Noise Control of Mining Machines

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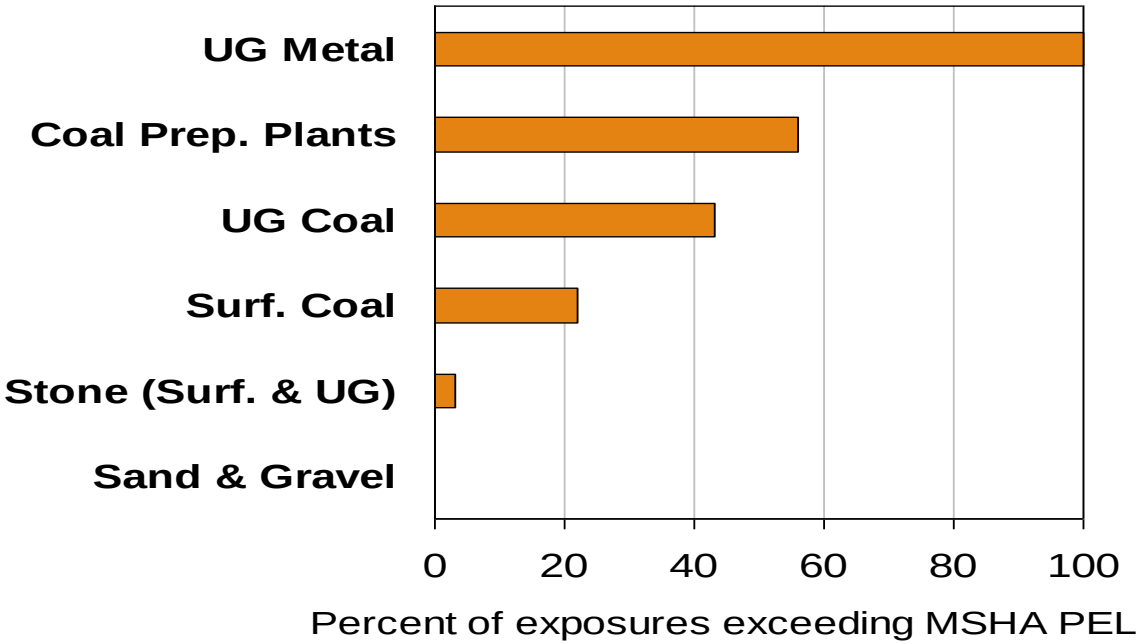
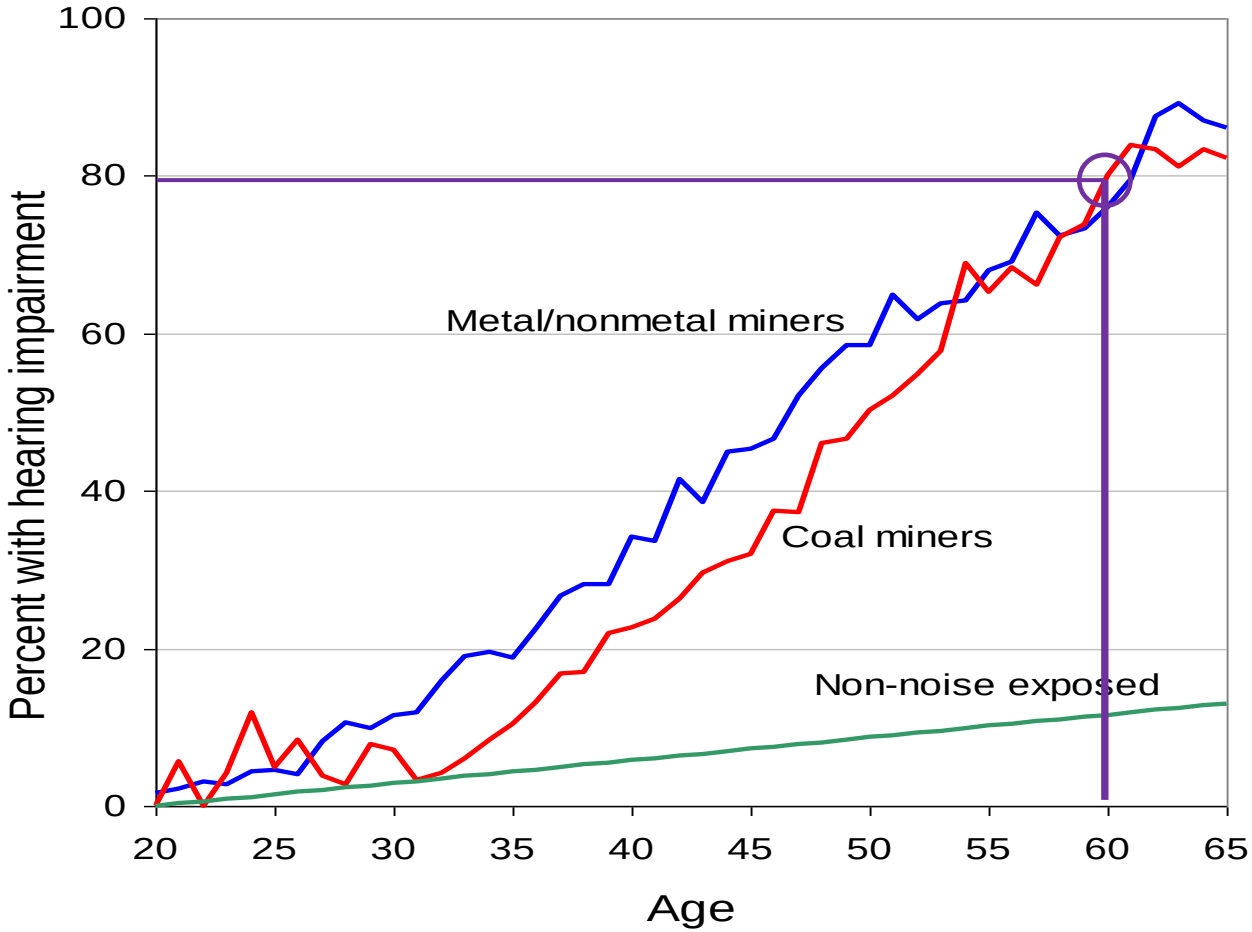
Agenda

- Miner noise overexposure
- Vibration damping-Continuous mining machine
- Vibration isolation-Roof bolting machine
- Air flow optimization-Haul truck
- Increasing mass/thickness to reduce vibration-Longwall shearer
- Sound insulation and sound absorption

