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Airborne Asbestos Fiber Exposure Assessment of Heavy Equipment Mechanics

- PO110 -

American Industrial Hygiene
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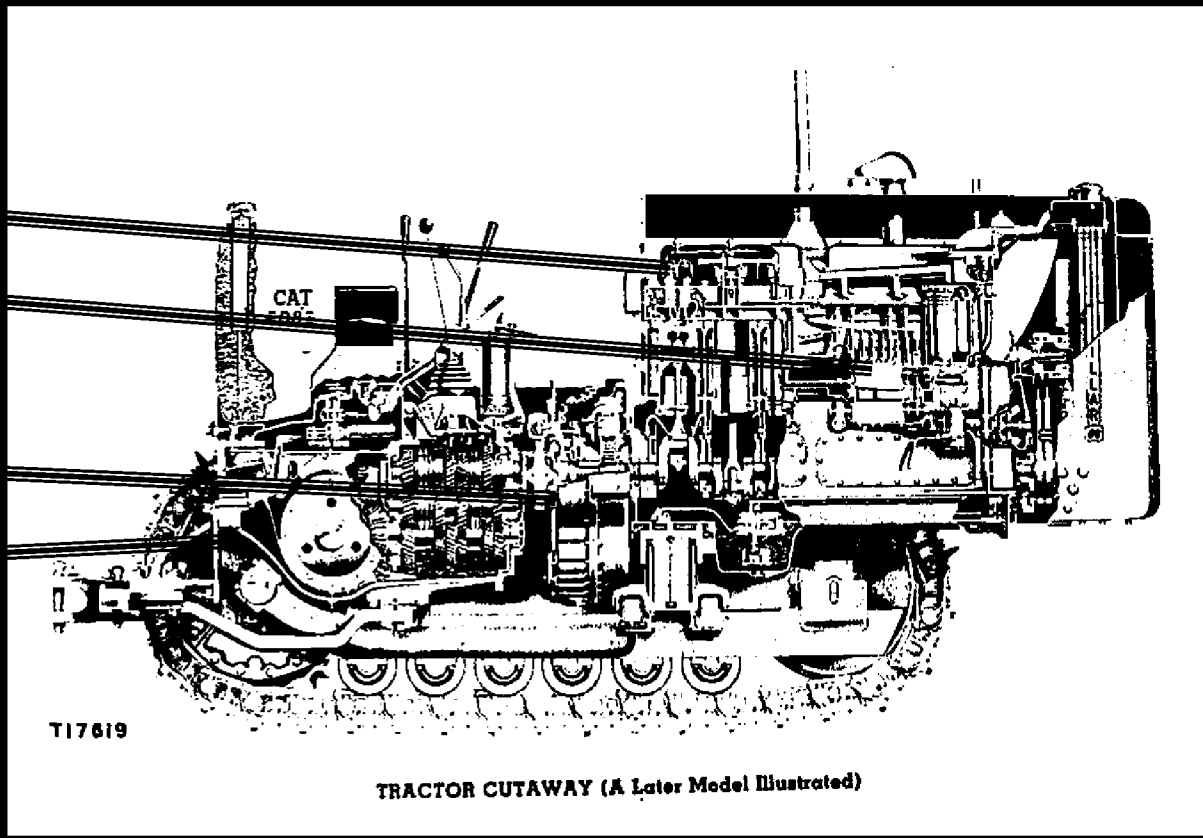
Boelter & Yates, Inc.
Park Ridge, IL

Study Purpose

- Determine the concentration of airborne fibers during maintenance and repair activities involving asbestos-containing friction products and gaskets on heavy equipment

Gasket & Friction Uses Track Machine

- Gaskets
  - Joints
  - Engine
- Friction
  - Clutch
  - Brakes



Assessment Strategy

- Personal and area air samples
- Heavy equipment repair facility
- Period of nine days
- Removal and replacement activities
- Asbestos-containing friction products and gaskets
- Four different pieces of heavy equipment
- Four mechanics

Analytical Methods

- Cleanliness - AHERA Federal Register Vol. 52, No. 210
- PCM - NIOSH Method 7400 for phase contrast microscopy
- TEM - NIOSH Method 7402 transmission electron microscopy
- PLM - EPA/600/R-93-116 (7/93 Edition)
- ACH – ASTM *Method E 741-00 Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution*
- Smoke, Fume and Particulate – ARTI HHPC-6 and TSI P-Trak
- CO, CO_2, Temp, RH – Q-Trak Model 8554

Statistical Analysis

- Calculated likely upper limits
  - Full-shift
  - Short-term exposures
- LogNorm2 - Statistical Analysis for Exposure Assessment, Version 2.9

