Long-Term Field Evaluation

Robert Stein, General Engineer, National Personal Protective Technology Laboratory (NPPTL), NIOSH
LTFE Topics

• Background
  – NPPTL Technology Evaluation Branch
  – Regulatory Authority
  – SCSR Deployment in Mines

• Long Term Field Evaluation (LTFE)
  – LTFE History
  – Proposed LTFE Program
    • Critical Parameters
Regulatory Authority

- Title 42, Code of Federal Regulations, Part 84 (42CFR84)
- NIOSH in conjunction with MSHA §84.3(2)(b)
  - Approved respirators for use in mines
  - Both entry and escape
- Tests and demonstrations of these approved respirators §84.65(e)
NIOSH Certification Testing

Man Test #4

- Test which assigns rated duration.
Man Test #4 Metabolic Load
MSHA/NIOSH Approved SCSRs

- CSE SR-100
- MSA Life Saver 60
- Draeger OXY-K Plus
- Ocenco M-20
- Ocenco EBA 6.5
SCSR History

- Pre-1981 miners rely on FSRs
- 1981 1st generation SCSRs
  - Joint MSHA/NIOSH approval under 30 CFR 11
  - MSHA (30 CFR 75.1714)
- 1983 LTFE begins
- 1989 2nd generation SCSRs
  - Smaller, lighter weight
- 2001 NPPTL Established
  - LTFE expands
  - 200 SCSRs/year
- 2006 MSHA Emergency Mine Evacuation Standard – Final Rule
Long-Term Field Evaluation (LTFE)
# Current Long-term Field Evaluation

**Objective:** Self-contained self-rescuers (SCSR) used for escape to a point of safety from a mine fire or explosion should provide dependable respiratory protection

<table>
<thead>
<tr>
<th>Applicable Standards</th>
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<tbody>
<tr>
<td>- 42 CFR Part 84</td>
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<td>- 30 CFR Part 75.1714</td>
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<thead>
<tr>
<th>Key Partners</th>
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<tr>
<td>MSHA</td>
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<td>ISEA</td>
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<td>UMWA</td>
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<td>NMA</td>
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<td>BCOA</td>
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<td>USWA</td>
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<th>Stakeholders</th>
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<tr>
<td>- ISEA and manufacturers</td>
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<td>- Respirator users</td>
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### Project Scope
- Mine-deployed units are collected for inspection and performance evaluation to assess their reliability through their projected service life
- 200 SCSRs per year are audited to ensure proper functioning in the event of an emergency

### Milestones
- 200 SCSRs per year are audited to ensure proper functioning in the event of an emergency

### Outputs
- SCSR failures will be prevented as a result of the discovery of design flaws or susceptibility to environmental damage
- Audit of certified performance of NIOSH-approved respirators
- Published report of operational readiness of aging units
We Have Been at this for a While
First Generation SCSRs

PASS 700E
Draeger Oxy SR 60B
MSA 60-Minute SCSR
CSE AU-9A1
Ocenco EBA 6.5
Deployed SCSRs (Phases 1 - 5)
Second-Generation SCSRs

CSE SR-100

MSA Life Saver 60

Draeger OXY-K Plus

Ocenco M-20

Ocenco EBA 6.5
Deployed SCSR (Phases 6 - 9)
**LTFE Protocol**

- **Objective**
  - Compare the performance of deployed SCSRs to new SCSRs.

- **Method**
  - Collection inspection
  - Sample
  - Replace
  - Laboratory inspection
  - Test

- **Report**
  - LTFE Report
  - Investigation reports
In-Mine Collection

- Mines participate on a voluntary basis
- Only conforming units are sought:
  - Must meet manufacturer’s requirements for use:
  - Visual inspection
  - Age
  - Indicators
  - Non-destructive testing
- Some non-conforming units are collected as a result of these circumstances.
- Deployment circumstances at the time of collection can be observed.
Indicators and ND Testing

High Temperature

Bed Degradation

CSE

Draeger

CSE
<table>
<thead>
<tr>
<th>Metabolic workload</th>
<th>BMS</th>
<th>Treadmill</th>
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<tbody>
<tr>
<td>O₂ consumption rate</td>
<td>1.35</td>
<td>1.35</td>
</tr>
<tr>
<td>CO₂ production rate</td>
<td>1.15</td>
<td>*</td>
</tr>
<tr>
<td>Ventilation rate</td>
<td>30.0</td>
<td>*</td>
</tr>
<tr>
<td>Tidal volume</td>
<td>1.68</td>
<td>*</td>
</tr>
<tr>
<td>Respiratory frequency</td>
<td>17.9</td>
<td>*</td>
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Inhalation: 89
Exhalation: 71

Pace of treadmill test is set to maintain oxygen consumption at the stated rate.
**LTFE Data and Results**

