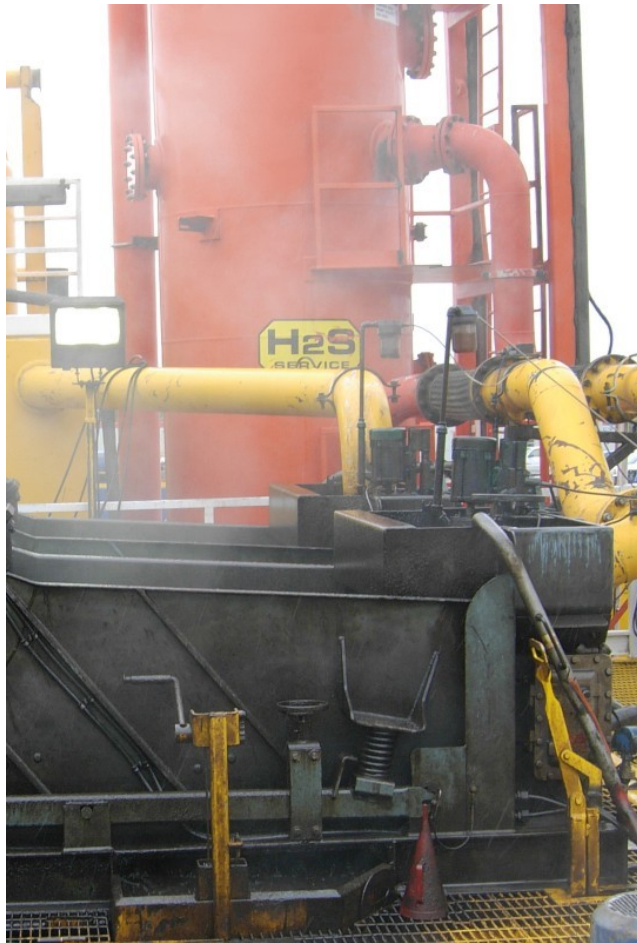
- Hygiene (wash) facilities in the Doghouse.
- Do not wash hands with diesel or other oils.
- Plan short durations in high exposure areas (e.g., around the shakers).
- Do not use diesel in spray/wash guns.
- Use covered part washers.
- Worker awareness and training.
- Accurate MSDS sheets.
- Rig-specific controls (e.g., for chemical mixing rooms).

Personal Protective Equipment Considerations

- **Eye protection** (safety glasses with side shields, goggles, full facepiece).
- **Safety footwear** (chemically resistant).
- **Protective clothing** (fire & chemical resistant coveralls – e.g., Nomex).
- **Disposable coveralls** (to protect from invert mud, e.g., polypropylene)
- **Skin protection**
 - Barrier creams
 - Gloves (e.g., Viton; not leather or fabric).
- **Respirators** (half-face or full-face with combination HEPA/organic vapour cartridges; some hood/helmets).



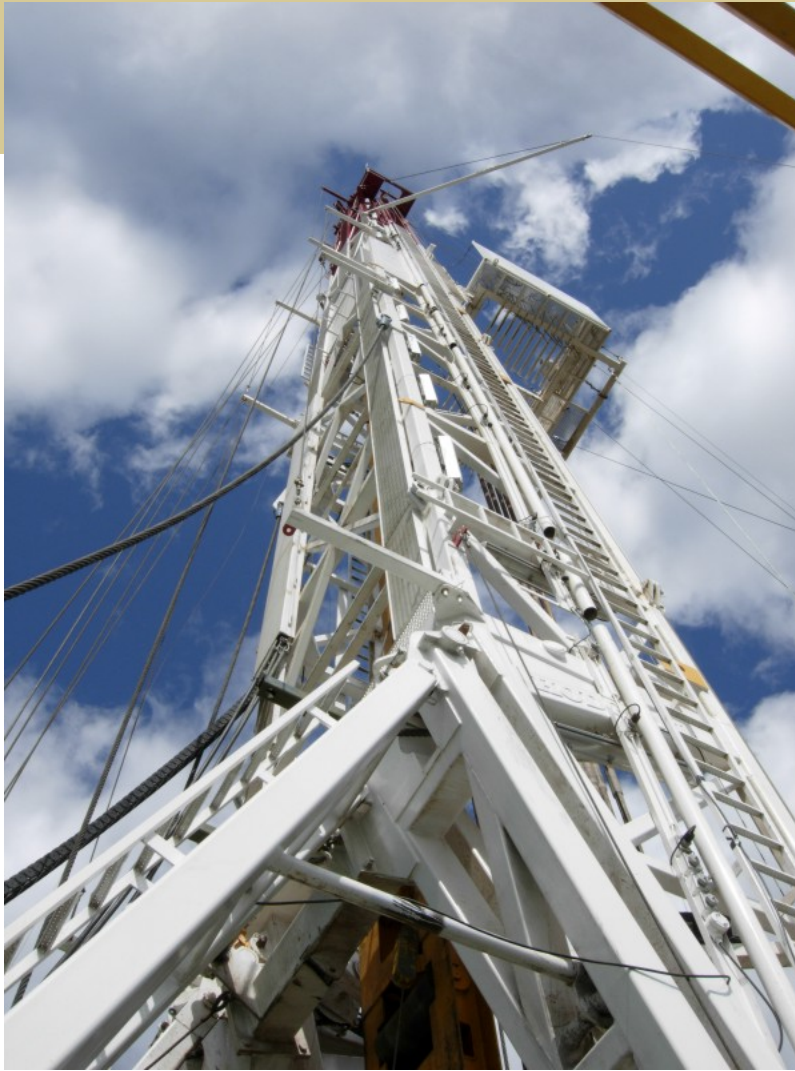
Other Hazardous Substances



- Hydrogen sulfide (H_2S)
- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Diesel fumes

Next Steps ...

- Develop exposure control plans for Drilling Rigs.
- Continue to work to reduce worker exposure to hydrocarbons from drilling fluids.



Discussion?