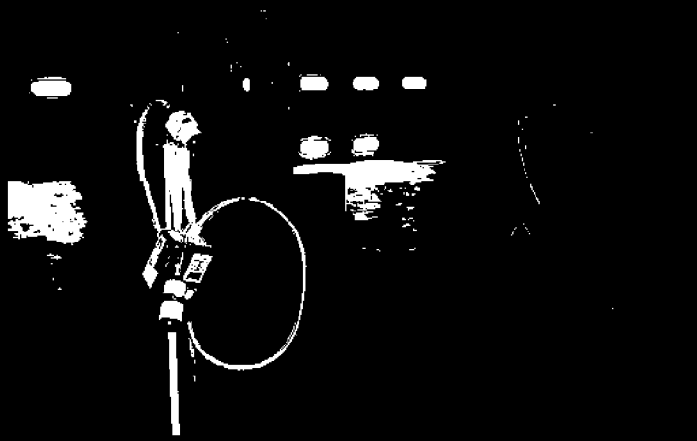
Results

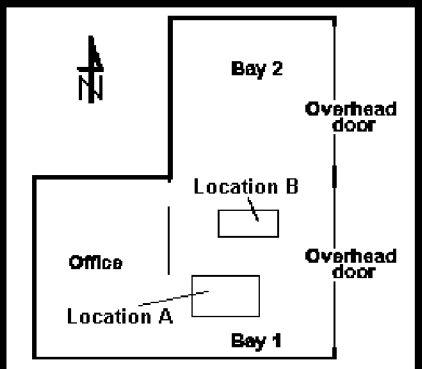
- Full-shift personal samples
  - 0.005 to 0.049 f/cc by PCM
  - 0.002 to 0.041 asbestos f/cc TEM
- STEL personal samples
  - 0.043 to 0.56 f/cc by both PCM and TEM
- 95% confidence that:
  - 95% of 8-hour TWA exposures <0.061 f/cc by PCM and <0.057 asbestos f/cc by TEM
  - 95% of STEL exposures <0.19 f/cc by PCM and <0.13 asbestos f/cc by TEM

Location of Testing

- Maintenance garage
- 40,320 ft^3
- Ventilation rates
- AHERA clean
- Random area samplers
- Typical tools and work practices
- Typical work pace

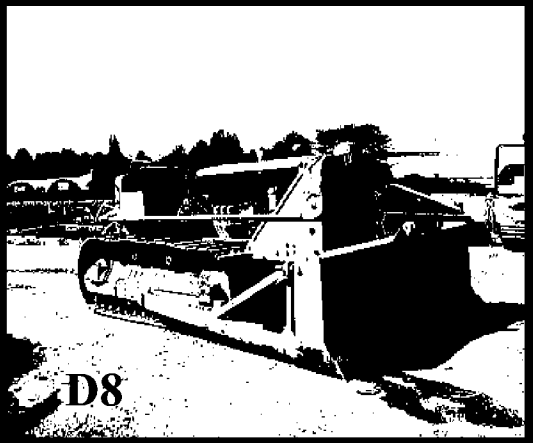


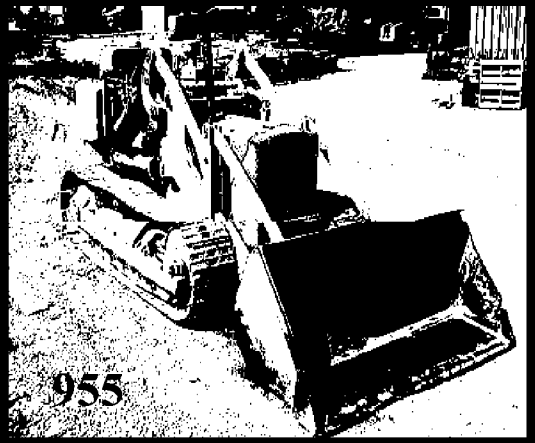




Selecting the Equipment

- Age
- History
- Original parts
- Availability
- Popularity
- Uniqueness









The Mechanics



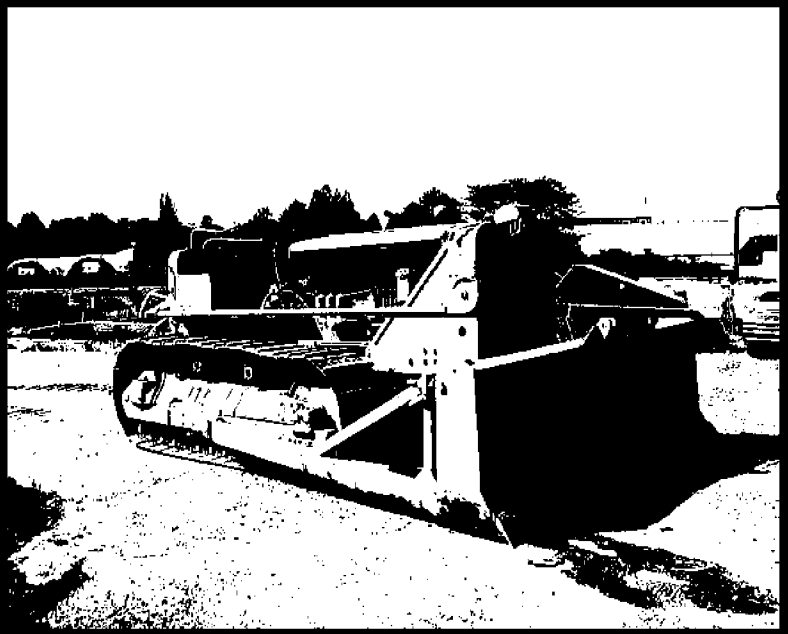
120+ combined years of experience

Assessment Conditions

- Worst case maintenance scenarios
- Very low ventilation rates (0.13 ACH with all doors and windows closed and 1 to 5 ACH with doors open).
- Multiple machines simultaneously
- Focus was working on these machines (limited distractions)
- Old vintage machines

