



Measurement of Diesel Particulate Matter (DPM) at Oil and Gas Extraction Sites

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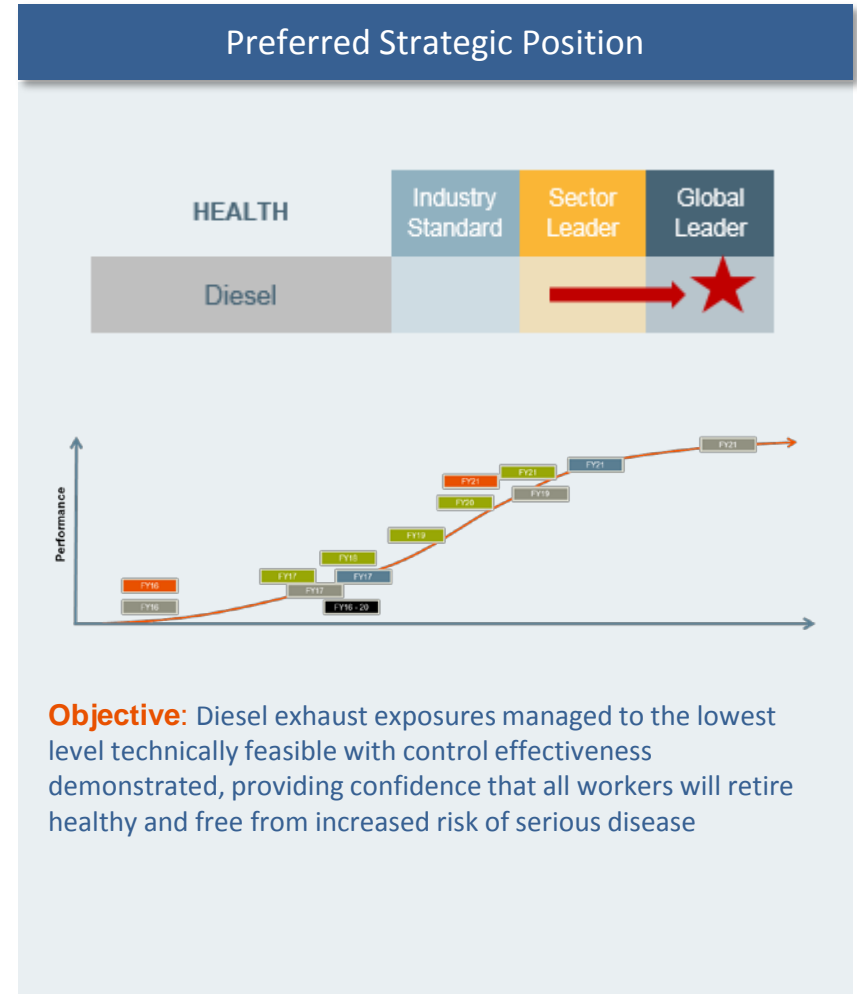
Protecting the health of our people

Our Value: Sustainability

Putting health and safety first, being environmentally responsible and supporting our communities.

Our HSE Framework is critical to protecting the long-term health of our people

- Sustainability Charter
- Corporate Standards
- Regular reporting of leading and lagging indicators to the Executive Leadership Team (ELT) and Board
- Global Strategic Position statements and Maturity Curves
- Annual ELT Key Performance Indicators tied to long term health public targets



Company Standards - Setting internal occupational exposure limits



Why this is important?

- Science continues to evolve but regulations lag far behind
- Default to regulatory limits would result in a material risk to our people

