



# **PGI Drilling and Completions Noise Project**

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**Principal Inspector – Rigs**  
**RSHQ**





# PGI Noise Project

a/- PI Well Ops – Donna Jamieson



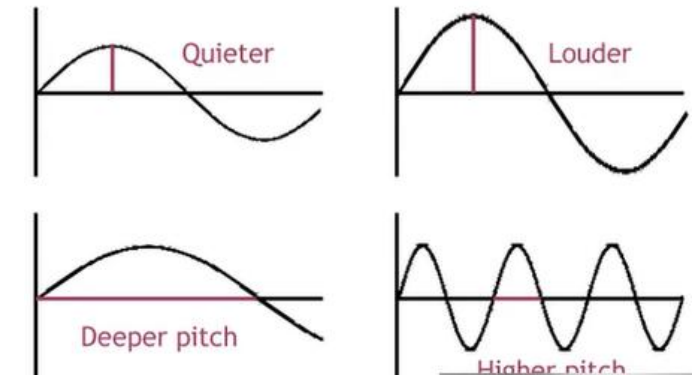
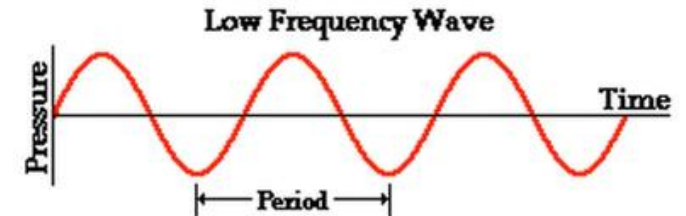
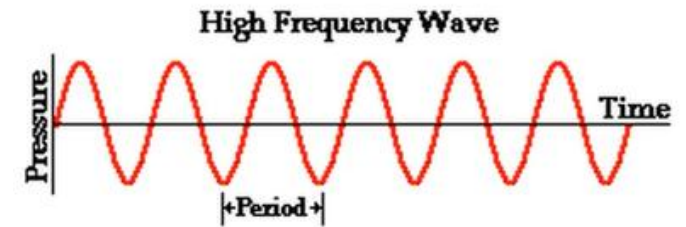


## Project scope - 2021

- Understand risk of hazardous noise across D&C *operating plant* & operations
- Gather qualitative data:
  - 80 personal noise assessments
  - ~500 area noise measurements
- Understand current risk mitigation strategies & use data to inform potential controls

# Noise and how we hear

- Sounds are pressure waves in a medium (solid, liquid or gas i.e. air), radiating from the source
- Analogue signal – mechanical vibration – electrochemical signal – brain for interpretation
- Loudness of noise is the frequency (Hz) & intensity (size)
- 12-hr shift target noise level:
  - $L_{Aeq}$  82 dB(A)
  - $L_{C,peak}$  140 dB(C)
- To quantify risk of decibels – equal energy rule
  - Double the energy = double the risk
  - 20dB increase = 100-fold energy increase



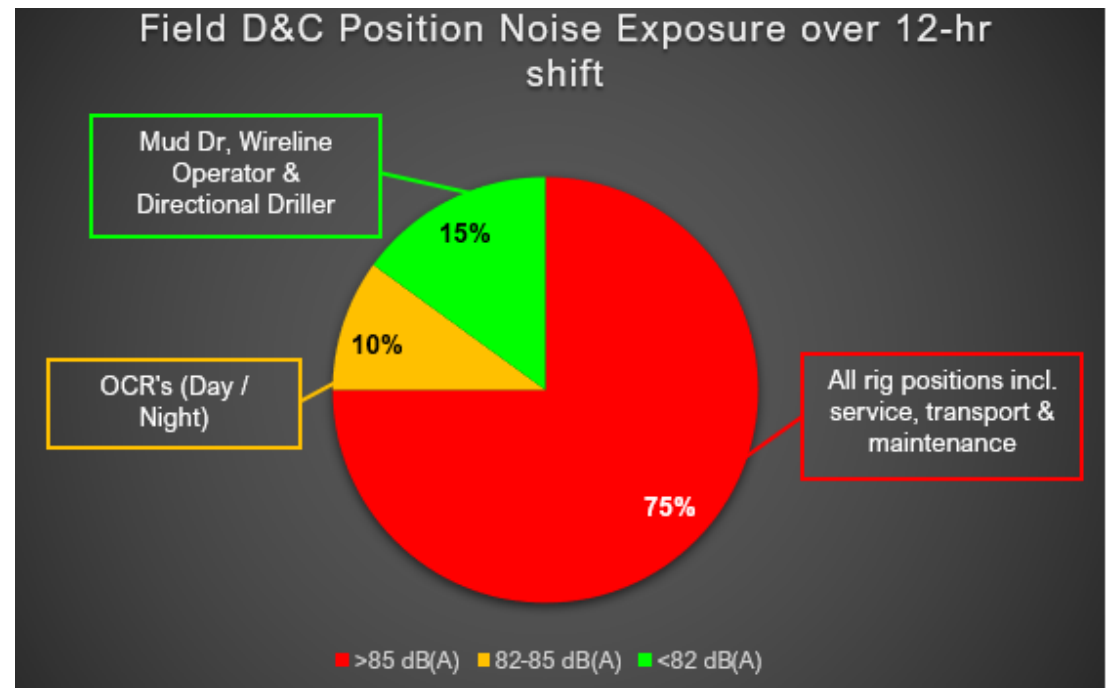
# Personal noise exposures

- **22 field positions sampled**

- 3 - below 82 dB(A)
- 2 - in action zone 82-85 dB(A)
- 15 – above 85 dB(A)