Noise overexposure and hearing loss are “facts of life” for miners



Source: Miners sampled in NIOSH Cross-Sectional Surveys



Source: John Franks, NIOSH

NIOSH Pittsburgh Mining Research Division: Health Hazards Prevention Branch

Develop noise control technology

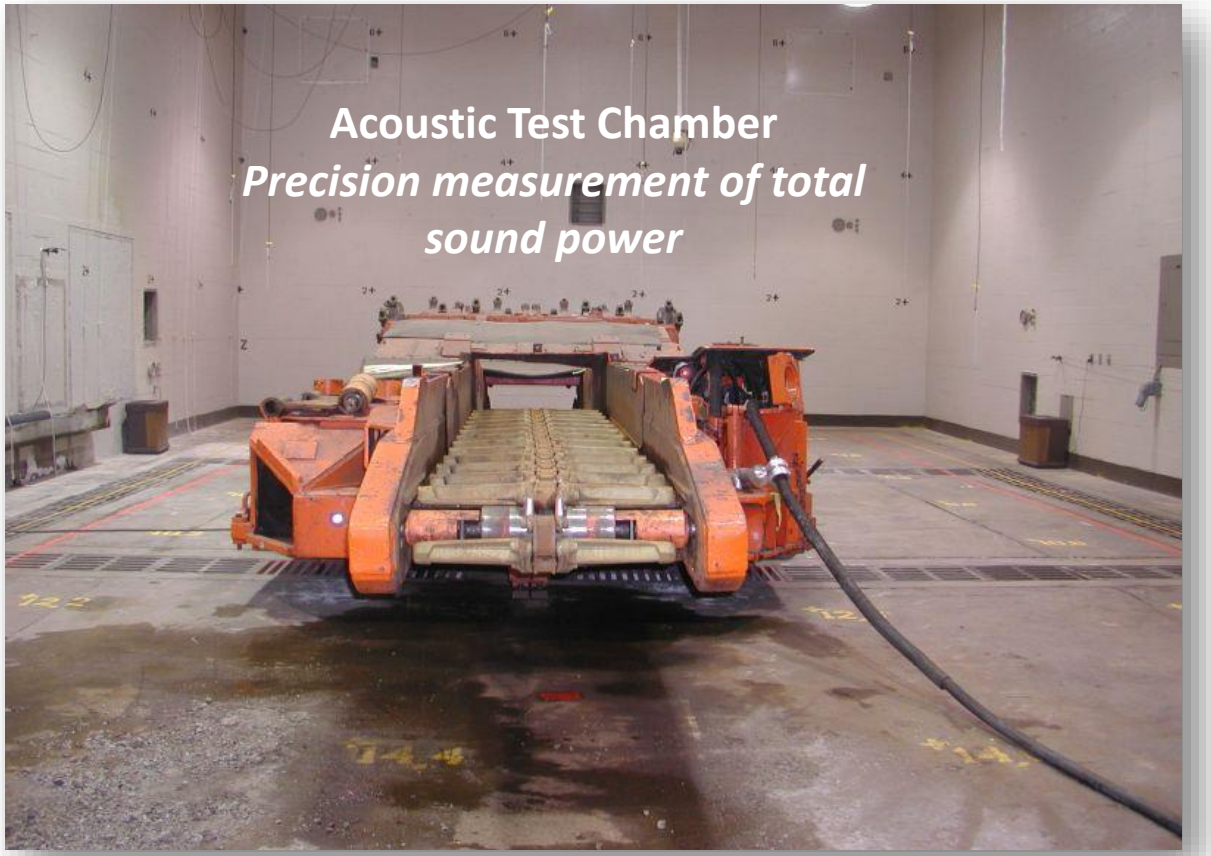
Technical support of MSHA and the mining industry

Educate the mining industry

Documentation of the effectiveness of controls and their implementation – scientific evidence

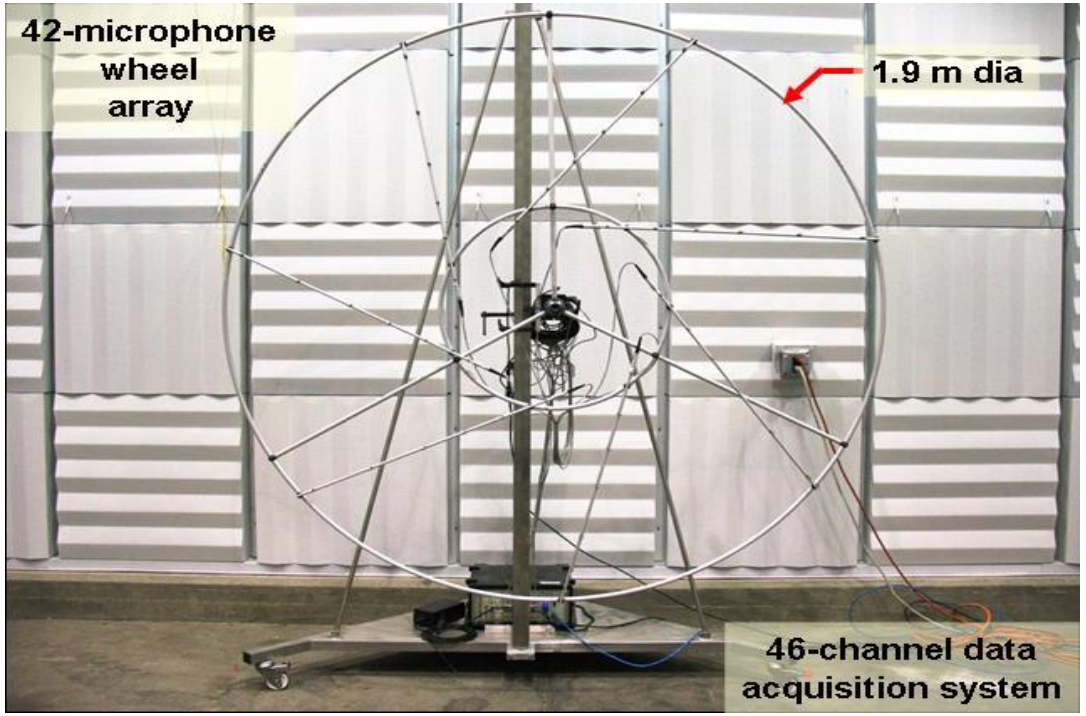
Facilitate the commercialization of controls

