AEROSPACE INDUSTRY

The theme of the presentation
ATLAS COPCO INDUSTRIAL TECHNIQUE
Part of the Atlas Copco Group

Founded in 1873 in Stockholm, Sweden. Presence in more than 90 countries.

<table>
<thead>
<tr>
<th></th>
<th>Atlas Copco Industrial Technique</th>
<th>The Atlas Copco Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employees</strong></td>
<td>5,130</td>
<td>44,000</td>
</tr>
<tr>
<td><strong>Annual revenues</strong></td>
<td>BSEK 11.5 (BEUR 1.3)</td>
<td>BSEK 94 (BEUR 10.3)</td>
</tr>
<tr>
<td><strong>Operating margin</strong></td>
<td>22.3%</td>
<td>18.2%</td>
</tr>
</tbody>
</table>

Figures annual report 2014.

ATLAS COPCO INDUSTRIAL TECHNIQUE
Divisions

Atlas Copco Industrial Technique

- Industrial Technique Service
- Motor Vehicle Industry Tools and Assembly Systems
- Industrial Assembly Solutions
- General Industry Tools and Assembly Systems
- Chicago Pneumatic Tools
ATLAS COPCO INDUSTRIAL TECHNIQUE
Products, processes and service

Tools and systems
• Standard solutions
• Customized solutions

Process
• Application know-how
• Tightening
• Drilling

Service
• Field service
• In-house

VIBRATION EXPOSURE
Causing permanent injuries

- Vascular disorders
- Nerve injuries
- Muscle and joint disorders

- Permanent and irreversible
- Affects you daily life

Pictures from A Color Atlas of vascular disorders in hand-arm vibration syndrome (Hiraki et al)
VIBRATION EXPOSURE

Regulations in the European Union

**Action Value**

\[ A(8) = 2.5 \text{ m/s}^2 \]

Employer required to make an action program to reduce the exposure

**Limit Value**

\[ A(8) = 5.0 \text{ m/s}^2 \]

Operator not allowed to exceed the limit value

\[
A(8) = a_{hv} \frac{T'}{T_0}
\]

\[ a_{hv} [\text{m/s}^2] \]

Declared vibration value/in-use value

Measured by manufacturer according to ISO 28927 / Measured during process

\[ T [\text{hour/min}] \]

Trigger time

Time the tool is triggered per 8 hour workday (estimated by employer)

\[ T_0 [\text{hour/min}] \]

Trigger time 8 hour reference (workday)

VIBRATION EXPOSURE

Sources to vibrations

- Imbalances from rotating parts
- Machined parts
- Inserted tools
- Forces to accelerate parts
- Piston in riveting hammer
- Process dependent
- Grinding wheel
**VIBRATION EXPOSURE**

Reducing vibrations

- Control magnitude of forces
- Decrease sensitivity
- Isolate (handle)

![Images of tools](image1.png)

- Autobalancer (grinder)
- Differential piston
- Increase mass
- Increase inertia
- Air servo riveting hammer

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**VIBRATION EXPOSURE**

Reducing vibrations - Grinder

**Main sources**

- Grinding wheel imbalance
- Vibrations from process

**Features**

1. Autobalancer
2. Short distance between CG and grinding wheel
3. Reduced sensitivity

**Impact**

1. Autobalancer
   - With: 3.9 m/s²
   - Without: 7.1 m/s²
2. Distance
   - Short: 3.9 m/s²
   - ANSI: 5.5 m/s²
**VIBRATION EXPOSURE**
Reducing vibrations – Riveting hammer

**Main sources**
Motion of piston
Reflected shockwave

**Features**
1. Vibration isolated handle
2. Support handle

**Impact**
1. Isolated handle
   - With: 3.9 m/s²
   - Without: >9 m/s²

Vibration damped riveting hammer (Atlas Copco RRH50, $a_{h}^* = 3.9 m/s^2$)
## Vibration Exposure

### Reducing Vibrations – Bucking Bar

![Image of vibration damped bucking bar](image)