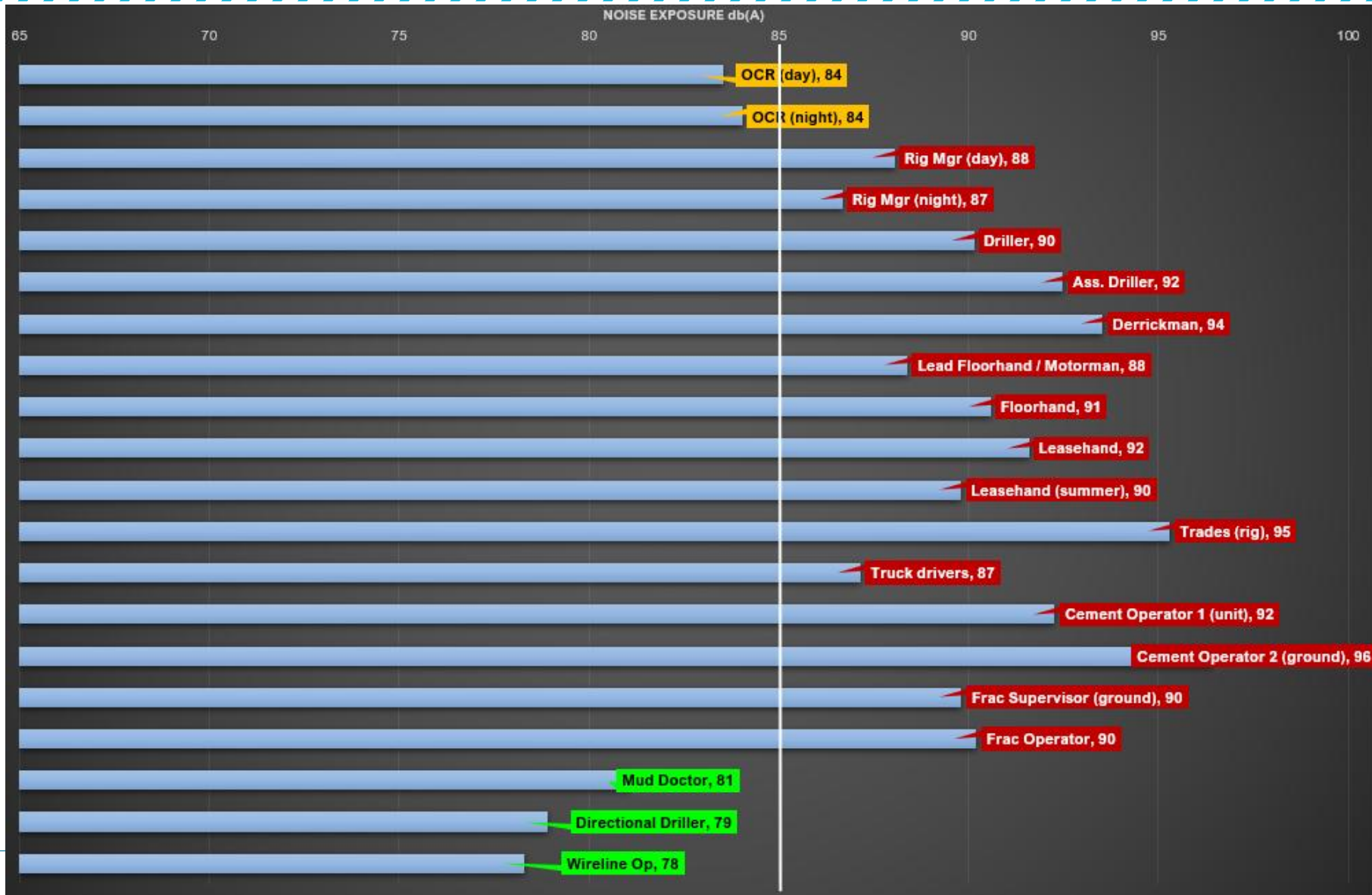
- **HPD (PPE) worn**

- ✓ 69%
- × 22%
- ? 9%





D&C field position average personal noise exposure



# Noise adverse health effects

- Noise Induced Hearing Loss (NIHL), 4,000Hz
- Acoustic trauma
- Temporary / Permanent Threshold Shift
- Tinnitus
- Fatigue & cardiovascular disorders incl. high blood pressure & heart disease
- Ototoxins





# Area Noise Measurements

## **D&C *operating plant & activities***

- Drilling & Well Servicing Rigs incl. trades
- Ancillary equipment incl.
  - Cement units
  - Wireline
  - Frac
  - Fluid management
  - Flowback