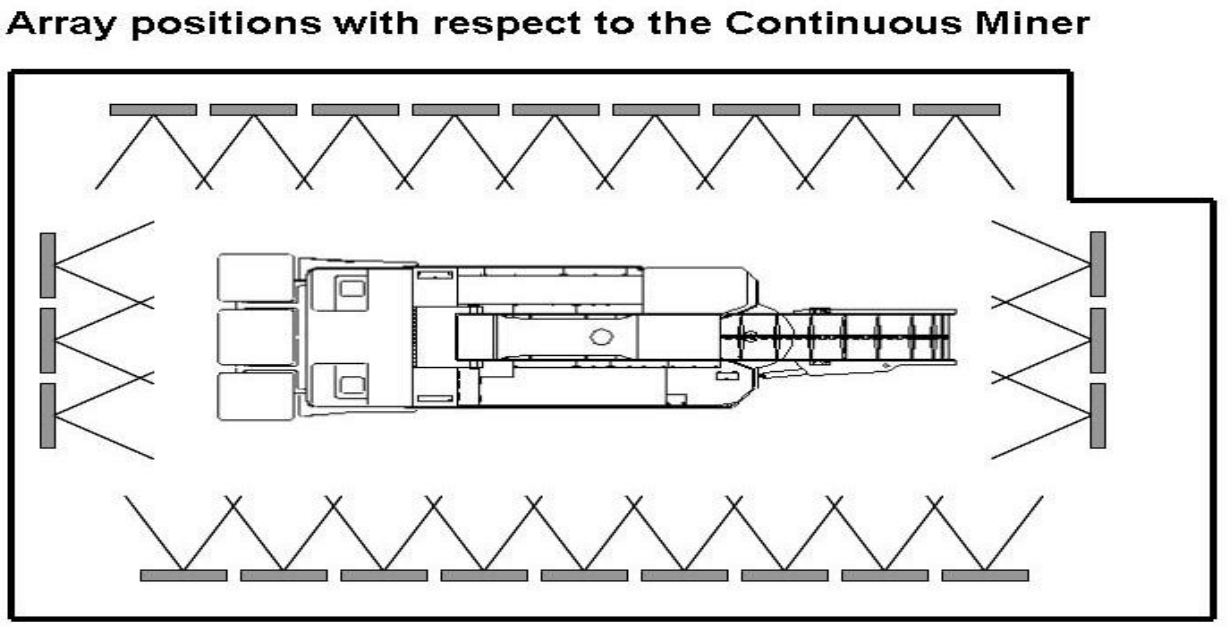
PMRD Acoustic Test Chambers



Continuous Mining Machine- Vibration Damping noise controls

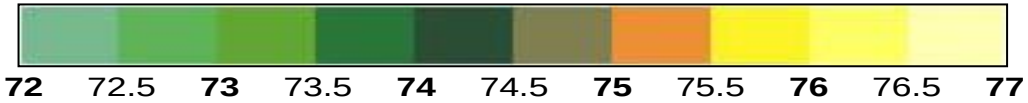
Acoustic Beamforming

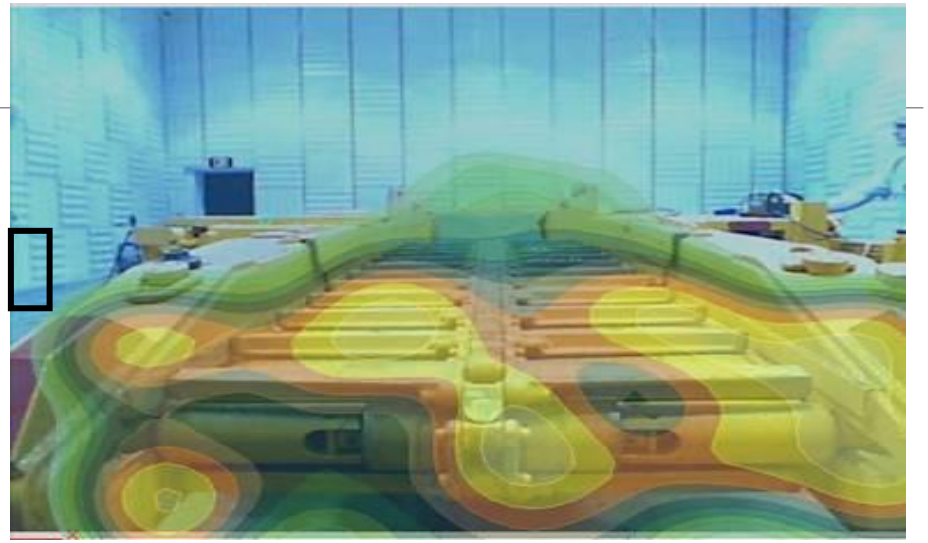




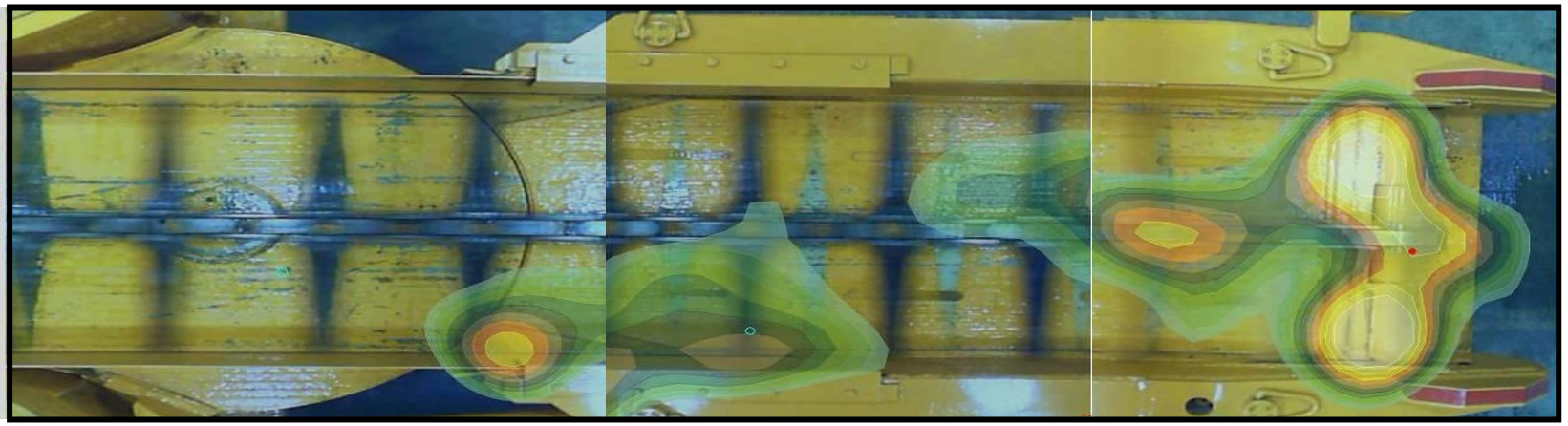
Acoustic Beamforming Results

Rear: 1600 Hz



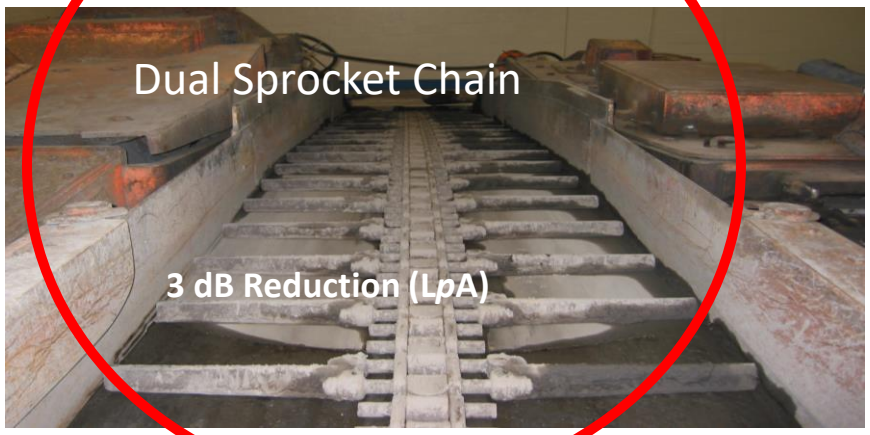


Overhead: 1600 Hz



Developed Noise Controls

Developed Noise Controls



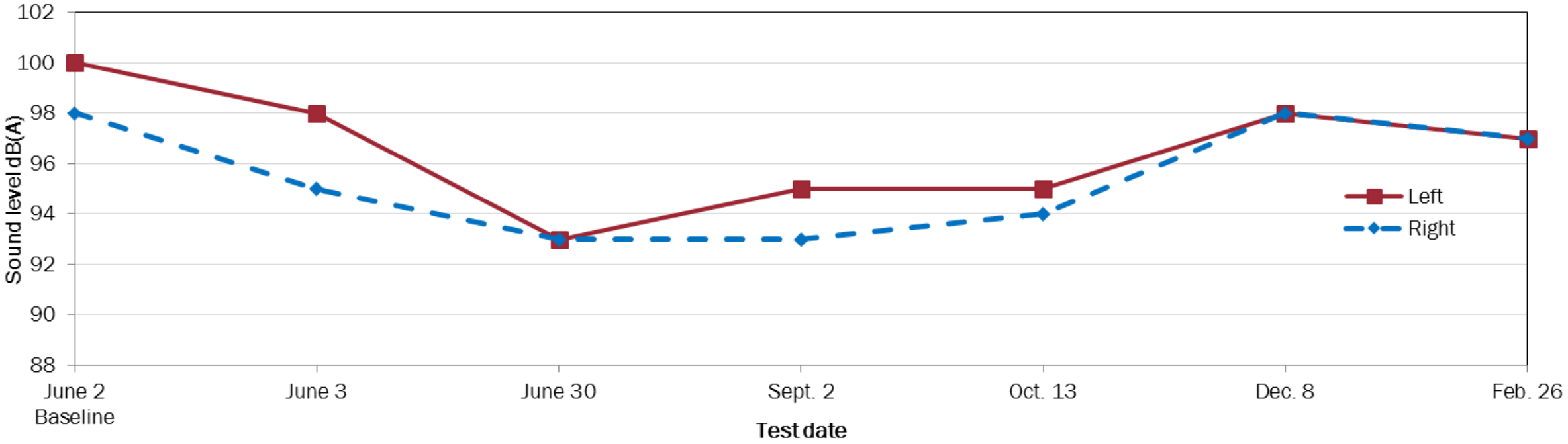
Effectiveness of Controls