- Evaluations are based on experimental protocols not certification standards
- Test methods, protocols and results are not substitutes for nor superior to 42 CFR 84
- Process of discovery
  - Not based on a random sample
  - Discover problems that the existing standard may not have anticipated
  - Compare new to field deployed SCSRs
  - Practical improvements
- Results
  - Test results alone do not guarantee successful use in a mine escape
  - Neither necessary nor sufficient evidence to change rated duration of an approved SCSR
Lessons Learned From 25 Years of LTFE

- Many SCSRs survive their entire service life
- All SCSRs are affected by deployment.
- Some performance degradation observed in all models
- Carried or worn SCSRs can be degraded more quickly.
- Individual SCSRs are seldom limited to one deployment mode throughout their useable life.
- Service life, inspection, and care are often poorly understood.
  - Many users and owners believe service life to be a guarantee of useful life.
  - Many SCSRs become obviously damaged, but even obviously damaged SCSRs are not always immediately removed from service.
Proposed LTTFE Program

- Critical Parameters
  - Major
  - Minor
  - Technical Basis
- Statistical Sampling Approach
- Reporting Requirements
## Life Support Criteria for LTFE

<table>
<thead>
<tr>
<th>Critical Parameters</th>
<th>Duration</th>
<th>As specified</th>
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<tbody>
<tr>
<td>Oxygen</td>
<td>15 %</td>
<td>1 Minute average, taken at 1 minute intervals</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>4%</td>
<td>See above</td>
</tr>
<tr>
<td>Loose Material in Breathing Circuit</td>
<td>&lt; 5mg.</td>
<td>Present in breathing tube or mouthpiece on opening</td>
</tr>
<tr>
<td>Breathing Circuit integrity</td>
<td>No punctures, tears or breaks</td>
<td></td>
</tr>
</tbody>
</table>
**Major and Minor Parameters**

- **Major Parameter**
  - A non-critical parameter that results in reduced protection for an individual using the SCSR
  - Examples are chemical migration from bed or scrubber in the breathing circuit interfering with donning the respirator; failure of Oxygen starters

- **Minor Parameter**
  - A parameter that is not likely to reduce the usability of the SCSR

- **Classification of observed parameter determined by NIOSH**
Current SCBA Approval Criteria

- 42 CFR 84 Subpart H - Self Contained Breathing Apparatus.
  - 84.70 (a) (91) Closed circuit apparatus
Duration

- 84.96 (a) The closed-circuit apparatus will be classified according to the length of time it supplies adequate breathing gas to the wearer during man test No. 4 described in table 4 of this subpart.
Oxygen content

- 84.79: minimum requirements
  - (a) Breathing gas used to supply apparatus shall be respirable and contain no less than 19.5 (dry atmosphere) volume percent oxygen.
**Carbon Dioxide (CO$_2$) Content**

- 84.97(c) maximum 2.0 percent carbon dioxide in inspired air for a one hour device (dead space test)
- 84.97(d) gas samples taken during the man test shall not contain more than more than 1.5 percent CO$_2$ taken downstream of the sorbent for mouthpiece only devices
Use of the BMS machine

- BMS is operated at the following conditions:
  - Oxygen Consumption Rate, VO2 = 1.35 lpm
  - Carbon Dioxide Production Rate, VCO2 = 1.15 lpm
  - Ventilation Rate, Ve = 30 lpm
  - Respiratory Frequency, 18 breaths per minute
- These values have been selected to approximate human performance at an equivalent VO2
The critical parameters were selected to allow some change from the certification test requirements

- Oxygen level is greater than or equal to 15.0 percent
- CO₂ level is less than or equal to 4.0 percent
- Foreign material loose in the breathing circuit shall not exceed 5 milligrams
- The breathing circuit shall not contain rips or tears in the breathing bag or breathing tube and nor breech of the breathing circuit integrity in any components
Critical Parameter Failure

- SCSR devices tested must pass a rigorous inspection to manufacturers standards
  - Critical parameters are expected to be related to storage NOT rough handling

- Critical parameter failures will result in the opening of a Certified Product Investigation Process to determine appropriate remedial action
Major or Minor Parameter Failure

- Major and minor parameter failure will be statistically evaluated to the AQL criteria in 42 CFR 84.41 (g)
  - A CPIP will be opened for defects exceeding the applicable AQL.
  - For defects within the acceptable AQL the manufacturer will be informally notified.
Reporting Requirements

- **SCSR Collection Report**
  - Only units meeting a strict application of the inspection criteria are accepted
  - For units not accepted the criteria for not accepting are reported to MSHA, Mine operator, worker

- **Individual mine testing report**
  - Serial number, pass or fail criteria
  - MSHA, mine operator
  - On completion of test

- **Annual Report**