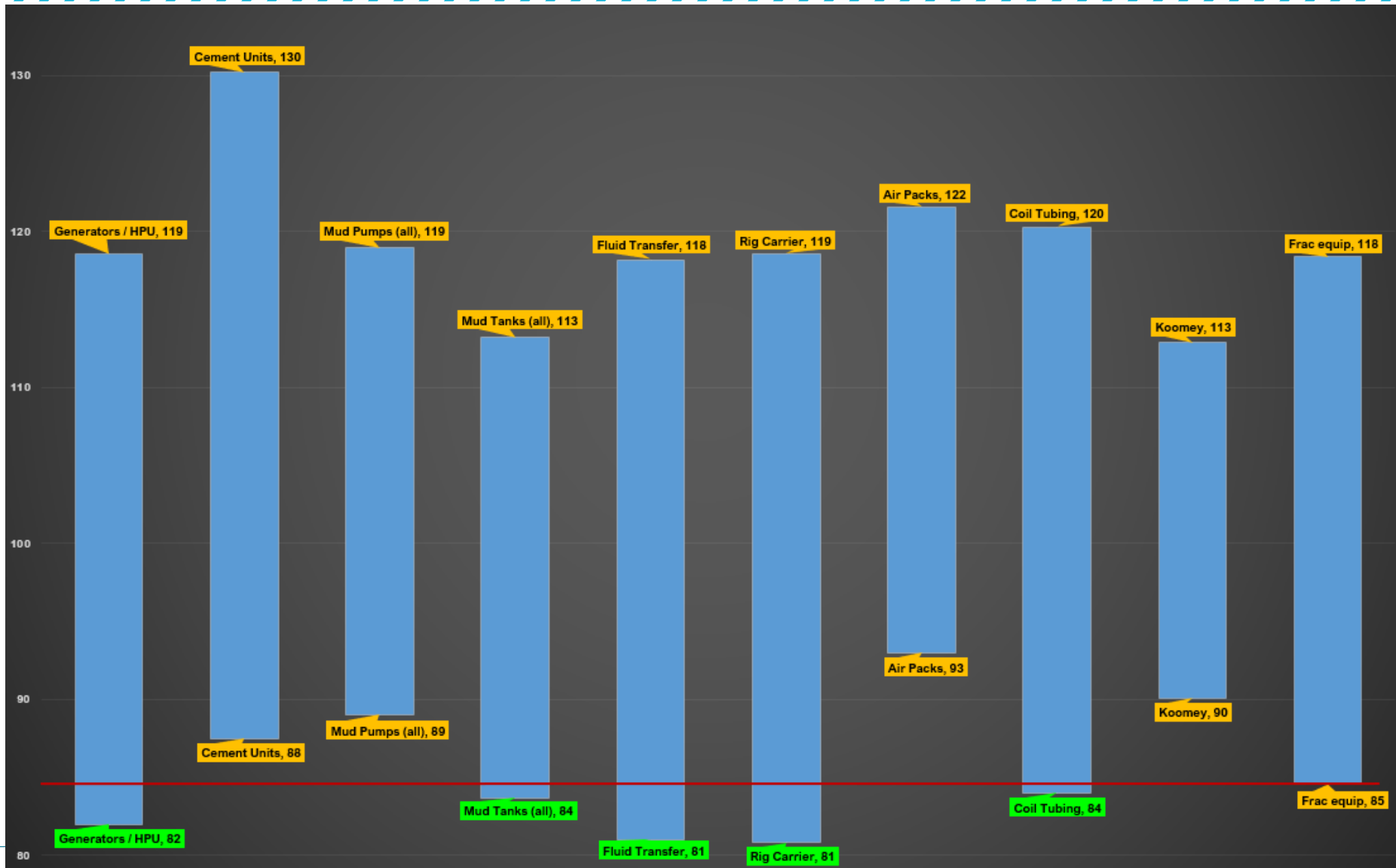
## **45% above, 55% below 85dB(A)**

- Equipment & operational noise mostly above except flowback,
- Lease below 82 dB(A) with exceptions.

