This presentation should not be considered a final statement of NIOSH policy or of any agency or individual who was involved. This information is intended for use in advancing knowledge needed to protect workers.

National Personal Protective Technology Laboratory

Standards Development Efforts for CBRN CC-SCBA

Sheraton Station Square; Pittsburgh, PA

John G. Kovac, Physical Scientist

December 13, 2005

CC-SCBA

CC-SCBA

- **NIOSH Limitation of Use**
  - Cannot be used when there is direct exposure to open flame or high radiant heat
- **NFPA 1981**
  - Positive pressure at high work rates
- **CBRN**
  - Not hardened

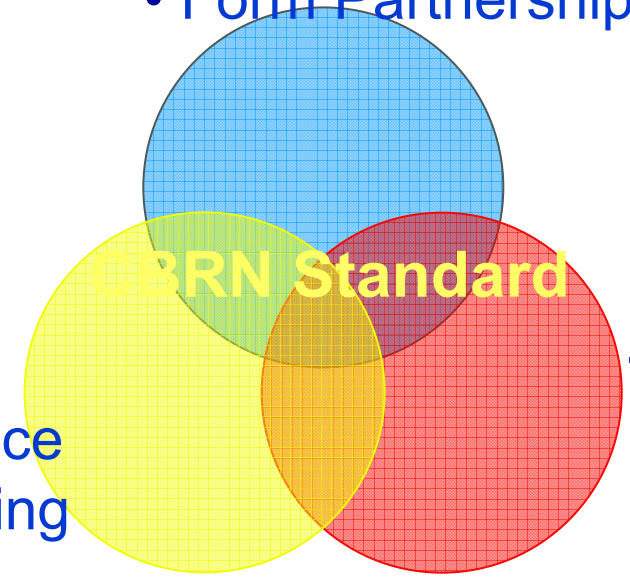
CBRN CC-SCBA Standard

- **Goal**
  - Develop a NIOSH/NPPTL full-facepiece, closed circuit, self-contained breathing apparatus (CC-SCBA) standard that addresses CBRN materials identified as inhalation hazards or possible terrorist hazards for emergency responders.

- **Use**
  - For long-duration missions, involving entry into an atmosphere where contaminant concentrations are IDLH, and which may not contain adequate O_2 Levels.