Standard chain: 103 dB(A)

Coated chain: 99 dB(A)

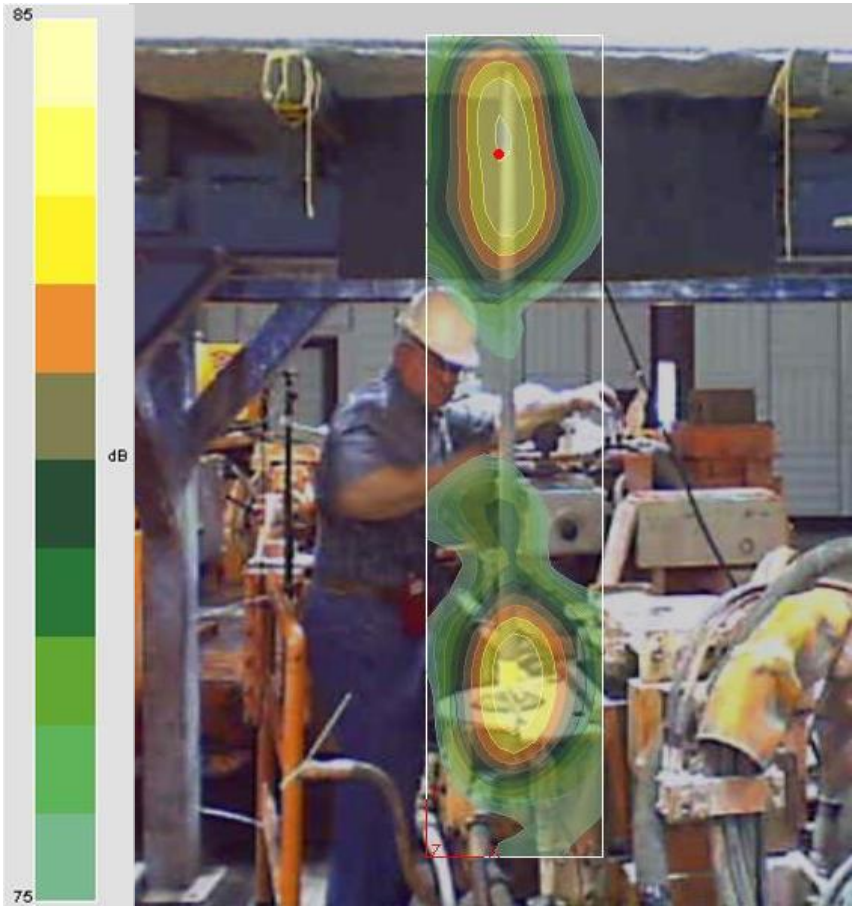
Coating Wear

Sound Level Reduction Over Time



Roof Bolting Machine-vibration isolating noise controls

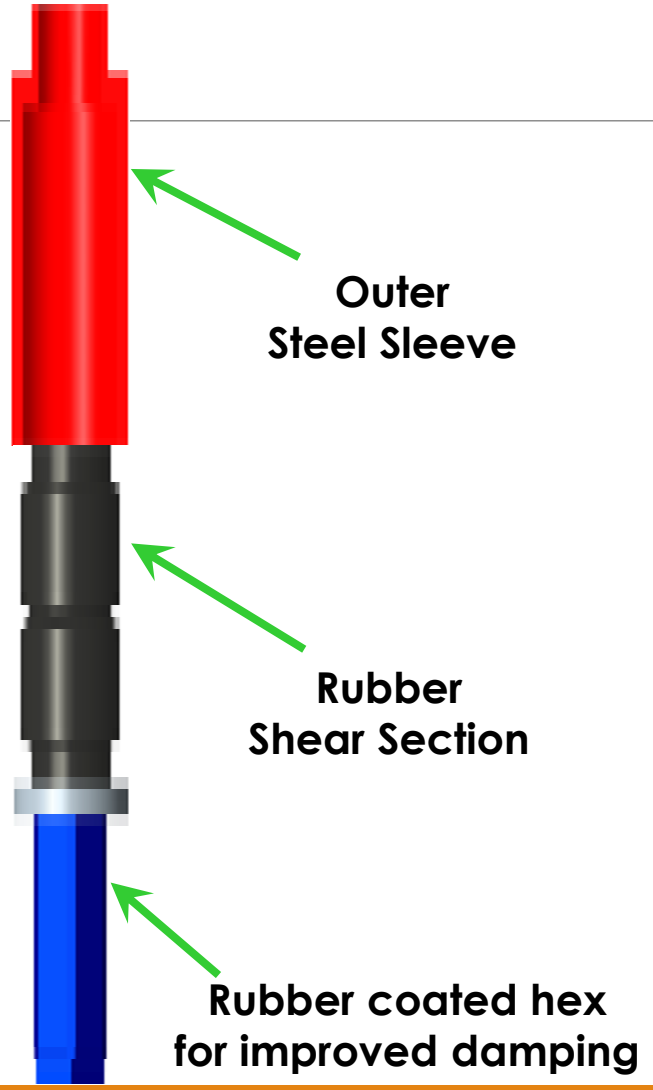
Noise generation from RBMs



Past NIOSH research has shown the drilling activity to produce the highest noise levels on the RBM, often exceeding 100 dB(A)

Operator overexposed during typical shift

The drill bit isolator reduces vibration transmitted to the drill steel and the chuck