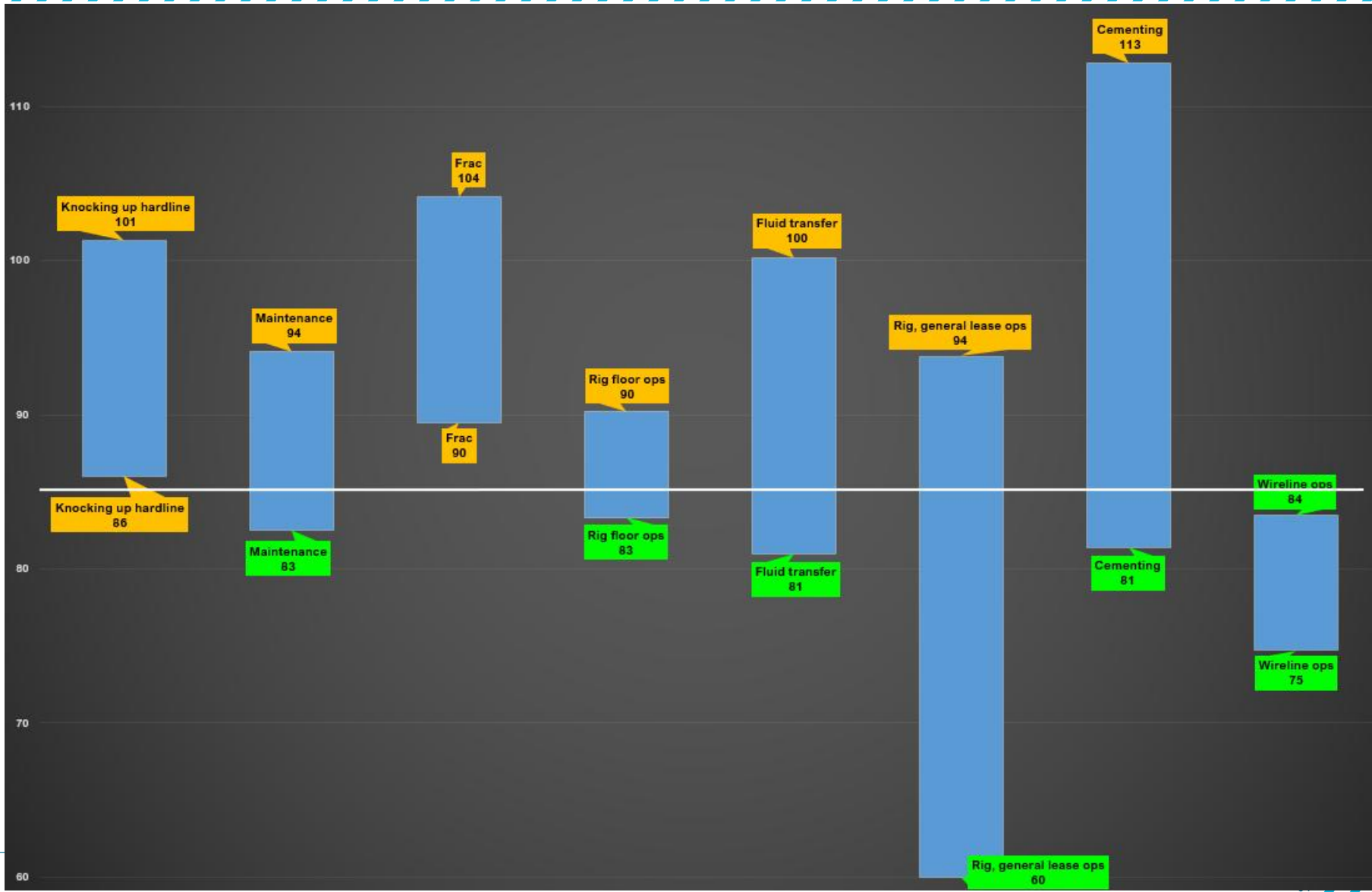




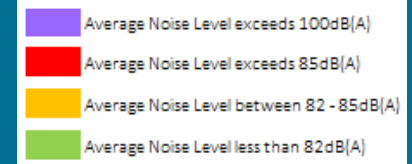
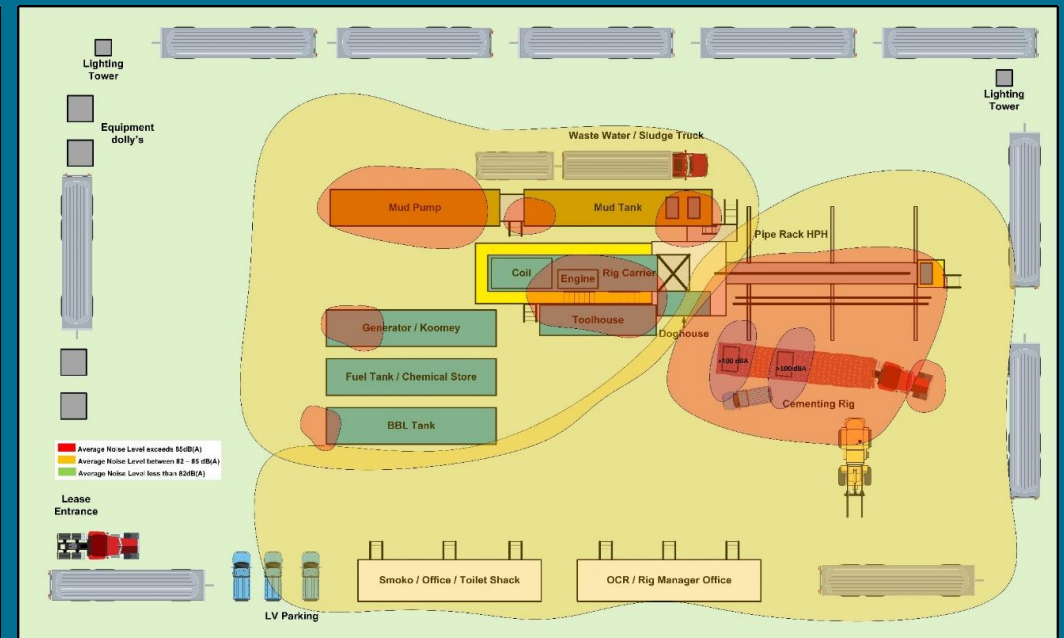
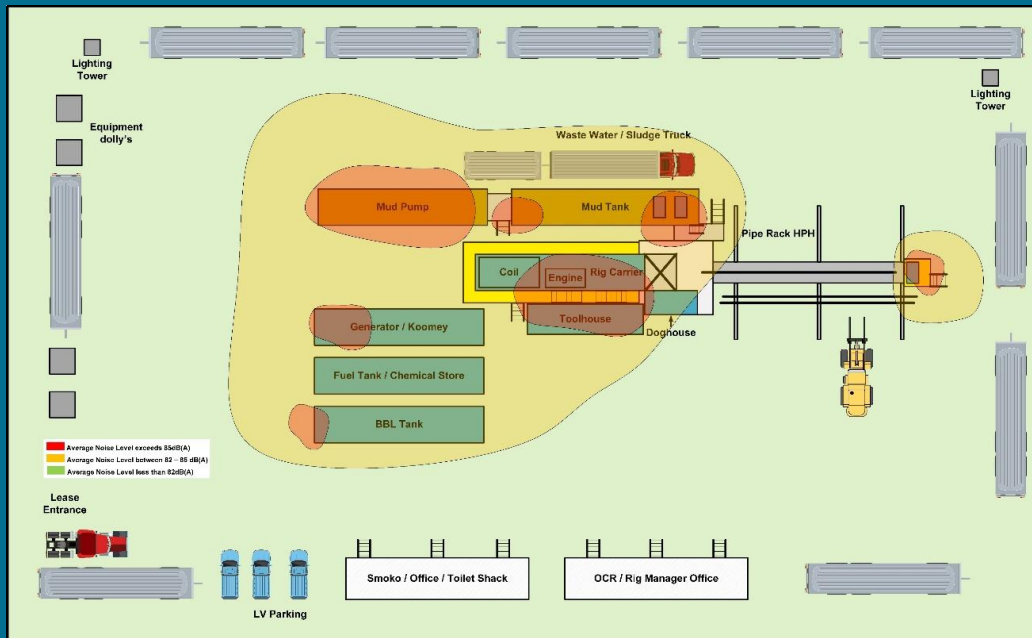
D&C Plant  
& Equip.  
min-max  
dB(A)  
noise  
levels



D&C  
Operations  
min-max  
dB(A)  
noise  
levels



# D&C operations impact on area noise levels



# Using Octave Band Analysis

- Octave Band Analysis (OBA) ranges from 31.5 -16,000 hertz
- Understanding the OBA assists in controlling the noise
  - Noise 'profile'
  - Select the 'right' HPD (in-ear dB(A) level)
- Higher pitched frequencies easier to control than lower



108.2	118.6	50.7	67.1	71.8	76.5	81.1	85.2	89.8	94.4	99.0	103.6
90.9	112.2	39.4	50.5	58.5	64.3	71.8	76.5	81.1	85.2	89.8	94.4
98.5	113.5	53.4	58.0	64.3	75.1	85.2	94.4	103.6	112.8	122.0	131.2
107.6	118.6	50.3	61.2	86.9	92.9	94.4	100.1	105.8	111.5	117.2	122.9
91.7	113.4	44.8	54.7	72.1	79.2	81.1	81.1	80.2	75.9	71.6	67.3
108.5	118.6	48.2	65.0	79.1	90.6	96.0	99.7	98.0	92.0	84.2	76.4
85.4	105.5	41.3	53.7	60.8	70.3	74.3	76.0	74.2	67.0	58.1	49.2
78.6	102.2	40.3	49.9	58.5	64.8	65.4	68.7	65.7	58.9	50.9	33.7
92.2	111.8	45.6	49.0	70.2	76.9	81.2	82.3	79.8	73.8	66.7	52.0
91.6	113.6	44.3	51.0	73.3	78.7	80.0	80.1	78.7	73.1	66.3	51.4
97.5	114	46.8	53.6	68.9	85.5	91.6	83.8	83.2	75.0	67.1	51.5
85.6	103.9	44.6	60.2	65.8	73.5	71.6	76.5	74.6	68.5	58.3	41.0
102.7	118.6	40.2	54.3	75.5	94.3	89.5	93.1	91.9	84.7	75.5	60.1
108.8	118.6	54.5	62.3	85.5	100.5	96.2	98.7	98.2	92.3	84.0	70.7
109.9	118.6	54.7	64.9	86.3	91.8	96.1	101.1	101.3	94.2	85.6	71.9
108.2	118.6	50.6	62.3	93.8	90.0	95.6	97.9	98.2	92.0	81.9	71.7
111.0	118.6	58.5	65.0	90.4	92.4	96.5	102.2	103.1	95.7	86.5	77.3
93.6	109.5	37.0	53.6	69.7	73.7	82.1	84.6	83.1	75.8	64.9	54.0
96.9	112.2	39.2	58.5	69.0	85.5	85.4	87.5	85.6	79.4	70.0	60.6
104.4	118.6	40.1	62.8	70.1	87.6	92.9	95.1	95.0	90.1	81.0	71.8
86.3	104	36.2	58.4	57.2	73.0	73.9	75.7	77.0	70.8	61.6	52.4
82.0	93.4	35.3	49.1	57.6	57.1	60.0	60.5	56.9	54.3	49.7	45.1
81.8	104.6	38.1	66.8	66.2	77.6	76.5	72.4	70.9	68.2	65.5	62.8
84.2	104.6	42.2	56.7	60.1	65.8	65.4	70.0	67.2	64.7	62.0	59.3
84.5	104.2	57.4	61.1	73.0	77.1	78.6	78.5	76.1	72.6	69.1	65.6