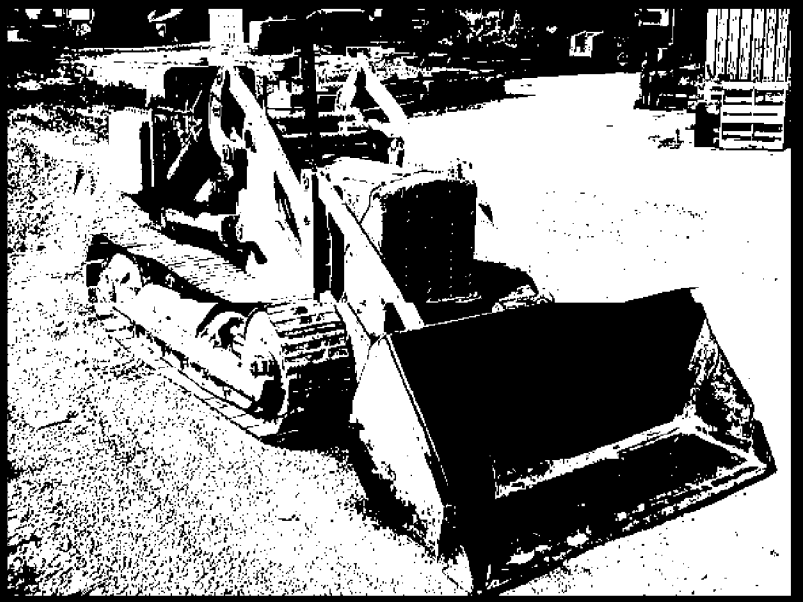
D8 Track Dozer

- Caterpillar D8 Track Dozer
- Manufactured in 1946
- Work performed:
  - Track & Cable Control Band Brakes
  - Clutch
  - Top End Engine Gaskets
- 9-day maintenance period



955 Track Loader

- Caterpillar 955 Track Loader
- Manufactured in 1958
- Work performed:
  - Track Band Brakes
  - Top End Engine Gaskets
- 6-day maintenance period



930 Wheel Loader

- Caterpillar 930 Wheel Loader
- Manufactured in 1968
- Work Performed:
  - Disc Brakes
- Half-day maintenance period

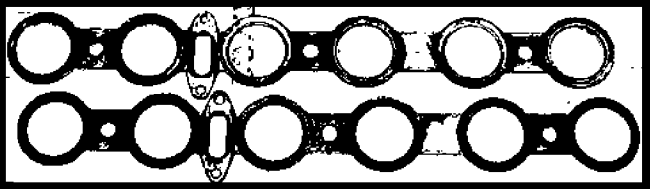


12E Motor Grader

- Caterpillar 12E Motor Grader
- Manufactured in 1959
- Work Performed:
  - Top End Engine Gaskets
  - Drum Brakes
- 2 ½ - day maintenance period



Test Statistics
Gaskets



- 62 gaskets removed and replaced
  - 4 head gaskets
  - 58 other gaskets
- *22 original gaskets contained asbestos*
- Original asbestos gaskets 3 to 85% chrysotile
- 6 of the replacement gaskets contained asbestos
- Replacement asbestos gaskets 20 to 40% chrysotile

Test Statistics
Friction Materials



- *51 friction sections contained asbestos*
  - 18 band
  - 5 drum
  - 12 disc
  - 16 clutch
- Original asbestos sections 15 to 85% chrysotile
- 24 of the replacement sections contained asbestos
- Replacement sections 15 to 95% chrysotile

