

Long-Term Field Evaluation

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Workplace
Safety and Health



NPPTL Research to Practice
through Partnerships

NPPTL Fall 07

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)**

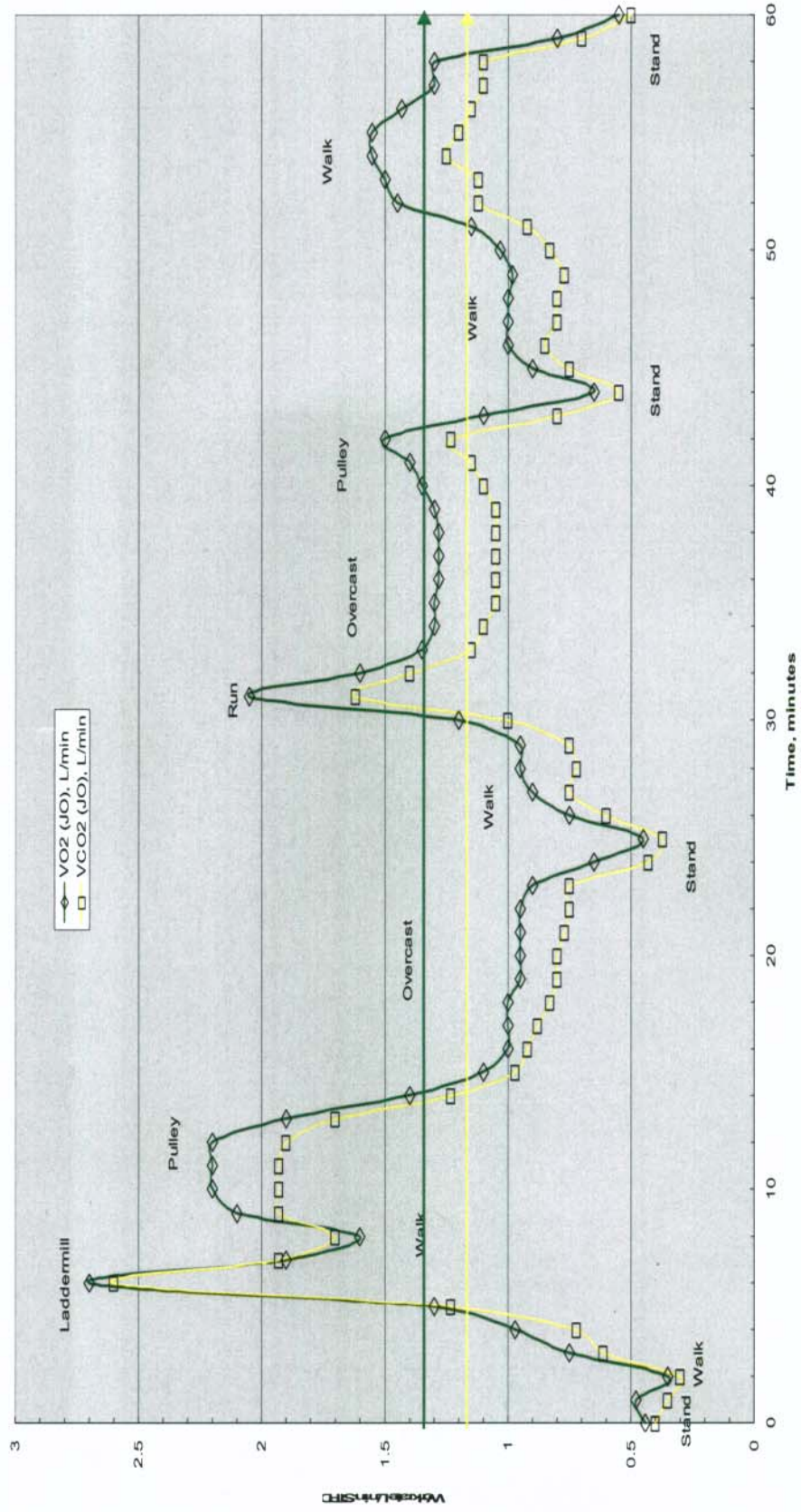
NIOSH Certification Testing

Man Test #4

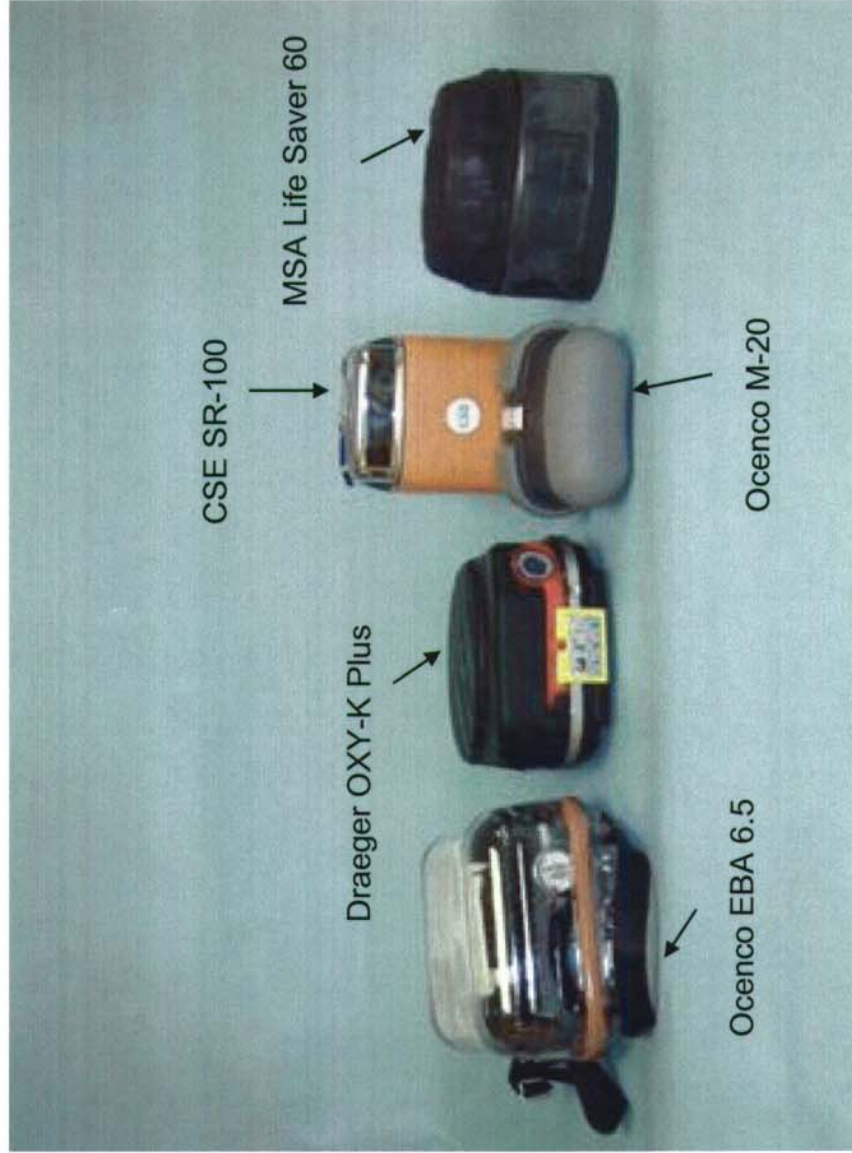
- Test which assigns rated duration.