# Analysing the noise profile

## Generators / HPU

- 250 – 4000 Hz ranges
- Av. 91 dB(A)
- Fans – ~3 dB noisier than engine

## Personal noise

- 90 – 92.4 dB(A) Rig crew
- 93.3 dB(A) Trades
  - 93 dB(A) for 70 min w/- no HPD exceeds Daily Dose Limit (DDL)
- Work task & work environment

Laeq (dBA)	LCPeak (dBA)	31.5	63	125	250	500	1000	2000	4000	8000	16000
66.9	97.7	44.8	41.4	48.8	53.3	53.5	56.3	57.2	52.6	43.8	39.0
96.5	115.7	39.3	59.6	76.9	77.4	82.6	86.9	86.8	79.7	68.8	55.1
84.1	108	44.0	58.5	70.1	68.5	70.1	72.8	72.6	63.7	57.8	43.1
83.8	104.3	33.3	52.4	70.9	70.9	70.4	75.1	76.2	61.8	47.8	34.3
81.5	104.1	39.0	52.8	65.1	65.2	70.2	73.9	69.9	60.6	49.0	36.3
84.6	104.1	32.3	49.4	58.7	70.7	76.2	75.3	71.3	69.6	61.0	48.2
102.3	118.5	35.4	59.1	72.5	87.7	90.3	92.9	92.3	84.3	73.6	60.2
108.2	118.6	50.7	67.1	74.9	96.4	93.3	99.4	99.3	91.3	79.1	67.8
90.9	112.2	39.4	50.5	71.8	76.5	79.5	82.4	79.8	73.6	65.8	50.6
98.5	113.5	53.4	58.0	64.3	75.1	85.2	94.1	87.8	82.7	70.5	53.1
107.6	118.6	50.3	61.2	86.9	92.9	94.4	100.1	97.6	90.6	82.9	66.4
91.7	113.4	44.8	54.7	72.1	79.2	81.1	81.1	80.2	75.9	69.2	55.5
108.5	118.6	48.2	65.0	79.1	90.6	96.0	99.7	98.0	92.0	84.2	69.6
85.4	105.5	41.3	53.7	60.8	70.3	74.3	76.0	74.2	67.0	58.1	42.9
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92.2	111.8	45.6	49.0	70.2	76.9	81.2	82.3	79.8	73.8	66.7	52.0
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96.9	112.2	39.2	58.5	69.0	85.5	85.4	87.5	85.6	79.4	70.1	56.5
104.4	118.6	40.1	62.8	70.1	87.6	92.9	95.1	95.0	90.1	81.4	67.1

# Analysing the noise profile

## Cement Units

- 250 – 4000 Hz ranges
- Av. 98 dB(A)
- Fans – ~3 dB noisier than engine

## Personal noise

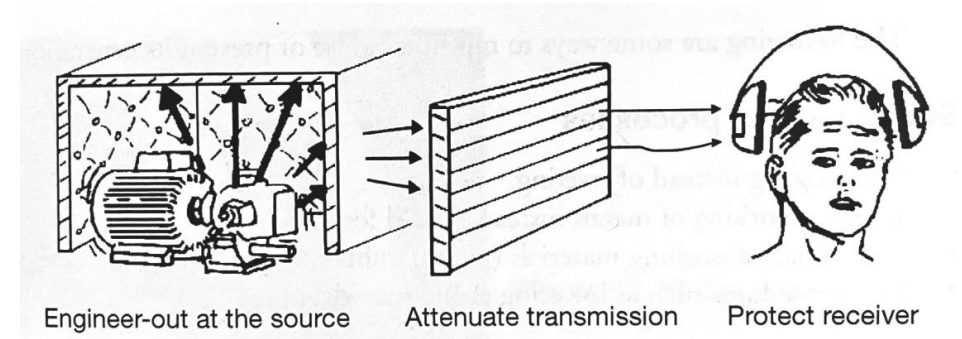
- 92.10 dB(A) Cement Supervisor
- 96.20 dB(A) Cement Operator
- 96 dB(A) for 35 min w/- no HPD exceeds Daily Dose Limit (DDL)
- Work task & work environment