D8 Track Brakes

Rotating brake band and abrasive cutting

OSHA 30-min EL
1 f/cc

Results (Avg.)
0.30 asb f/cc



OSHA 8-hr TWA
0.1 f/cc

Results
0.046 asb f/cc

D8 Master Clutch

Punch out rivets, scrape, grind and reline drive plate

OSHA 30-min EL
1 f/cc

Results (avg)
0.16 asb f/cc



OSHA 8-hr TWA
0.1 f/cc

Results (avg)
0.055 asb f/cc

955 Engine Top End

Grinding off engine gasket residue

OSHA 30-min EL
1 f/cc

Results (avg)
0.25 asb f/cc



OSHA 8-hr TWA
0.1 f/cc

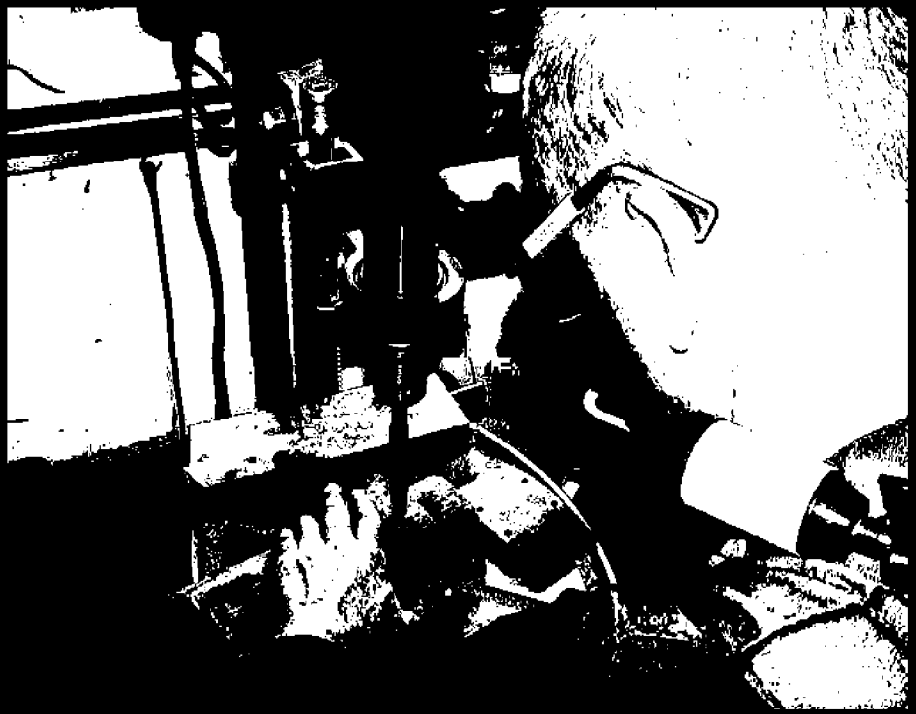
Results (avg)
0.030 asb f/cc

955 Friction

Drilling lining

OSHA 30-min EL
1 f/cc

Results
<0.038 asb f/cc



OSHA 8-hr TWA
0.1 f/cc

Results (avg)
0.016 asb f/cc

955 Friction

Track brake relining with rivets

OSHA 30-min EL
1 f/cc

Results (avg)
<0.043 asb f/cc



OSHA 8-hr TWA
0.1 f/cc

Results (avg)
0.016 asb f/cc

930 Friction

Disc brake pad removal

OSHA 30-min EL
1 f/cc

Results (avg)
<0.044 asb f/cc



OSHA 8-hr TWA
0.1 f/cc

Results (avg)
0.024 asb f/cc

930 Friction

Disc brake reinstallation

OSHA 30-min EL
1 f/cc

Results (avg)
<0.044 asb f/cc



OSHA 8-hr TWA
0.1 f/cc

Results (avg)
0.024 asb f/cc

12E Friction

Drum brake

OSHA 30-min EL
1 f/cc

Results (avg)
***<0.045* asb f/cc**



OSHA 8-hr TWA
0.1 f/cc

Results (avg)
***0.005* asb f/cc**

Bulk Samples
Friction-related dust and debris

- 15 samples were taken of debris and scrapings from friction products
  - 6 samples had asbestos content of <1%
  - No asbestos was detected in the other 9 samples





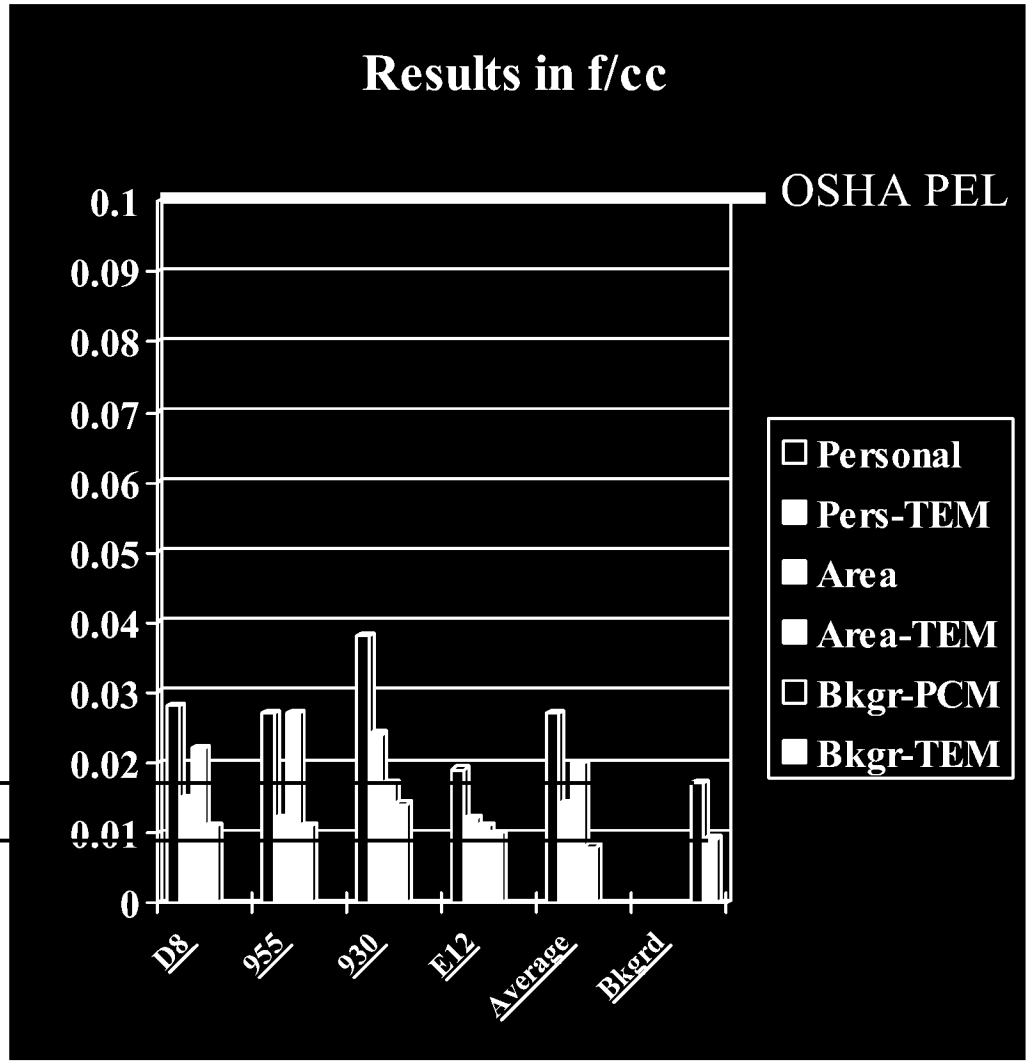


Summary of Air Sampling Results (Entire Study)