Man Test #4 Metabolic Load



MSHA/NIOSH Approved SCSRs



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

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

Applicable Standards

- 42 CFR Part 84
- 30 CFR Part 75.1714

Key Partners

MSHA
ISEA
UMWA
NMA
BCOA
USWA

Stakeholders

- ISEA and manufacturers
- Respirator users

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



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NPPTL is a part of

First Generation SCSRs



PASS 700E

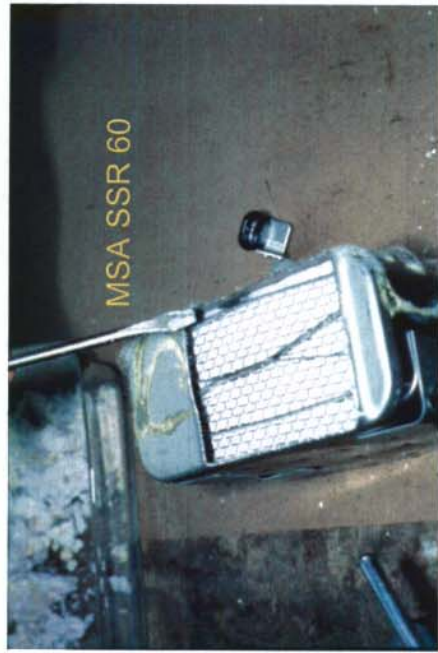
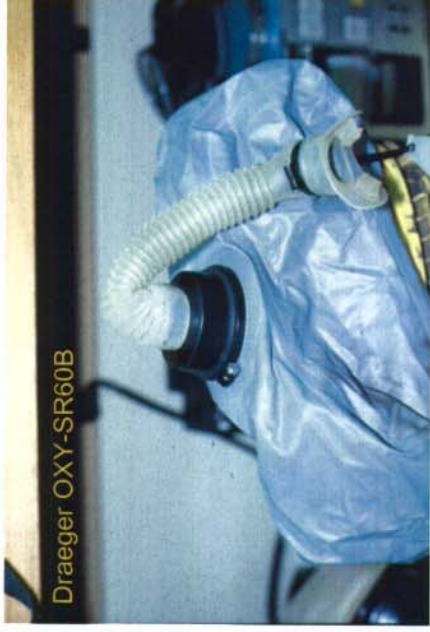
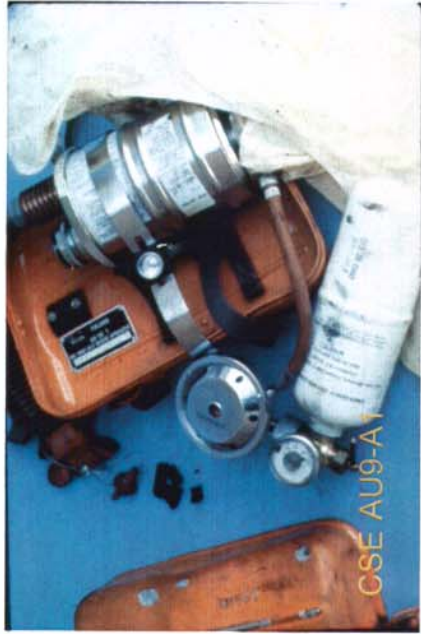
Draeger Oxy SR 60B