Laeq (dBA)	LCPeak (dBA)	31.5	63	125	250	500	1000	2000	4000	8000	16000
108.6	125.5	42.2	51.0	81.0	87.2	92.0	95.3	95.5	90.6	83.1	70.3
105.5	119.8	40.7	51.2	73.0	78.6	88.2	90.7	91.1	91.0	93.6	93.3
110.3	126.4	40.1	52.0	83.2	87.3	94.6	94.3	97.4	94.5	95.3	96.6
87.5	111.2	38.1	50.3	66.7	67.2	73.4	78.5	78.4	72.7	64.2	52.1
98.6	116.1	42.9	51.4	65.2	79.2	82.1	88.7	84.9	80.4	73.0	61.7
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95.9	114.7	40.5	51.5	72.2	81.5	81.3	85.4	84.0	79.7	74.5	63.0
89.8	108.8	38.8	52.2	61.2	80.7	77.6	80.1	78.7	72.8	64.0	47.9
102.7	120.5	41.2	50.5	64.7	97.7	89.5	91.1	89.4	82.9	72.8	57.1
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87.5	111.5	47.6	49.3	60.0	80.2	74.6	77.3	75.2	68.2	56.6	42.7
84.9	102.7	50.0	55.7	54.7	64.0	70.8	78.5	73.8	70.6	57.2	46.7
90.3	105.8	50.5	57.1	55.0	62.4	75.5	82.0	83.0	75.2	64.4	53.3
92	110.6	40.9	60.5	63.9	66.8	78.9	82.8	83.9	78.5	66.7	56.0
83.6	102.9	37.5	53.6	60.1	60.8	69.8	72.7	75.5	73.0	61.1	47.6
112.8	130.2	40.0	58.1	74.6	95.7	95.3	99.4	97.3	92.3	85.9	77.9
109.8	128.1	44.1	59.3	78.8	107.3	93.0	97.1	95.6	85.6	74.2	60.4
95.8	113.8	35.5	50.9	65.7	91.4	80.4	84.5	82.7	76.4	70.5	60.1
110.5	129	44.8	60.6	77.7	107.7	93.3	97.8	96.5	89.2	76.9	59.6
99.8	119.5	36.7	61.0	69.5	91.0	86.0	88.8	88.8	82.8	72.5	61.3
104	121.6	36.8	53.4	70.4	98.8	89.5	91.9	92.2	83.9	75.5	60.1
88.3	106.6	52.8	57.1	57.0	61.5	73.1	82.1	75.7	72.7	58.3	47.6

# Noise controls

## Control at source

- Elimination or modification of noise source or process
- Buy quiet - prioritise in design stage

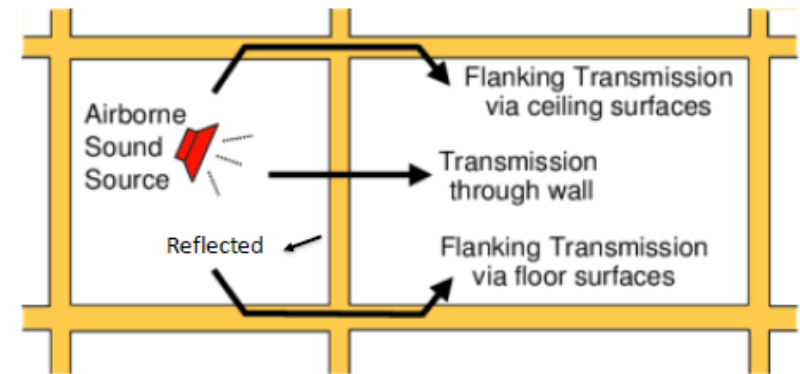


## Control between source & receiver

- Most effective
- Enclosures, barriers, sound-proofed rooms, damping hard surfaces

## Control noise at receiver

- Enclosures, barriers, sound-proofing, training, HPD
- HPD = interim measure or no feasible engineering noise controls



# Noise types & solutions

Maintenance!

## Machinery Noise:

- Mechanical impacts
- High-velocity air or fluid flow
- Vibrating surface areas
- Vibrations of product being processed

## Source Noise Reduction example:

- Diesel compressor
- Silencer & enclosure
- = 20 dB(A) noise reduction
  - 100-fold energy decrease!!!

## Radiated Noise

- Add stiffeners to large unsupported metal panels
- Add small openings/perforations in large solid surfaces
- Use gridded metal
- Add vibration damping material

## Silencers:

- High-pressure pressure regulators, air vents & blow downs
- Internal combustion engines
- Compressors (Reciprocating, Centrifugal)



# Noise types & solutions

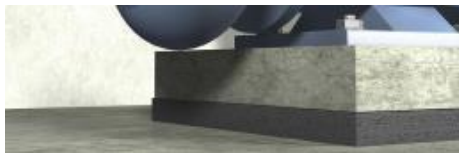
MOC!

## Vibration Damping

- Effective for:
  - Metal enclosure walls
  - Fan housings
  - Gearbox casings
  - Thin metal machine casings/panels
  - Hopper bins & product chutes



Rubber grommets



Machine dampening 'padding'

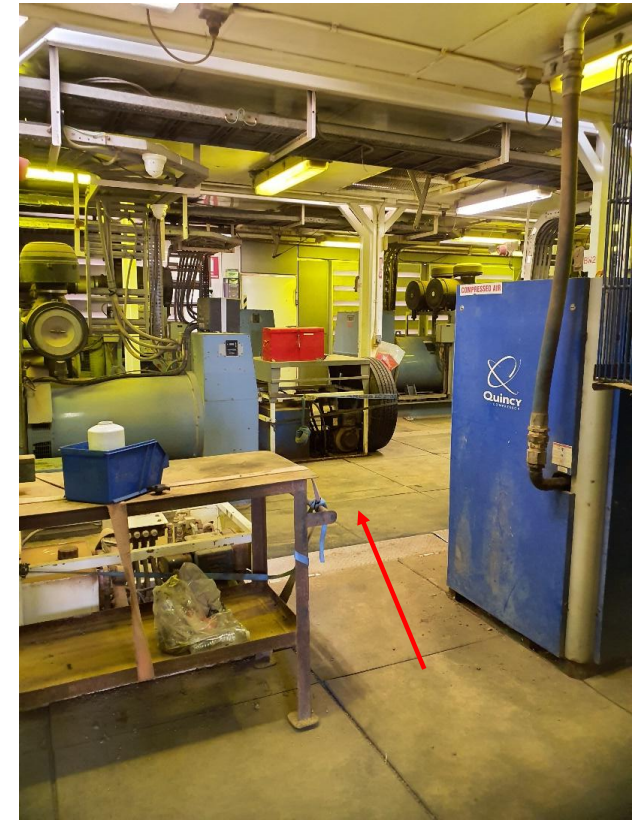
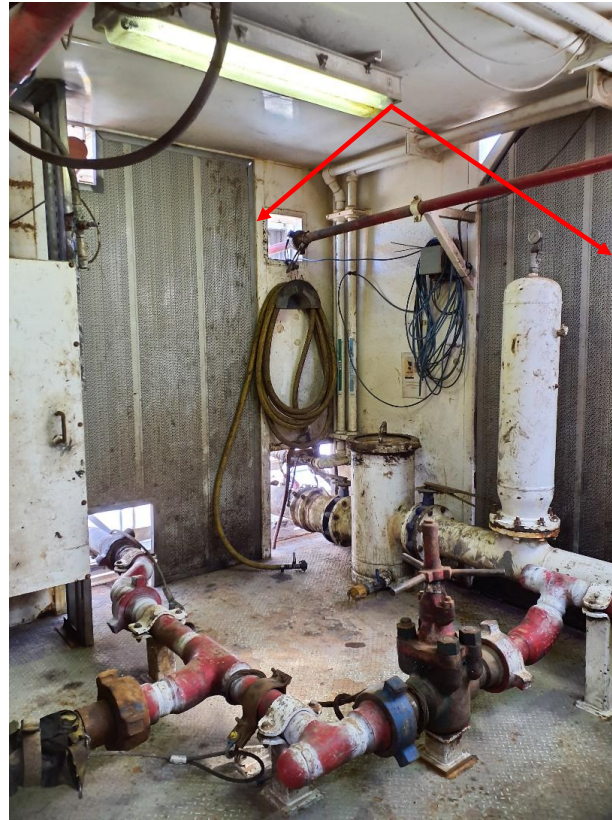
## Vibration Isolation