- *All results are well below respective PEL*
- Average 8-hr TWA = 0.014 asbestos f/cc (0.1 PEL)
- Average 30-min EL = 0.060 asbestos f/cc (1.0 PEL)
- Average of area samples is 0.008 asbestos f/cc

Average Results by Equipment Type

- No 8-hr TWA exceeds the current OSHA Permissible Exposure Limit of 0.1 f/cc



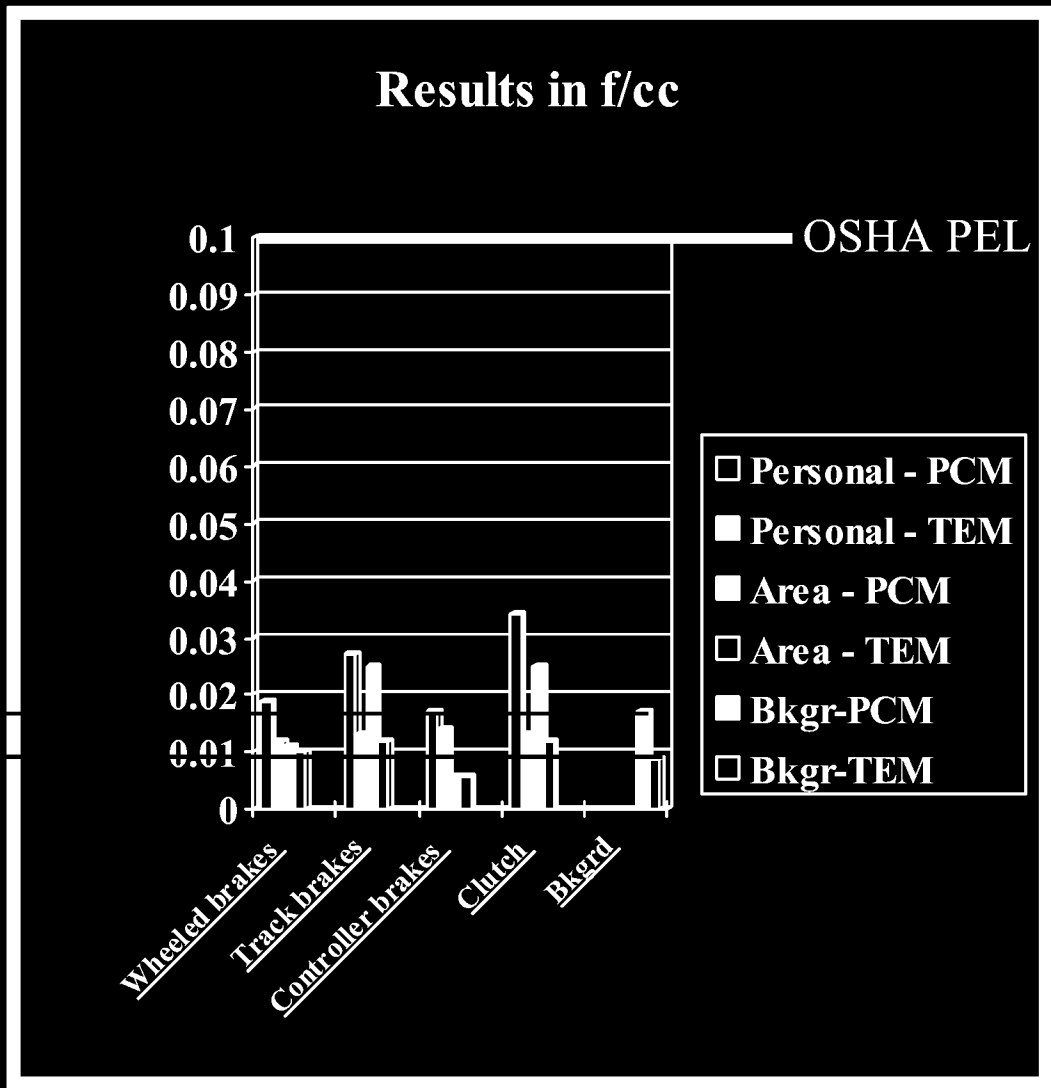
Background total fiber