Effective CBRN Standards Development

Public Process
- Transparent
- Identify Key Stakeholders
- Form Partnerships

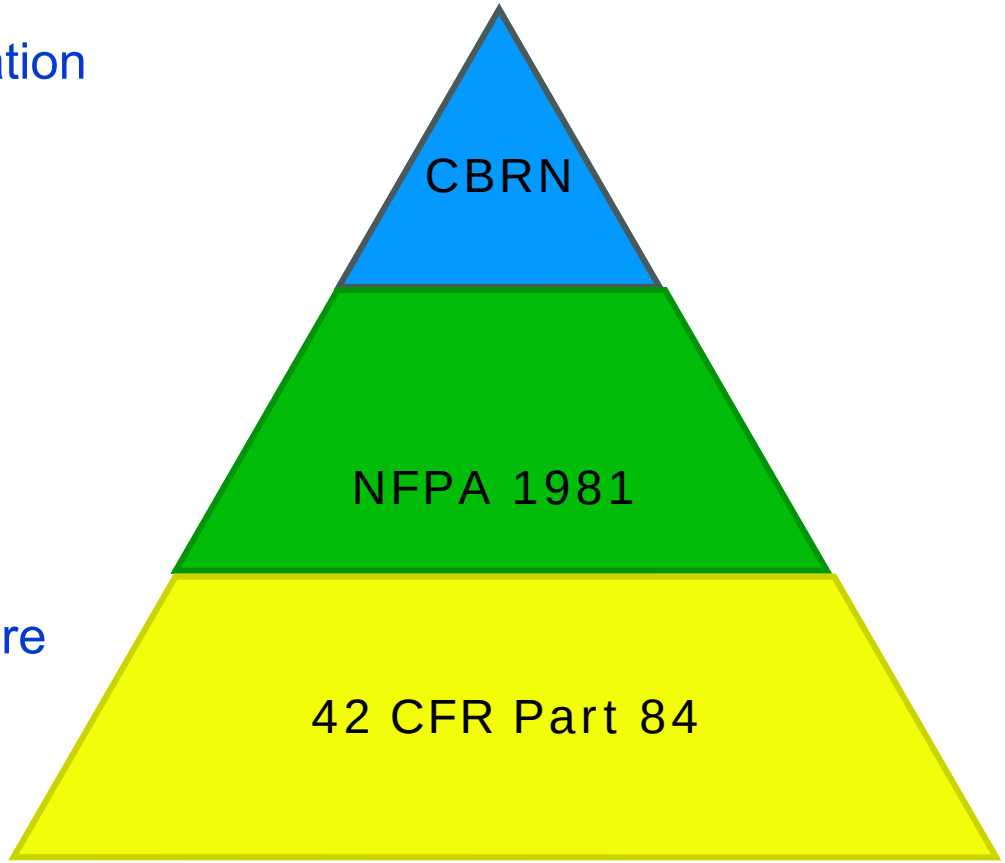


Best Practice
- Good Science
- Benchmarking
- Research
- Peer Review

Focus on Performance
- Hazards Analysis
- Human Capabilities
- Quality Assurance
- Reliability
- Practical Use

CBRN CC-SCBA Concept Standard

- Tier 3: Special CBRN Requirements
  - CWA penetration and permeation resistance
  - Practical performance
- Tier 2: NFPA 1981
  - High Work Rate Performance
  - Operational Performance
    - Environmental Temperature
    - Heat and Flame
- **Tier 1: 42 CFR, Part 84**
  - Establish duration
  - Limitation on use



CBRN CC-SCBA Requirements

- **Concept calls for adapting the:**

  NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services

  to CBRN CC-SCBA

- **Use of an Automated Breathing and Metabolic Simulator (ABMS) for performance testing**

Special Requirements

- **Firefighter Protection Requirements**
  - Fabric Flame Resistance
  - Fabric Heat Resistance
  - Thread Heat Resistance
  - Heat and Flame Resistance Performance

Special Requirements

- **Requirements for CBRN Use**
  - Operational Performance
  - Environmental Operational Performance
  - Vibration Endurance
  - Accelerated Corrosion
  - Particulate Resistance
  - Facepiece Lens Haze, Luminous Transmittance and Abrasion Resistance
  - Communication Performance
  - Chemical Agent Permeation and Penetration Resistance
  - Laboratory Respiratory Protection Level **(LRPL)**

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Standards Development Effort of the Concept Standard for CBRN, Full Facepiece, CC-SCBA

Sheraton Station Square; Pittsburgh, PA

Frank Palya Jr., General Engineer

December 13, 2005

Purpose

- **To discuss the special requirements and updates of the Concept Standard for CBRN CC-SCBA**

- **Concept Standard:**
  - Special Requirements for CBRN Use
  - High Radiant Heat and Open Flame Resistance Requirements

- **Both sets are required to obtain CBRN Certification**

Special Requirements for CBRN Use

- **Operational Performance**
- **Environmental Temperature Operational Performance**
- **Vibration Endurance**
- **Accelerated Corrosion Resistance**
- **Particulate Resistance**
- **Facepiece Lens Haze, Luminous Transmittance, and Abrasion Resistance**
- **Communications Performance**
- **Chemical Agent Permeation and Penetration Resistance Against Distilled Mustard (HD) and Sarin (GB) Agent**
- **Laboratory Respiratory Protection Level (LRPL)**

Operational Performance Requirement

- **Must meet the requirements of Table 1**
- **Requirement Changes**
  - Test Functionality of End Of Service Life (ESLI) alarms and any monitoring systems
  - Not required to operate for the rated duration period established under 42 CFR 84.100 while following the protocol in Table 2b
    - Test is to determine functionality not duration
- **Will be tested in accordance with (IAW) the NIOSH Standard Test Procedure (STP) for operating the NIOSH Automated Breathing and Metabolic Simulator (ABMS) which is under development**

