Docket 008A
December 2, 2008
Rich Volko
Policy and Standards Development Branch

Work Rate Evolution
(PARP)
Powered Air-Purifying Respirator

Technology Laboratory
National Personal Protective
Assisted class

Approval requirement to be determined for Breath

Classifications

Breath Assisted and Positive Pressure PAPR

Additional Work Rates Now Under Consideration

Additional work rate

Positive pressure at maximum manufacturer specified

of PAPR Standard

Work Rates Proposed in December 2007 Draft

Constant flow requirement

Current approval method

Stages of PAPR Work Rate Evolution
Vacuum blower flow
- Vacuum blower removes air from chamber to chamber and atmosphere differential between main intake zero pressure

Blower outside sealed chamber with meteor monitored with dry test

Respiratory Inlet Covering

Required for approval

Minimum constant airflow

Current PAPR airflow requirements
Work rate corresponding to 40 Lpm breathing rate

In most cases, these flows are capable of maintaining positive pressure in the breathing zone of the PAPR respiratory inlet covering at a minimum rate of 170 Lpm for loose-fitting PAPR and 115 Lpm for tight-fitting PAPR.

<table>
<thead>
<tr>
<th>Flow Rate (Lpm)</th>
<th>PAPR Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>170 Lpm</td>
<td>Loose-fitting PAPR</td>
</tr>
<tr>
<td>115 Lpm</td>
<td>Tight-fitting PAPR</td>
</tr>
</tbody>
</table>

Currently Approved Minimum Flow Rates

Current PAPR Airflow Requirements
- Flexibility
- Comfort
- Cost savings
- Positive pressure
- Sufficient airflow
- Improved protection

Original objectives of multiple work rate approvals

Work Rates Proposed in PAPR Standard Concept Paper (December 21, 2007)
<table>
<thead>
<tr>
<th>Peak Flow</th>
<th>Respiratory Rate (L/min)</th>
<th>Tidal Volume (L)</th>
<th>Minute Volume (L/min)</th>
<th>Work Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.79 LPM</td>
<td>1.95 liters @ 29.1 per minute</td>
<td>57 liters</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>1.25 LPM</td>
<td>1.67 liters @ 24 per minute</td>
<td>40 liters</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>0.85 LPM</td>
<td>1.30 liters @ 19.2 per minute</td>
<td>25 liters</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Proposed NIOSH Work Rates (Sinuoidal Waveform) (Concept Paper 21st December 2007)
specified work rate
mounted on a breathing machine operating at the
zone of respiratory inlet covering while properly
- PAPR must maintain positive pressure in breathing
- For intended use of PAPR
- Manufacturer specifies highest work rate from table

- Protocol tested

Concept Paper (December 21, 2007)
Work Rates Proposed in PAPR Standard
and for all three work rates for loose-fitting PAPR
moderate and high work rates for tight-fitting PAPR

Required flows experimentally determined for
respiratory inlet covering

Positive pressure in the breathing zone of the
Minimum constant airflow required to maintain

Challlenge testing

Appropriate airflow for particulate and gas/vapor

Performance at specified work rate

Additional criteria for fully evaluating PAPR

Concept Paper (December 21, 2007)

Work Rates Proposed in PAPR Standard
<table>
<thead>
<tr>
<th>Flow Associated with Each Work Rate</th>
<th>Respirator Type</th>
<th>Work Rate</th>
<th>Rate</th>
<th>Moderate Work Rate</th>
<th>Rate</th>
<th>Low Work Rate</th>
<th>Rate</th>
<th>Flow Applicable in Single Speed Units on Positive Pressure Tests</th>
<th>Flow Associated with Each Work Rate</th>
<th>Respirator Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>235 Lpm</td>
<td>Loose-Fitting</td>
<td>170 Lpm</td>
<td>115 Lpm</td>
<td>Tight-Fitting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>170 Lpm</td>
<td></td>
<td></td>
<td></td>
<td>Not Applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Work Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate Work Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Work Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Concepet Paper (December 21, 2007)
Work Rates Proposed in PAPR Standard

(Read text: CDC Workplace Safety and Health, NIOSH, NPTL)
lies of manufactured battery packs through external power supply in controlled by varying input voltage respiratory inlet coverings both tight and loose-fitting two blower models equipped with flow rates of several samples of commercially available desired constant flow rates not PARP designed to operate at - PARP designed to operate at respiratory inlet coverings breathing zones of PARP maintaining positive pressure in constant airflow required to experimental determination of Concept Paper (December 21, 2007) Work Rates Proposed in PARP Standard
Pressure can be calculated.

- Flow at voltage required to maintain positive
  now be predicted.

- Voltages required to obtain desired test flows can
  polynomial fit
    - Plot data and correlate using second order
      test meter and a mass flow meter
    
      - Measure airflow for each sample using both a dry
        sample

- Vary voltage and record airflow for each paper
  • Calibration of airflow versus voltage

Concept Paper (December 21, 2007)

Work Rates Proposal in PAP Standard
Mfr. 2 Composite Tight Fitting Paper Flow vs Voltage Data

Concept Paper (December 21, 2007)

Work Rates Proposed in Paper Standard
Average PAPR flow
- Calculated from canister AP and
  flow profile, flow profile drop
- Monitor and record breathing zone pressure and canister pressure
- Monitor and record breathing machine variable frequency and tidal volume covering on torso coupled to a
  machine test
- Mount PAPR respiratory inlet

Positive pressure breathing

Concept Paper (December 21, 2007)
Work Rates Proposed in PAPR Standard
(December 21, 2007)

Concept Paper proposed in PAPR Standard

Work Rates Proposal in PAPR Standard
Excellent agreement of predicted flow with average –

Same model

Excellent repeatability between different samples of –

Meter used to determine flow

Regardless of whether dry test meter or mass flow

Flow versus voltage correlations were similar –

Breathing machine tests

Conclusions from positive pressure PAP

Concept paper (December 21, 2007)

Work rates proposed in PAP standard
both models tested

three work rates for loose-fitting PAPR similar for
Flow required to maintain positive pressure at all
models tested

work rates for tight-fitting PAPR similar for both
Flow required to maintain positive pressure at both

breathing machine tests (cont.)

Conclusions from positive pressure PAPR

Concept Paper (December 21, 2007)
Work Rates Proposed in PAPR Standard
ISO standard man (body surface of 1.8m²)

- Based on International Technical Specification
- Extremely high (78 Lpm, 99 Lpm or both)
- Sedentary (11Lpm)

Additional work rates (expressed as respiration rates)
- Positive pressure
- Breath assisted

**TWO PASS Classes**

**Work Rates Under Consideration for Inclusion in PAPP Standard**
Unidentified tidal volume and frequency

Undetected ventilation profile

Extreme high work rate(s)

Unidentified tidal volume and frequency

Sinusoidal ventilation profile

Secondary rate

Characterization of proposed work rates

Work Rates Under Consideration for Inclusion

in PAPR Standard
Work Rates Under Consideration for Inclusion in PAPR Standard

- 11 Lpm
- 25 Lpm
- 40 Lpm
- 40 Lpm
- 57 Lpm
- Other ISO (78 Lpm or 99 Lpm)

Positive Pressure Monitored

Breath Assisted

(PAPR Subpart P)