Background asbestos fiber

Friction Results by Task

- No 8-hr TWA exceeds the current OSHA Permissible Exposure Limit of 0.1 f/cc

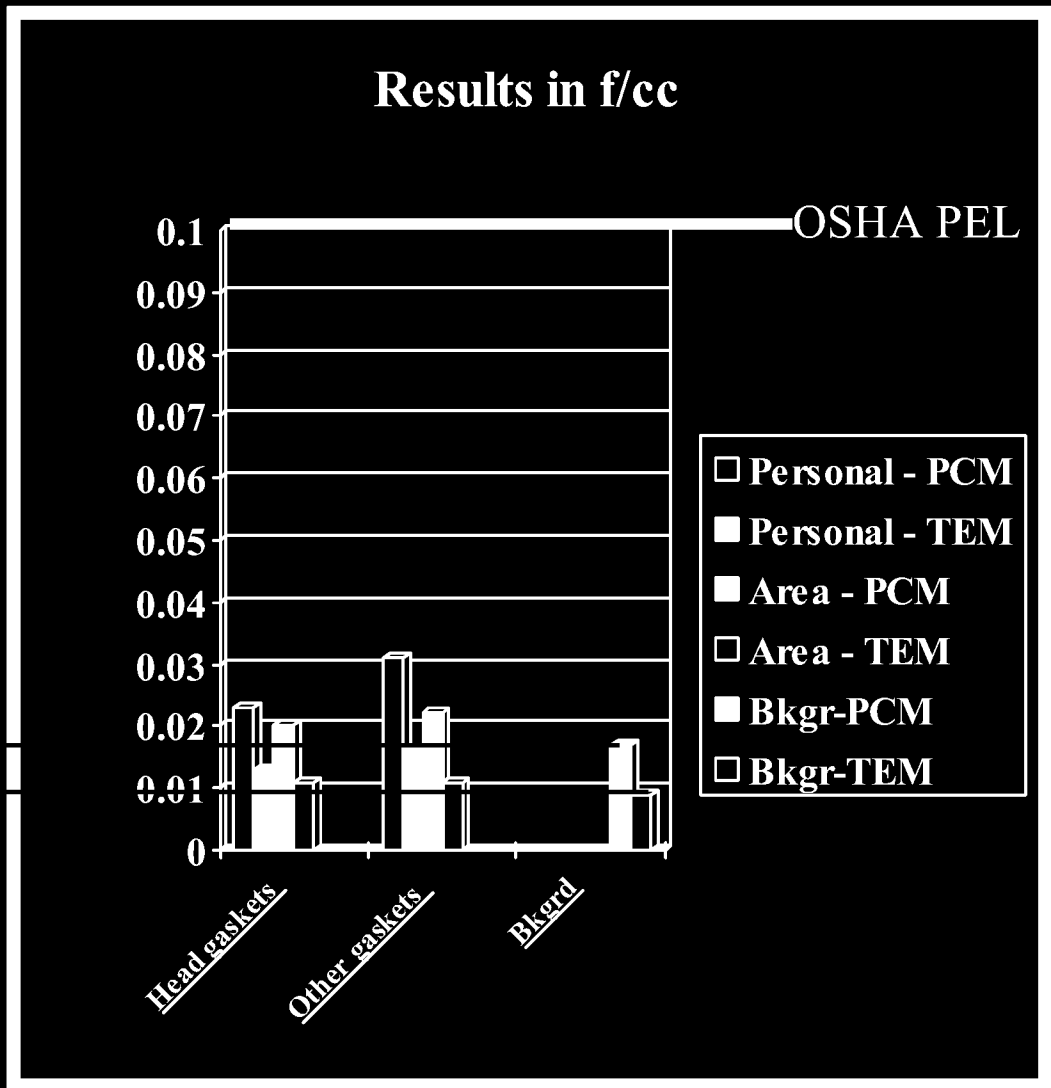
Background total fiber
Background asbestos fiber



Gasket Results by Task

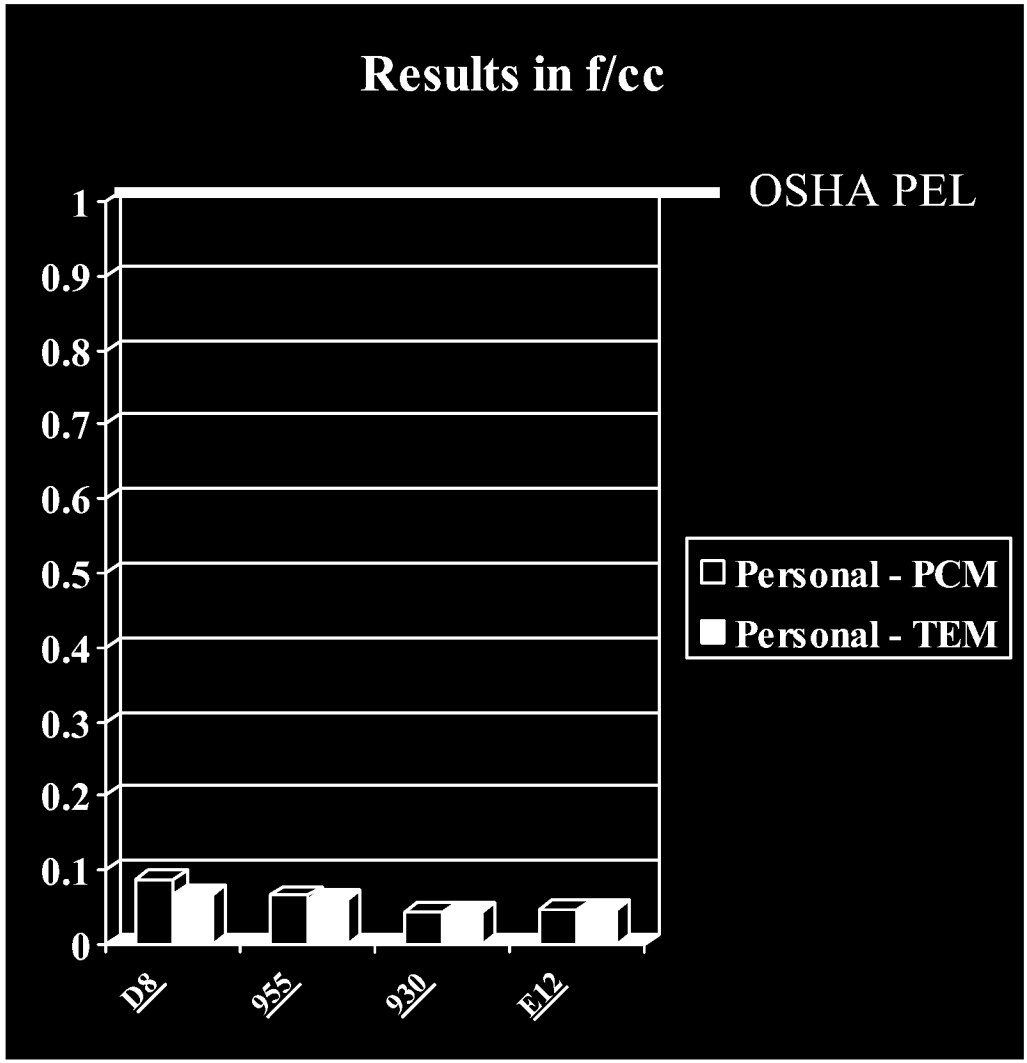
- No 8-hr TWA exceeds the current OSHA Permissible Exposure Limit of 0.1 f/cc