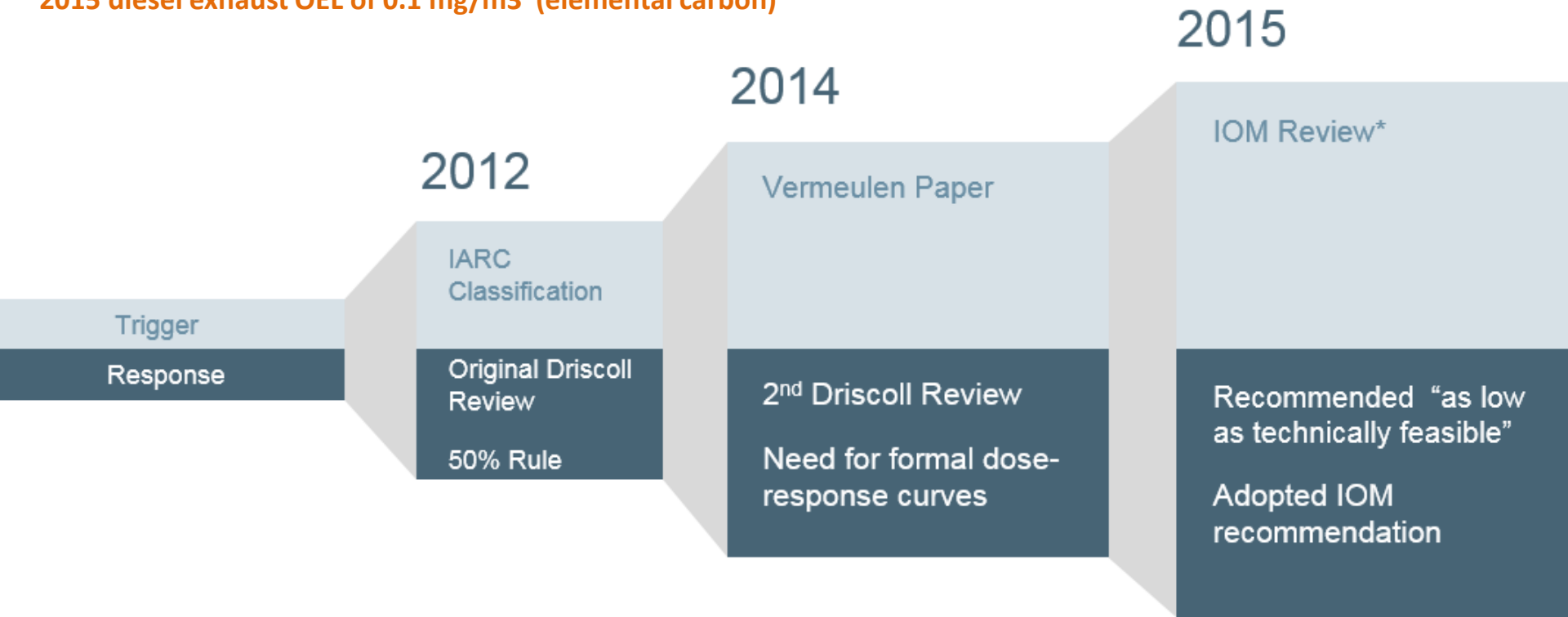
What is the process?

- Continuous monitoring of the science
- Annual benchmarking with Peers
- Independent expert review triggers



Diesel OEL review process

2015 diesel exhaust OEL of 0.1 mg/m³ (elemental carbon)



* IOM Report is posted online: MSHA – Public comments on Exposure of Underground Miners to Diesel Exhaust (AB86-Com-5-1)