Current NIOSH-developed noise control for RBM: 35-mm Drill Bit Isolator

Drill bit isolator

- Current design for drilling with 35-mm drill bits
- 3-5 dB reduction

Available from Kennametal

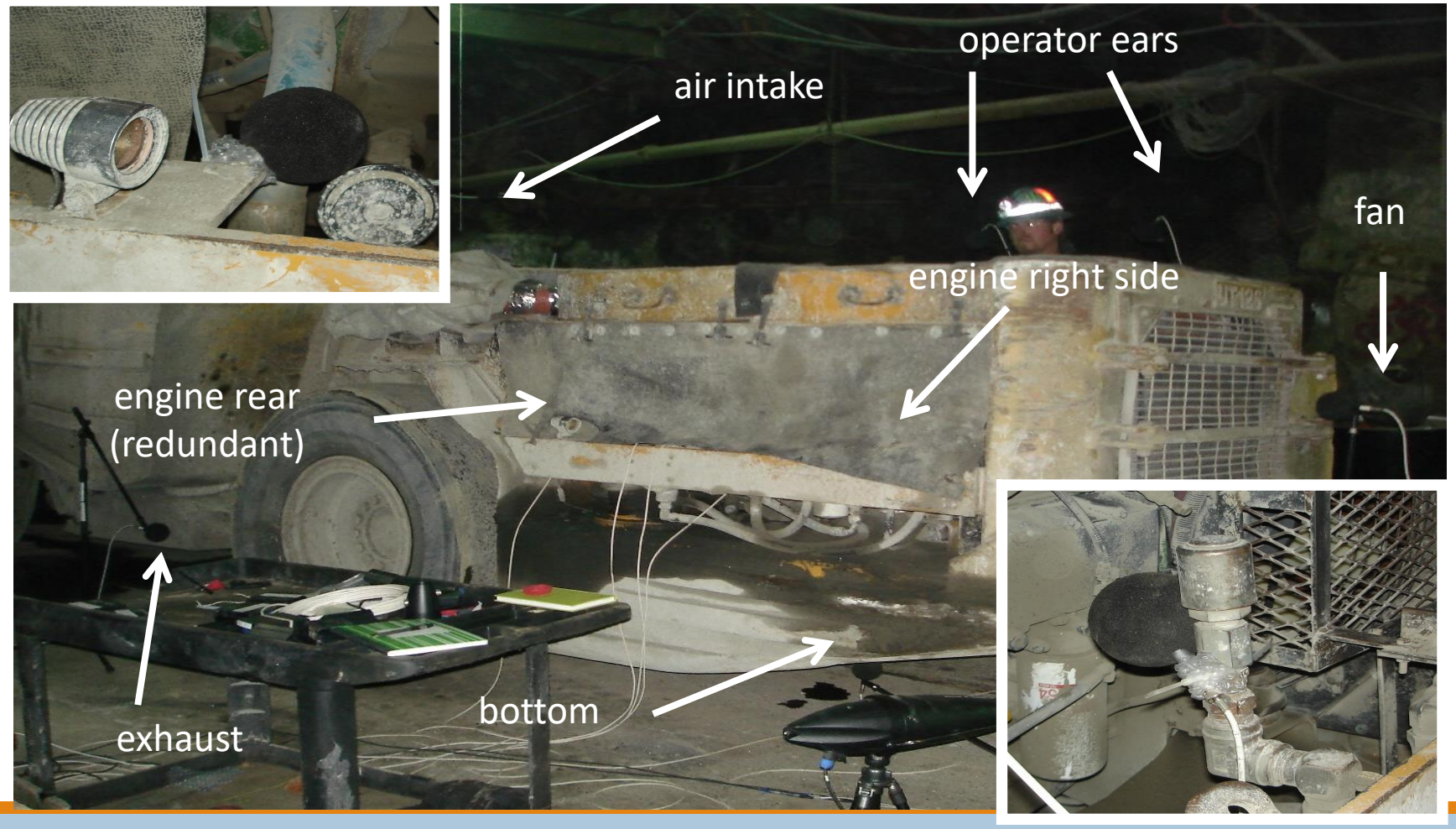
Necessary to develop and evaluate smaller size for drilling with 25-mm drill bits

Underground Haul Truck- air flow optimization controls

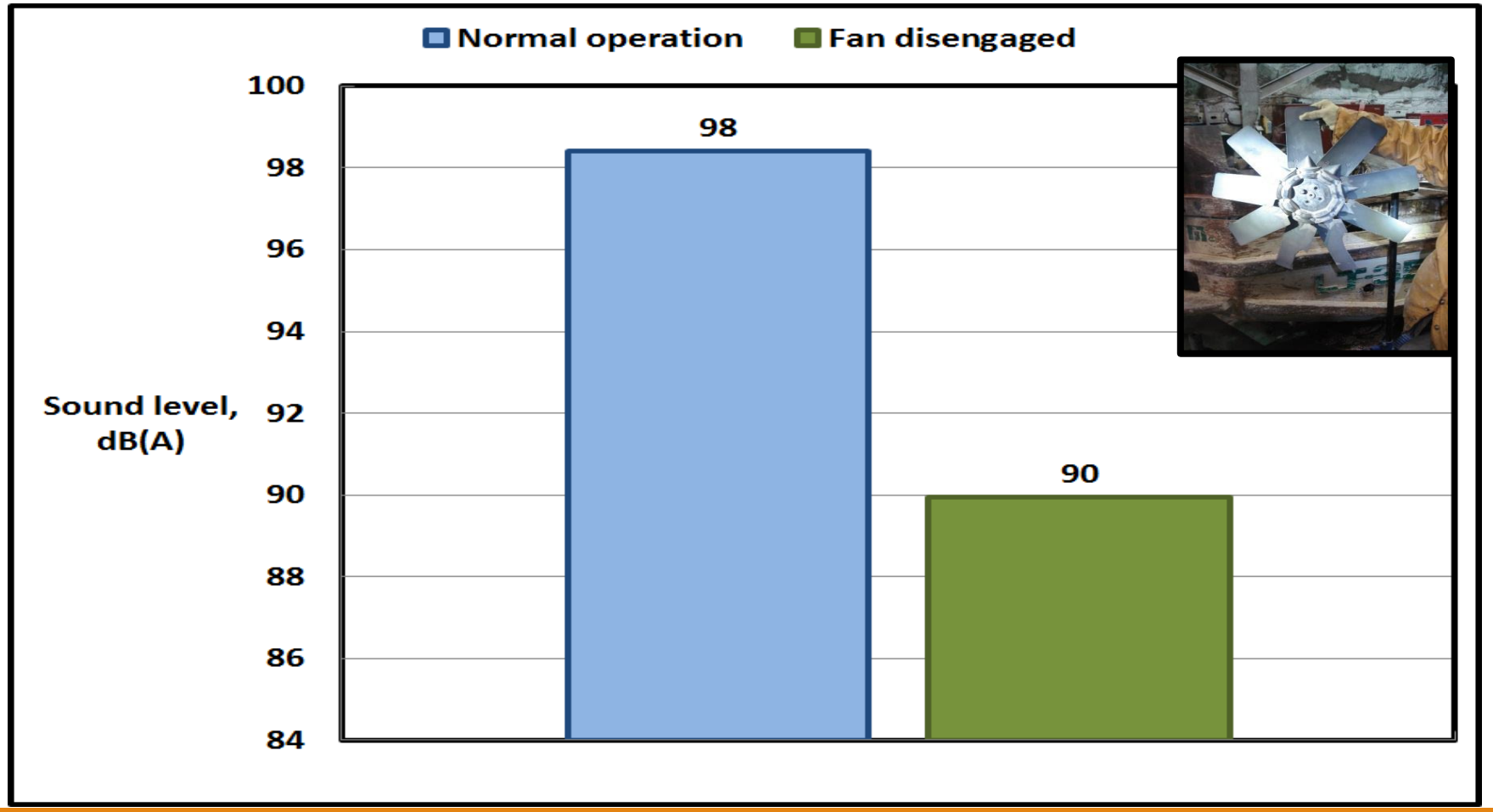
Noise Source Identification

- Testing done underground using Source Path Contribution analysis
- Focus on airborne noise since the operator is exposed - not in an enclosed cab
- Primary sources thought to be engine exhaust, engine cooling fan, engine block radiation, engine intake, and ancillary equipment