Background total fiber
Background asbestos fiber



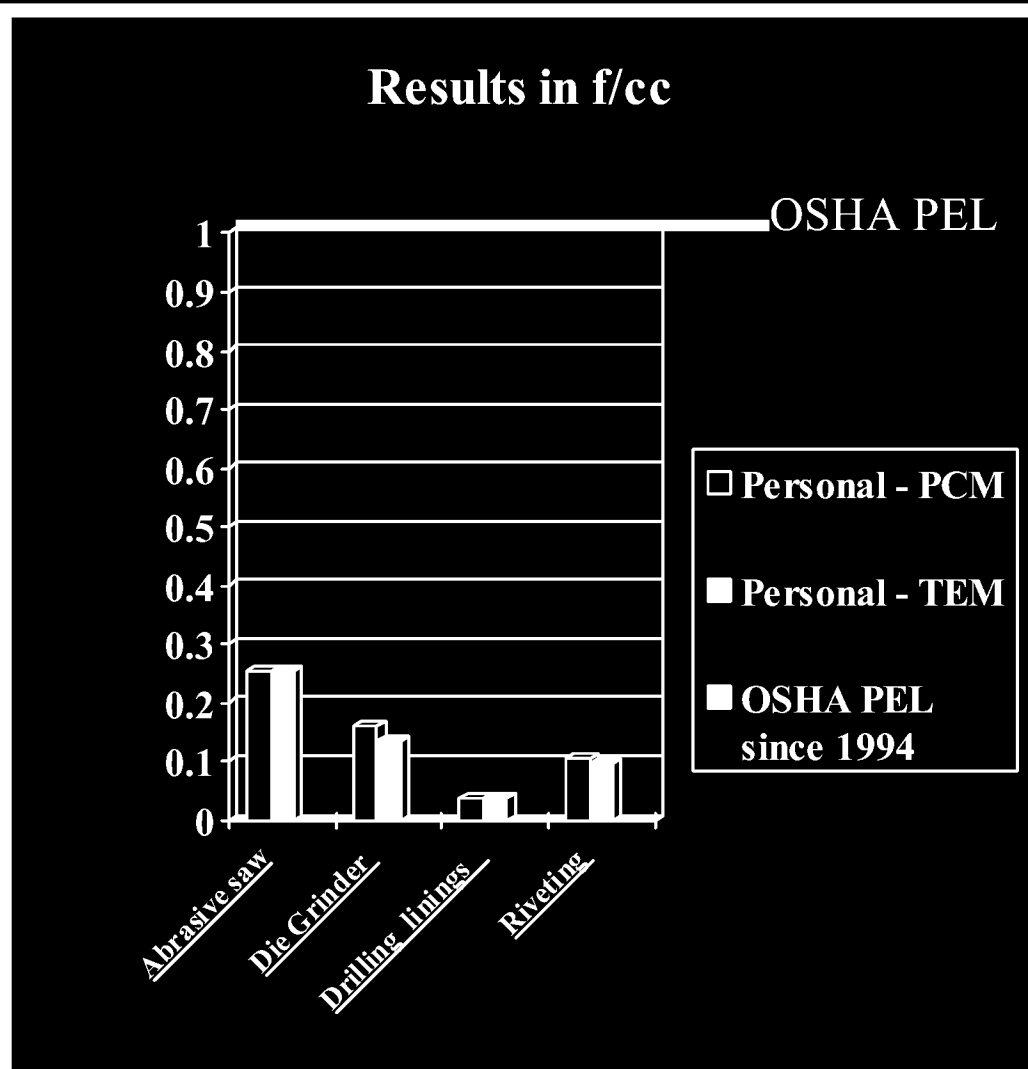
Average Excursion Limit Results by Equipment Type