Environmental Temperature Operational Performance Requirement

- **Requirement Changes**
  - Breathing Gas Wet-bulb temperature in Table 1 was waived during Hot and Hot Temperature Shock tests
  - Cold temperature operational limit shall be established by CC-SCBA manufacturer
  - Replace CO_2 absorbent material and coolant mechanism IAW manufacturer's instructions between cold and hot temperature shock tests
    - Rationale: Degradation of absorbent and coolant mechanism during soak periods of extreme temperature
    - Challenge: May be difficult to replace absorbent and coolant within the 3 minute requirement between conditions

Vibration Endurance Requirement

- **Requirement Changes**
  - The O_2 bottle shall be empty (0 Gauge Pressure) during the vibration portion of the test
    - Rationale: Inconsequential weight difference between a full and an empty bottle to effect test outcome
      - Less than 1.75 lbs weight difference

CBRN Requirements with No Changes

- **Accelerated Corrosion Resistance**
- **Particulate Resistance**
- **Facepiece Lens Haze, Luminous Transmittance, and Abrasion Resistance**
- **Communications Performance Requirement**
- **Laboratory Respiratory Protection Level (LRPL)**

Develop NIOSH STPs to Test Requirements

- **Testing will be conducted IAW NIOSH STPs that will be based on NFPA 1981 Standard, 2002 edition for the following requirements:**
  - Accelerated Corrosion Resistance
  - Particulate Resistance
  - Facepiece Lens Haze, Luminous Transmittance, and Abrasion Resistance
  - Communications Performance Requirement
  - Vibration Endurance
- **Rationale: NIOSH STPs can be updated to reflect the latest changes of the NFPA 1981 Standard**

Chemical Agent Permeation and Penetration Resistance Against Distilled Mustard (HD) and Sarin (GB) Agent

- **Requirement Changes**
  - Test Functionality of ESLI alarms and any monitoring systems
  - The O_2 and CO_2 concentrations in the breathing gas will not be monitored after the CC-SCBA meets the rated duration period established under 42 CFR 84.100. by the applicant
  - Decay rate of vapor challenge will follow the same decay profile as the NIOSH CBRN Open-Circuit SCBA Standard
  - Test airflow rate (30 L/min): Volume measured at Standard Temperature = 0°C and Pressure Dry = 760 mm HG (STPD)

High Radiant Heat and Open Flame Resistance Requirements

- **Fabric Flame Resistance**
  - No requirement or test method change
- **Fabric Heat Resistance**
  - No requirement or test method change
- **Thread Heat Resistance**
  - No requirement or test method change
- **Testing will be conducted IAW NIOSH STPs that will be based on the NFPA 1981 Standard, 2002 edition**
  - Rationale: The NIOSH STPs can be updated to reflect the latest changes of the NFPA 1981 Standard

Heat and Flame Resistance Performance

- **Requirement Changes**
  - At this time, NIOSH will use a breathing machine to test this requirement and not the ABMS
  - Only the minimum and maximum breathing gas pressure requirements in Table 1 of Section 3.1 shall be met
  - Rationale: Difficult to integrate the ABMS with the NFPA Open Flame Test Apparatus and dangerous to test with a full O_2 bottle
- **Testing will be IAW a NIOSH STP that will be based on the NFPA 1981 Standard, 2002 edition**
  - Rationale: The NIOSH STP can be updated to reflect the latest changes to the latest NFPA 1981 Standard

Questions

- **Mr. Frank Palya, NIOSH/NPPTL**
  - fcp2@cdc.gov
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Table 1—Performance requirements

Parameter	Requirement
CO_2 concentration of dry breathing gas during inhalation	≤ 4% by volume
O_2 concentration of dry breathing gas during inhalation	≥ 15% by volume
Wet-bulb temperature of breathing gas during inhalation	≤ 50☜C
Maximum breathing gas pressure	≤ 200 mm, w.g.
Minimum breathing gas pressure	≥ 0 mm, w.g.