SPC Analysis Measurements



Engine Cooling Fan Primary Noise Source

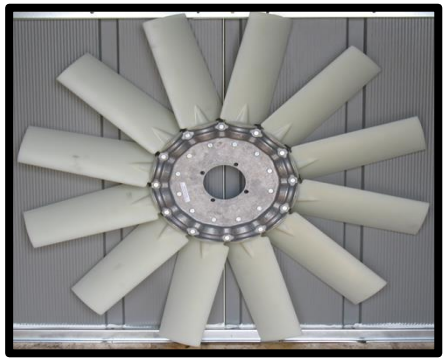


Fan Noise Test Stand Developed

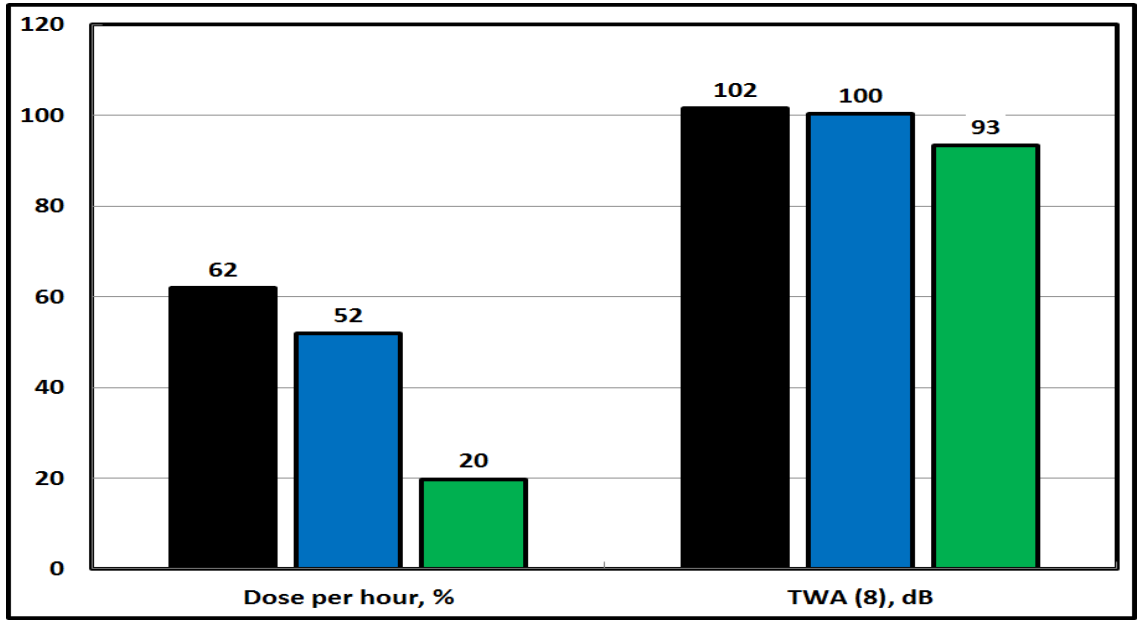
Selection of Best Fan and Operating Conditions for Reduced Noise

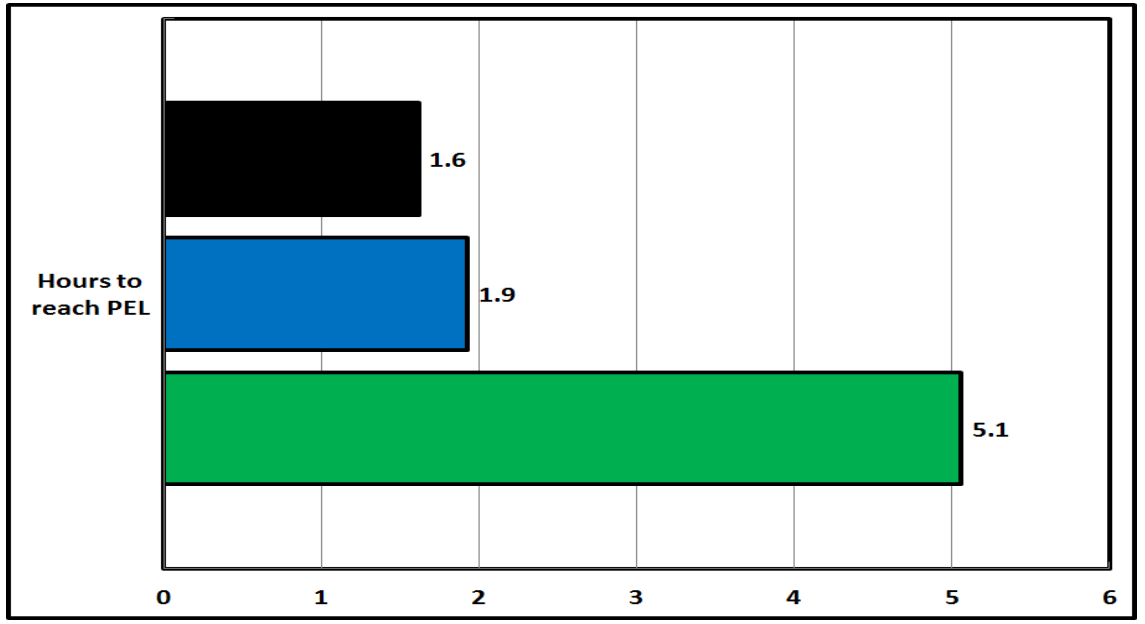
	Stock	New
Air flow (CFM)	16,400	16,400
Fan type	airfoil	sickle
Fan diameter (in)	30	32
Rotation speed (rpm)	2,450	2,100
Sound power (dBA)	116.1	113.5

Noise Control Retrofit Solution

	TYPE	DIAMETER	**hub pulley to reduce rotation speed**
stock		30”	
new		32”	