- No 30-min EL exceeds the current OSHA Permissible Exposure Limit of 1.0 f/cc



Worst Case Tasks
All below PEL

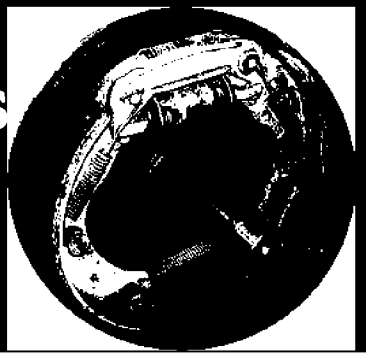
- No 30-min EL exceeds the current OSHA Permissible Exposure Limit of 1.0 f/cc



Comparing Results – Auto Mechanics -

- Study consistent with published literature
- Numerous studies of auto mechanics performing brake work
- Historic studies (1968-1996) all show exposures below respective PEL

Other Friction Studies
(8-hr TWA)

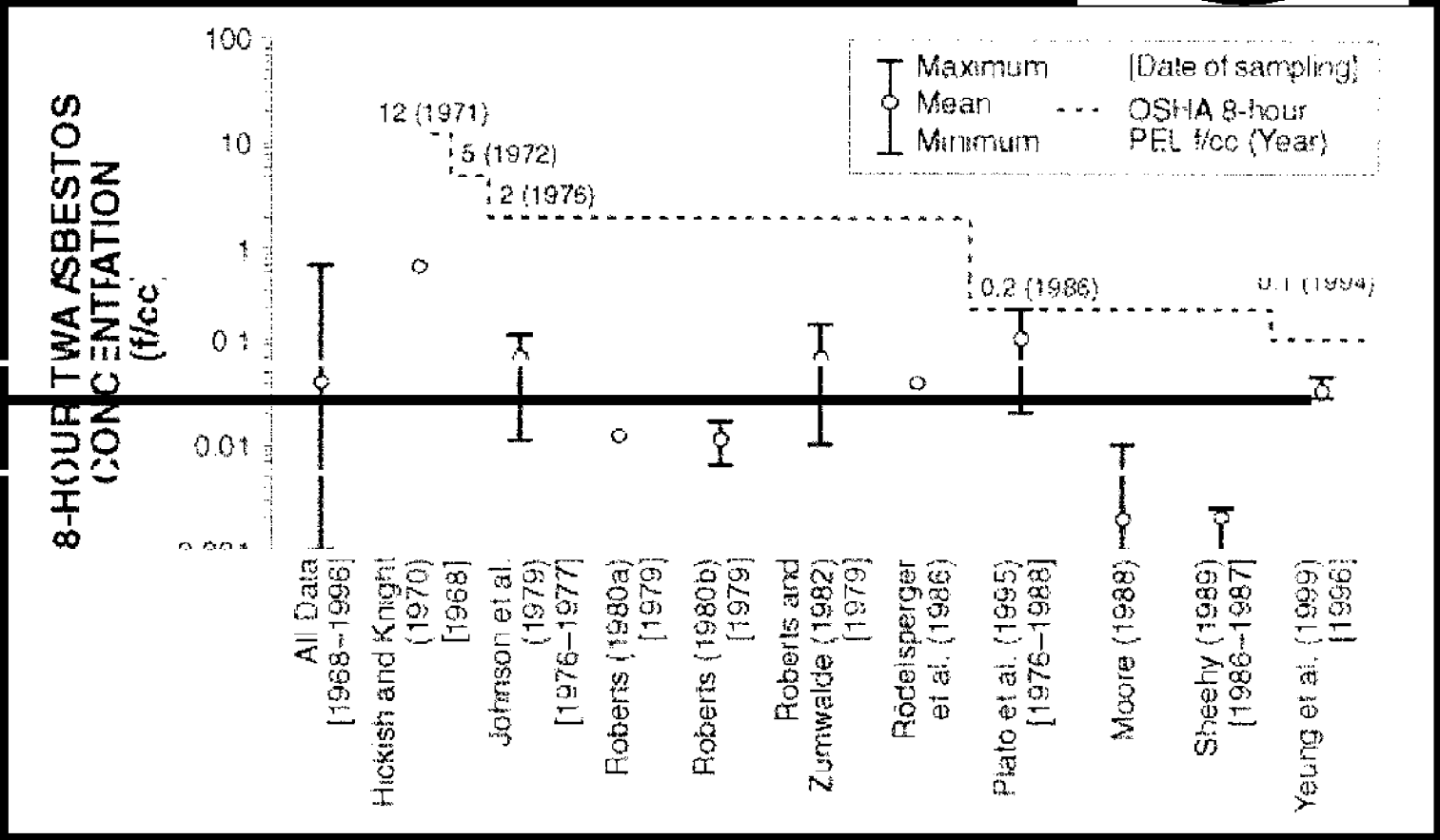


2003 Heavy Equip Study

Maximum

Mean

Minimum



Conclusions

- Repair and maintenance of asbestos-containing friction products and gaskets in heavy equipment results in exposures well below both OSHA's standard for an 8-hour TWA and the 30-minute EL

- Aggressive activities such as scraping, hammering, drilling, abrasive cutting, riveting, and cleaning using a die grinder or compressed air on materials containing asbestos did not yield significant concentrations based on a STEL nor contribute meaningfully to the 8-hr TWA

Airborne Asbestos Fiber Exposure Assessment of Heavy Equipment Mechanics

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