- Enclosure isolation
- Rotating machinery mounts & bases
- Flex connectors for piping systems
- Pipe hangers

## Lagging

- Resilient absorptive material
- Control for radiant heat emitted
- Thick layer/s for low frequency absorption

# Attenuate transmission control example



Enclosure of noisy equipment using dampening material/s

ENS R965



# Source control example



Engineer at source using enclosure



HALLI CU



# Learnings

- Inadequate assessment of personal noise exposure levels
  - Controls based on environmental noise maps (apples vs potatoes)
  - Competent person reqd.
- Worker awareness OFI
- Risk management OFI incl. inadequate controls
- Other hazards not considered





# Effective risk management of noise

## Formal Safety Assessment, s675(1)(e) PG Act

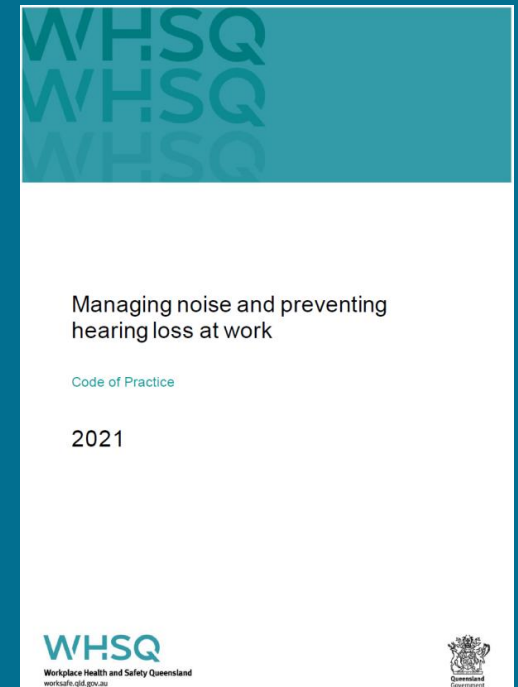
- Benchmark against OEL
- Over attenuation vs under attenuation – both risky!