Evaluation in Field

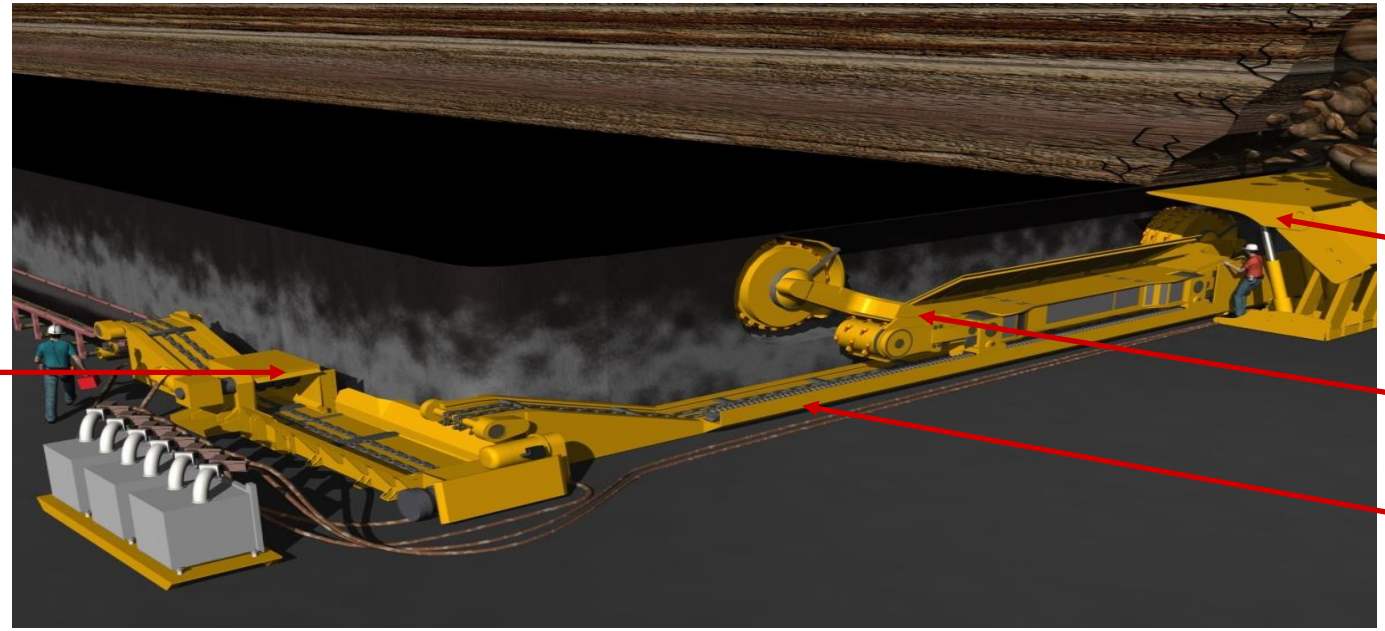




- Resulted in a 9 dB reduction in the TWA
- More than tripled the time to reach the MSHA PEL
- Maintained adequate airflow

- Stock condition, or baseline
- New barrier material Duracote 5356
- 32” sickle fan and fan hub pulley ratio from 1:1 to 0.9:1

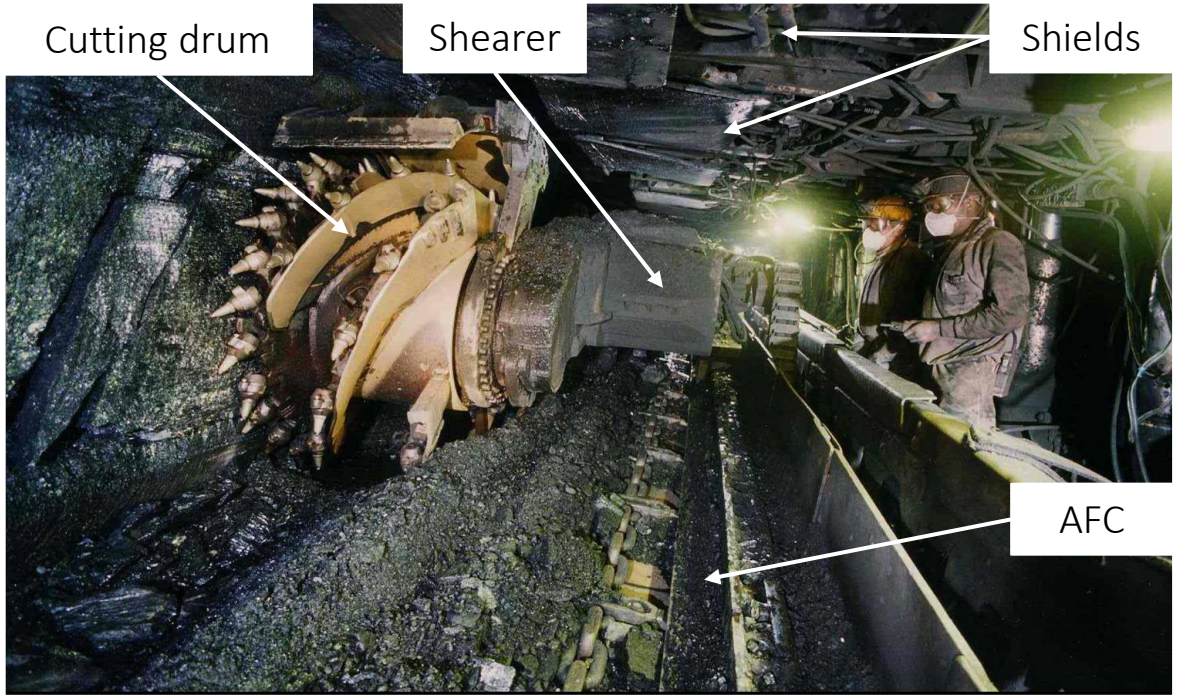
Longwall Mining System Overview- increasing mass to reduce vibration



- Longwall systems generate sound levels from 93 to 105 dB(A)
- Two major noise sources are the shearer and the stageloader

Longwall Mining System Shearer

- Roughly 50% of the coal is mined using the longwall mining system
- Over 305 m long
- Operators follow the course of the shearer along this length for each pass
- Confined and highly reverberant space