### Process Dependent Vibrations – Grinding Wheel/Disc

<table>
<thead>
<tr>
<th>Disc Type</th>
<th>Removal Rate</th>
<th>Vibration Emission</th>
<th>Feed Force</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyrolit premium disc</td>
<td>110 g/min</td>
<td>6.1 m/s²</td>
<td>80 N</td>
<td><img src="image" alt="Image of finish" /></td>
</tr>
<tr>
<td>3M Cubitron – Fiber Disc</td>
<td>235 g/min</td>
<td>2.7 m/s²</td>
<td>30 N</td>
<td><img src="image" alt="Image of finish" /></td>
</tr>
</tbody>
</table>
NOISE EXPOSURE

Regulations in the European Union

**Lower action value**

\[ L_{ex}(8) = 80 \text{ dB(A)} \]

Individual hearing protections should be available to workers.

**Upper action value**

\[ L_{ex}(8) = 85 \text{ dB(A)} \]

Individual hearing protection shall be used.

**Limit value**

\[ L_{ex}(8) = 87 \text{ dB(A)} \]

Operator not allowed to exceed the limit value. Hearing protection included in the assessment.

\[
L_{ex}(8) = 10 \log\left[\frac{T}{8}\right] \left[10^{(\frac{L_{10}}{10})}\right]
\]

- **L [dB(A)]**
  - Declared noise value/In-use noise
    - Measured by manufacturer according to ISO15744 / Measured during process
  - Trigger time
    - Time the tool is triggered per 8 hour workday (estimated by employer)

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3 dominating sources

- **Air flow noise (pneumatic tools)**
  - Aerodynamic noise
    - Pulsating flow
- **Vibration induced noise**
- **Process noise**
  - Grinding wheel grinding
    - Increased air consumption
Reducing process noise – Impact wrenches and pulse tools

Reducing process noise – Impact wrenches
**PRODUCTIVITY**

Reducing exposure and increasing productivity

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**Trigger time \([T]\)**

Reduce trigger time - reduce exposure

Valid for both noise and vibrations

\[
A(\theta) = a_h \sqrt{\frac{T}{T_0}}
\]

\[
L_{ex}(\theta) = 10 \log \left[ 10^{\frac{A(\theta)}{10}} \right]
\]

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**Increasing power**

Output power and "work done" goes hand in hand

More power means more work done

A certain job task can be done in shorter time

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**PRODUCTIVITY**

Example: Vane grinder Vs. Turbine grinder

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**Vane grinder**

- Power: 1.3 kW
- Weight: 1.5
- Vib. Emission: 4.9 m/s²
- Noise emission: 85 dB(A)

\[
A(\theta) = 2.5 \text{ m/s}^2
\]

\[
L_{ex}(\theta) : 79 \text{ dB(A)}
\]

\[
T : 2h
\]

---

**Turbine grinder**

- Power: 2.2 kW
- Weight: 2.1
- Vib. Emission: 3.9 m/s²
- Noise emission: 78 dB(A)

\[
A(\theta) = 1.5 \text{ m/s}^2
\]

\[
L_{ex}(\theta) : 70 \text{ dB(A)}
\]

\[
T : 1h 11 \text{ min}
\]

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**2h to do the job**
**PRODUCTIVITY**

Example: Riveting hammers

**Non-isolated**
- Power: 125 W
- Weight: 1.4 kg
- Vib Emission: 14.7 m/s²
- Noise emission: 93 dB(A)

- A(8): 7.4 m/s²
- Lₘₐₓ₁₇₆ₜ: 87 dB(A)
- T: 2h

**Vibration isolated**
- Power: 180 W
- Weight: 1.3 kg
- Vib Emission: 3.9 m/s²
- Noise emission: 91 dB(A)

- A(8): 1.6 m/s²
- Lₘₐₓ₁₇₆ₜ: 85 dB(A)
- T: 1h 23 min

**SUMMARY**

- Injuries a result of bad ergonomics
  - Vibrations causes injuries to hand-arm system
  - Noise causes hearing losses

- Emission and trigger time important
  - Find tools with low(er) emission value
  - Change tool, process, inserted tools etc. to reduce trigger time

- Combination of productivity and ergonomics saves people and money
  - Look at the whole picture