MSA 60-Minute SCSR

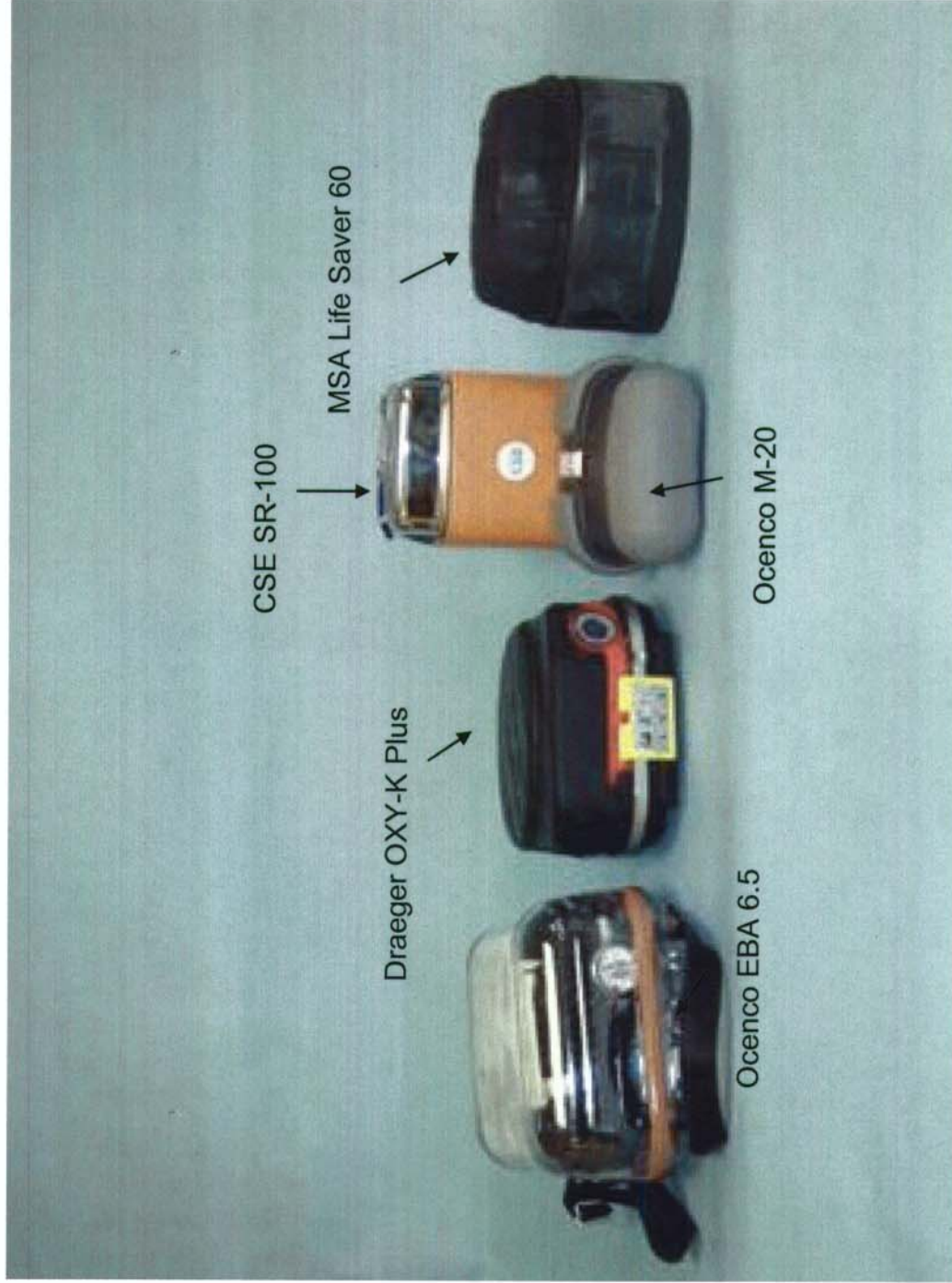
CSE AU-9A1

Ocenco EBA 6.5

Deployed SCSRs (Phases 1 - 5)



Second-Generation SCSRs



Deployed SCSRs (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



CSE

Bed Degradation



CSE



Draeger

LTFE Testing



BMS



Man Test - Treadmill

Metabolic workload	BMS	Treadmill
O ₂ consumption rate L/min.	1.35	1.35
CO ₂ production rate L/min.	1.15	*
Ventilation rate L/min.	30.0	*
Tidal volume L/breath	1.68	*
Respiratory frequency breaths/min.	17.9	*
Inhalation L/minute	89	*
Exhalation L/minute	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 LTFE Program

- **Critical Parameters**
 - Major
 - Minor
 - Technical Basis
- **Statistical Sampling Approach**
- **Reporting Requirements**

Life Support Criteria for LTFE

Critical Parameters		
Duration	As specified	
Oxygen	15 %	1 Minute average, taken at 1 minute intervals
Carbon Dioxide	4%	See above
Loose Material in Breathing Circuit	< 5mg.	Present in breathing tube or mouthpiece on opening
Breathing Circuit integrity	No punctures, tears or breaks	

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 (CO₂) 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 CO₂ taken downstream of the sorbent for mouthpiece only devices

Use of the BMS machine

- **BMS is operated at the following conditions:**
 - Oxygen Consumption Rate, $VO_2 = 1.35$ lpm
 - Carbon Dioxide Production Rate, $VCO_2 = 1.15$ lpm
 - Ventilation Rate, $V_e = 30$ lpm
 - Respiratory Frequency, 18 breaths per minute
- **These values have been selected to approximate human performance at an equivalent VO_2**
 - **Steady-state respiratory responses to tasks used in Federal testing of self-contained breathing apparatus.** Eliezer Kamon, Thomas Bernard, and Richard Stein. American Industrial Hygiene Association Journal, December 1975, pp. 886-896.

Critical parameters

- **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 breach 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**