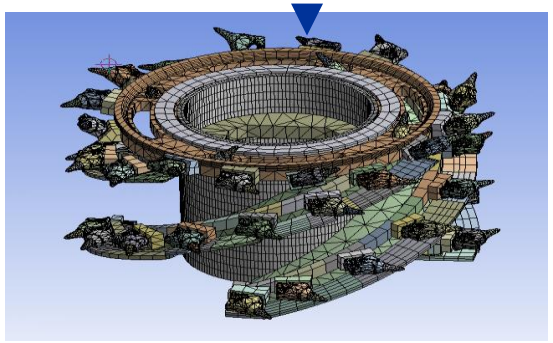
Program of Control Development

Experimental Modal Analysis

Validate

Operational Force Data

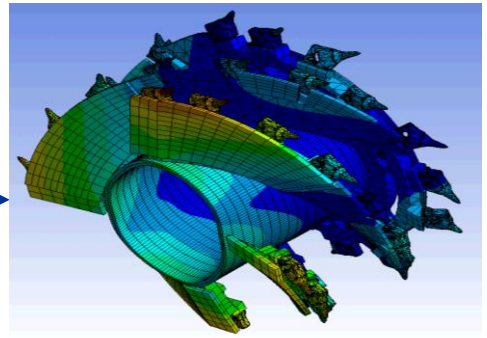
Input



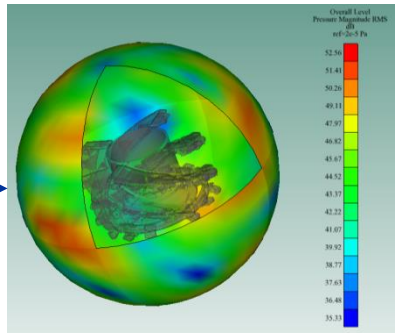
Finite Element Model

Output

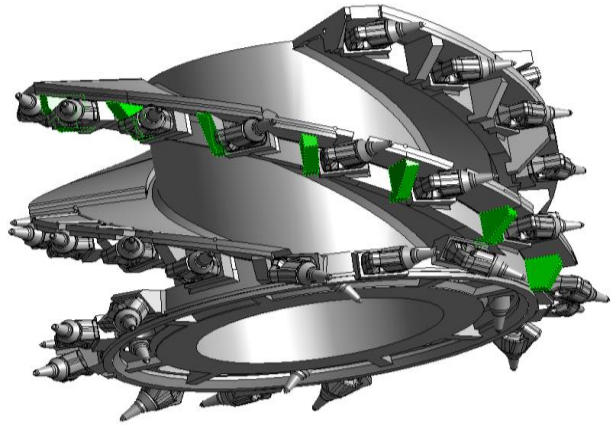
Structural Response



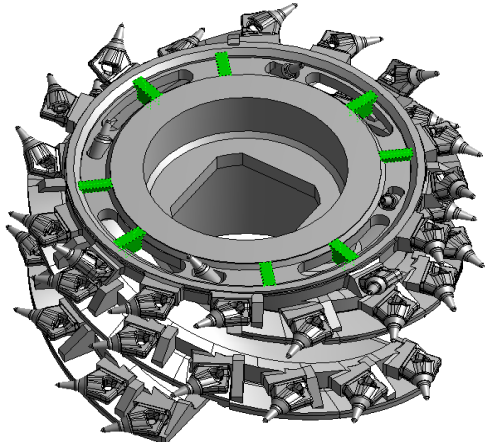
Sound Radiation



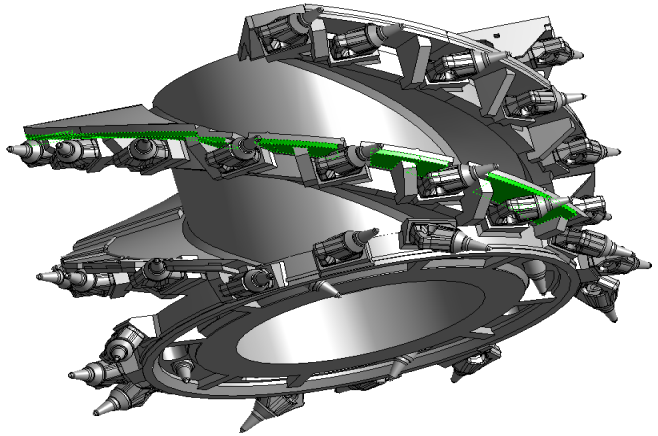
Noise Control Solution – increase mass



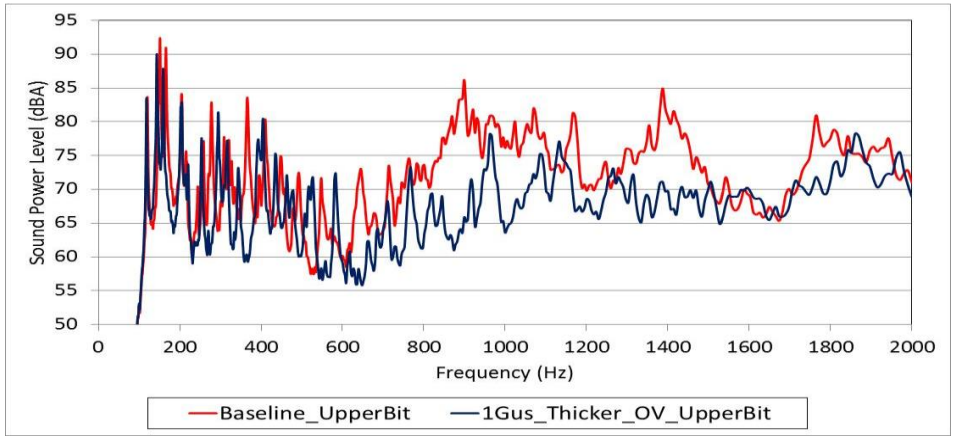
One gusset per pedestal, for all the pedestals on the four vanes, is added



Eight ribs added to the face ring

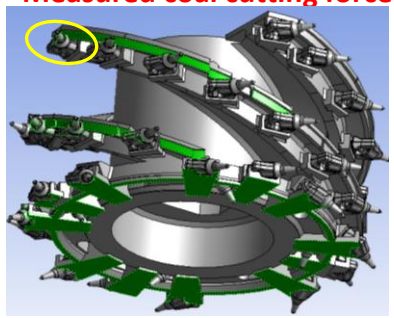


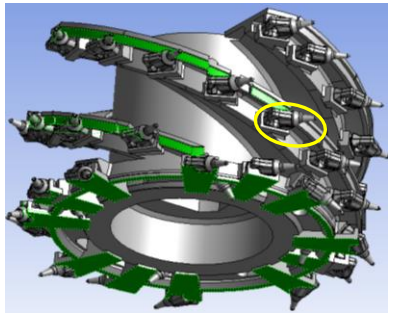
The thickness of all the outer vane plates is increased

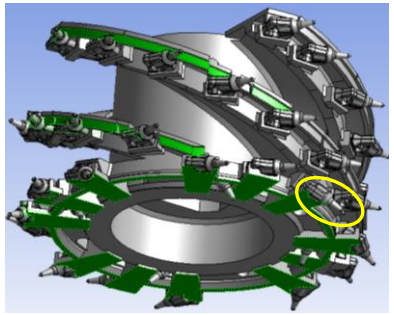


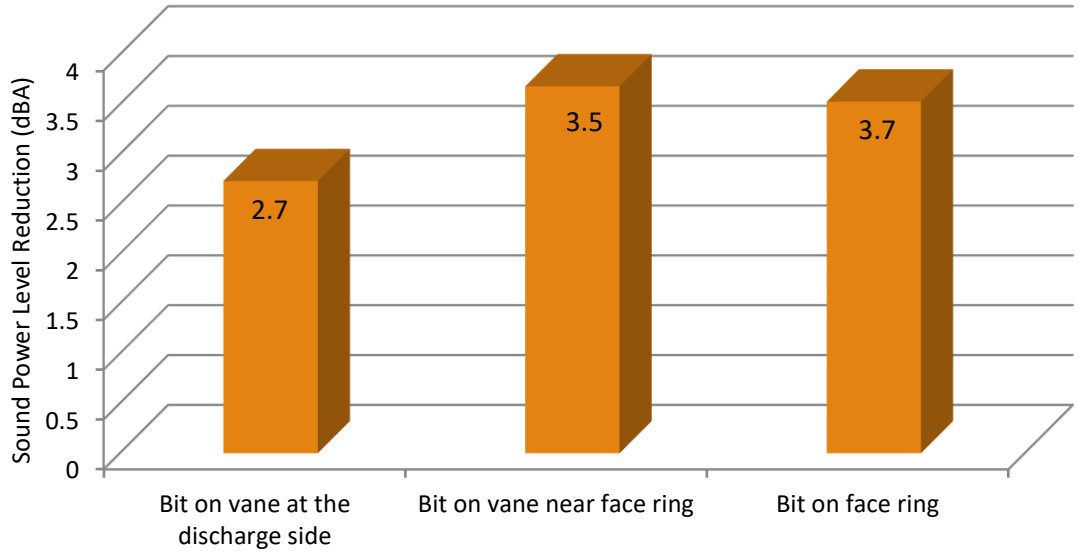
Predicted Results

Measured coal cutting force









Sound insulation and Sound absorption

Off the shelf products available

Absorptive panels and curtains

Partial and complete cabs

Surround the sound source or the worker

Windows, doors, windshields

Operator booths
Equipment enclosures

Conclusions

- Effective noise control solutions have been developed for large mining machines
- Noise reductions of as much of 8 dB have been achieved
- A critical part of noise controls for large machines is identifying the source
- Just as important as noise control effectiveness are other parameters including
  - Durability
  - Ability to retrofit
  - Impact on production and serviceability
  - Acceptance

Questions

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