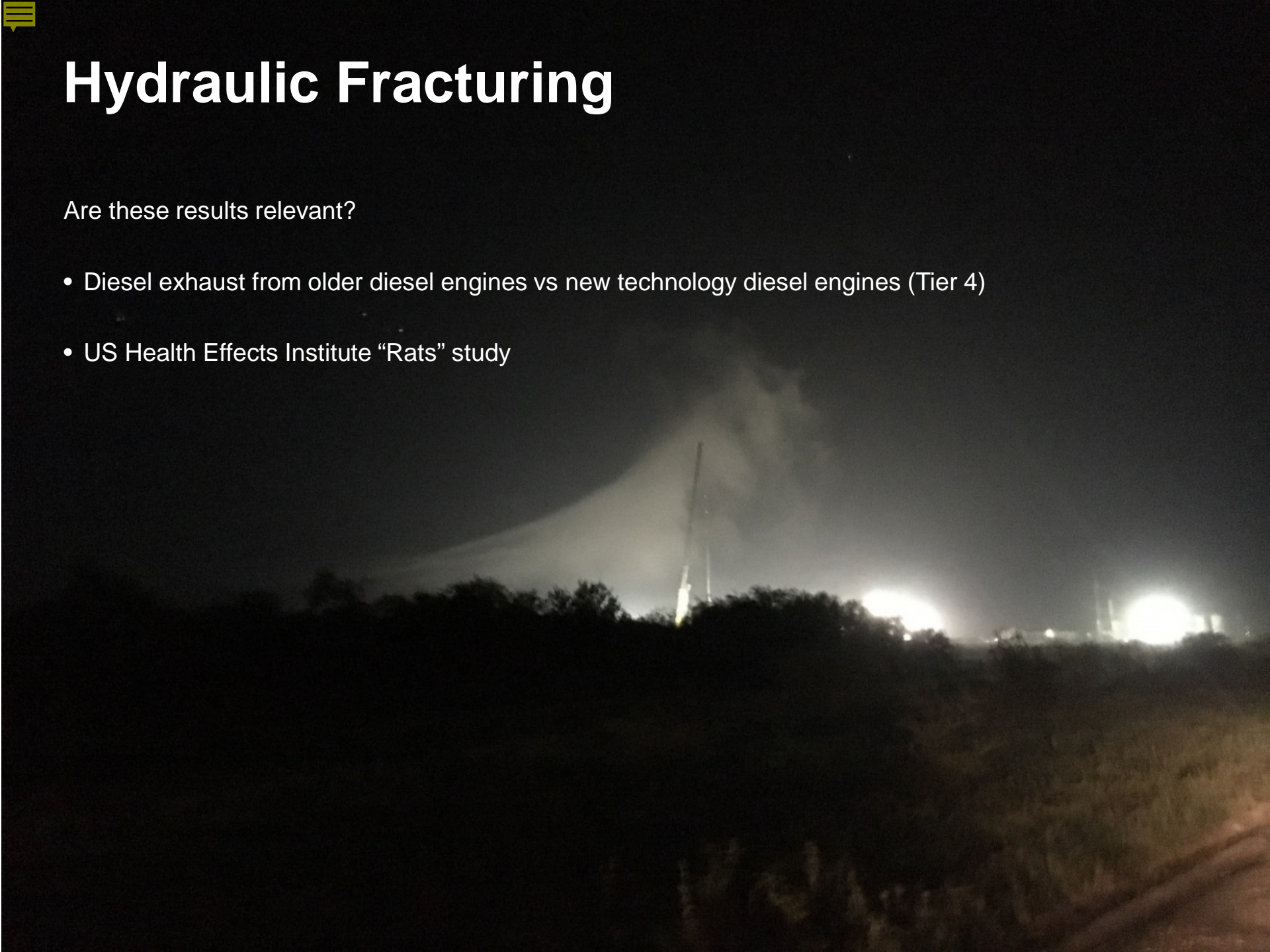


November 29-30, 2016

Hydraulic Fracturing

Are these results relevant?

- Diesel exhaust from older diesel engines vs new technology diesel engines (Tier 4)
- US Health Effects Institute “Rats” study



Shale Completions - Current Status

Current Operations

- Exposure risk is on Hydraulic Fracturing locations.
- Committed to managing exposures to “as low as technically feasible”
- Initial target of 30 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)
- Key challenge is lack of access to the highest tier, reduced activity to verify effectiveness of controls or suitable electric substitutes based on reduced activity

Design into potential future hydraulic fracturing campaigns

- Eliminate diesel where feasible
- Where not Tier 4 Final where available

Engage with others

- Share information and how we are responding
- Stimulate discussion and debate



Shale Completions - Field Assessments

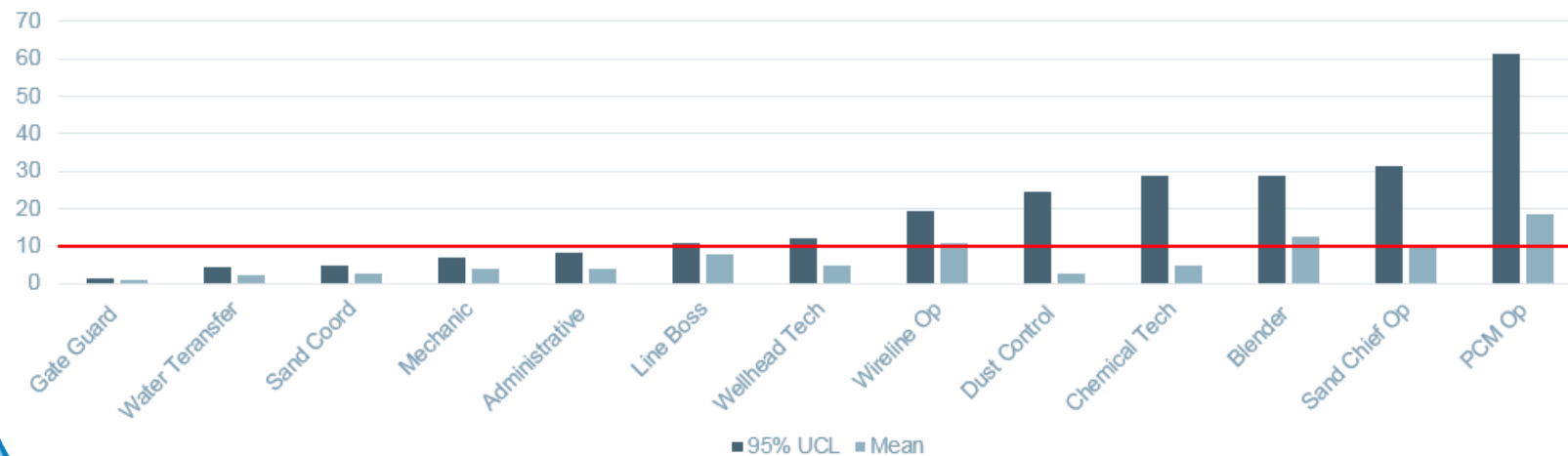
What has been done?

- Prior to late 2015, Qualitative risk assessment completed for Shale Operations
- Permian and Eagle Ford Basins

Sampling challenges:

- Limited number of samples per job function
- Sampling errors/malfunctions
- Environmental Factors

Exposure SEG on BHPB Hydraulic Fracturing Sites (as EC ug/m3)



DPM Controls Suggestions - Hydraulic Fracturing Sites

Currently verifying the effectiveness of:

- Reducing excessive idling
- Reviewing Site Orientation
- Setting in-house emissions standards
- Training workforce on exposure situations
- Measuring exposures utilizing real-time instruments
- Using newer, higher Tier engines and retiring older, dirtier engines (Tier 2, some T3)
- Using high quality low sulphur fuel and ensuring the quality of fuel delivered to the vehicle and its engine



Summary

Occupational Exposure Limits

- No US limit

HF Exposure Assessments

- Exposure during hydraulic fracturing can exceed 10 $\mu\text{g}/\text{m}^3$ for anyone on location, downwind from the hydraulic fracturing pumps.

What can you do?

- If you are in oil and gas – conduct internal review of OEL and Risk Assessments
- Identify current controls in place
- Evaluate if additional controls can be used