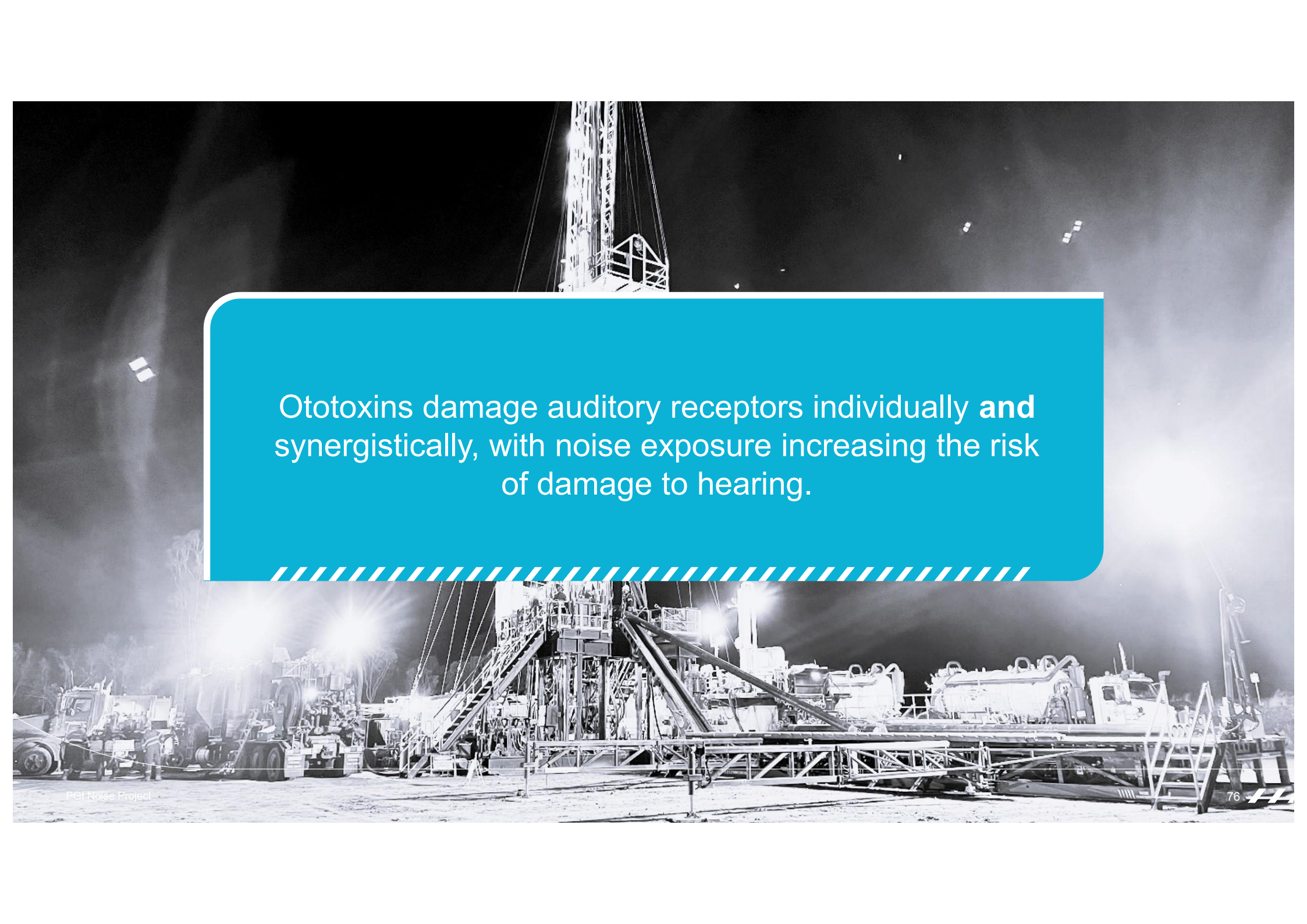
## Review existing controls

- HPD “one-size-fits-all” ineffective (Shrek ears)
- Compromised engineering controls (doors left open on enclosures)

## Review effectiveness of controls, s700-701 PG Act

- Audiometric testing recommended 1-yr based on project findings
  - $\geq 100$  dB(A)  $L_{Aeq,8h}$
  - Ototoxic airborne exposure  $> 50\%$  WES (regardless of noise level)
  - Ototoxins @ any level +  $> 80$  dB(A)  $L_{Aeq,8h}$  or  $135$  dB(C)  $L_{C,peak}$ 
    - All positions except Wireline, Directional Driller & Mud Dr.





Ototoxins damage auditory receptors individually **and** synergistically, with noise exposure increasing the risk of damage to hearing.

# Ototoxins

## Solvents

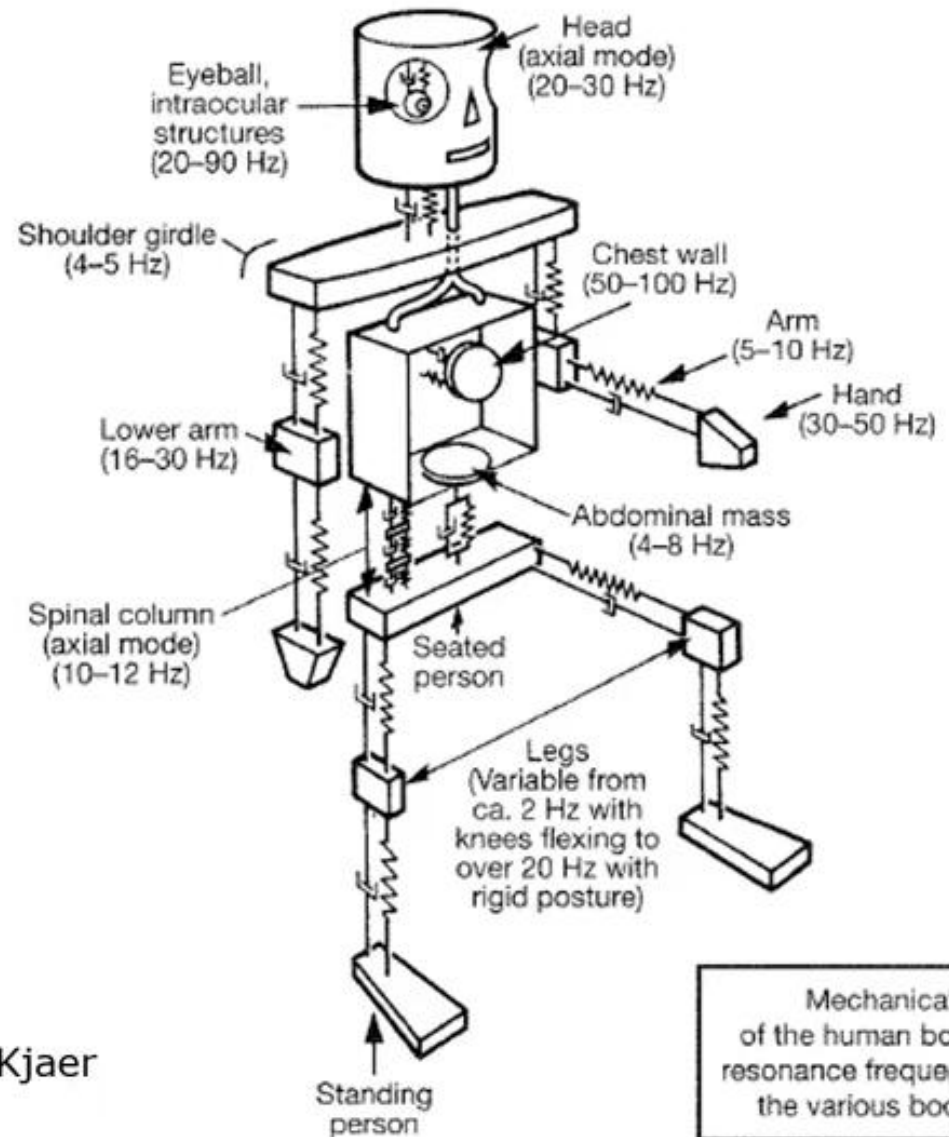
- Hand cleaners / cleaning products
  - Skin absorption – solvent mixtures & fuels, white spirits

## Asphyxiants

- Carbon Monoxide (CO) & Diesel Particulate Matter (DPM)
  - Diesel combustion engines, control - wind direction

## Physical (Vibration)

- WBV + HAV
  - Standing on vibrating equipment for shift, driving



Source:  
Bruel & Kjaer



# Thank-you!

- ✓ COHO Resources
- ✓ Ensign Australia
- ✓ Halliburton Australia
- ✓ Origin Energy
- ✓ Roma Transport Services
- ✓ Santos Ltd
- ✓ Savanna Energy Services
- ✓ Senex Energy Ltd
- ✓ Silver City Drilling
- ✓ Ventia
- ✓ Westside Corporation





Resources  
Safety & Health  
Queensland

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