Table 2a—Parameters

Parameter	Work load A	Work load B
Ventilation rate, liters/min, at T lung , P local and 100% RH	100	40
Respiratory frequency, breaths/min	30	18
Oxygen consumption rate, liters/min,	3.2	1.35
Carbon dioxide production rate, liters/min,	3.4	1.15

Volumes **measured at Standard Temperature = 0 ºC and Pressure Dry = 760 mm HG (STPD)**

Table 2b—Protocol

Rated duration as established by 42 CFR 84.100	Work load	Starting time (minutes)	Duration (minutes)
	A	0	12
Hour 1	B	12	43
	A	55	5
	B	60	25
Hour 2	A	85	5
	B	90	25
	A	115	5
	B	120	25
Hour 3	A	145	5
	B	150	30
Hour 4 and beyond	B	180	60

Table 3—Environmental test conditions

Environment	Temperature	Test duration	Test procedure
Cold (EBM*)	EBM Temp ± 1°C (EBM Temp °F ± 2°F)	Cold soak for a minimum of 12 hours	Perform test at EBM Temp ± 1°C (EBM Temp °F ± 2°F)
Hot	71°C ± 1°C (160°F ± 2°F)	Hot soak for a minimum of 12 hours	Perform test at 71°C ± 5°C (160°F ± 10°F)
Cold temperature shock	71°C ± 1°C (160°F ± 2°F) transferred to EBM Temp ± 1°C (EBM Temp °F ± 2°F); Test temperature shall be EBM Temp ± 1°C (EBM Temp °F ± 2°F)	Hot soak for a minimum of 12 hours; initiate test within 3 minutes in cold chamber	Initiate test within 3 minutes after transferring apparatus to cold chamber
Hot temperature shock	EBM Temp ± 1°C (EBM Temp °F ± 2°F) transferred to 71°C ± 1°C (160°F ± 2°F); Test temperature shall be 71°C ± 5°C (160°F ± 10°F)	Cold soak for a minimum of 12 hours; initiate test within 3 minutes in hot chamber	Initiate test within 3 minutes after transferring apparatus to hot chamber

***EBM - The cold temperature operational limit shall be established by the manufacturer**

Table 4—Simultaneous liquid and vapor challenge of SCBA with distilled sulfur mustard (HD)

Agent	Challenge concentration	Duration of challenge (min)	Breathing machine airflow rate (L/min)	Maximum peak excursion (mg/m^3)	Maximum breakthrough (concentration integrated over minimum service life ($mg\text{-}min/m^3$)	Number of systems tested	Minimum service life (hours)
HD-Vapor	300 mg/m^3 ††	30*	30 L/min (STPD) §§	0.60 ‡	6.0 §	3	† ‡‡
HD-Liquid	0.86 mL	Minimum service life					

*** Vapor challenge generation will start immediately after the liquid drops have been applied and the test chamber has been sealed**

† The test period begins upon the start of initial vapor generation

‡ Three consecutive sequential test data points at or exceeding 0.6 mg/m3 will collectively constitute a failure where each test value is based on a detector sample time of approximately 2 minutes

§ The cumulative Ct, including all peak data points, must not be exceeded for the duration of the minimum service life

‡‡ Minimum service life is equal to applicant's identified duration plus one hour

†† Decay rate of vapor challenge will follow the same profile as the decay rate of the NIOSH CBRN Standard for an Open-Circuit SCBA

§§ Standard temperature 0oC and Pressure Dry 760 mm HG (STPD)EBM - The cold temperature operational limit shall be established by the manufacturer

Table 5—Vapor challenge of SCBA with Sarin (GB)

Agent	Challenge concentration	Duration of challenge (min)	Breathing machine airflow rate (L/min)	Maximum peak excursion (mg/m^3)	Maximum breakthrough (concentration integrated over minimum service life ($mg\text{-}min/m^3$)	Number of systems tested	Minimum service life (hours)
GB-Vapor	2,000 mg/m^3 ††	30*	30 L/min (STPD) §§	0.087 ‡	2.1 §	3	† ‡‡

*** The vapor challenge generation will be initiated immediately after test chamber has been sealed**
† The test period begins upon initial generation of vapor concentration
‡ Three consecutive sequential test data points at or exceeding 0.087 mg/m3 will collectively constitute a failure where each test value is based on a detector sample time of approximately 2 minutes
§ The cumulative Ct including all peak data points must not be exceeded for the duration of the Minimum Service Life
‡‡ Minimum service life is equal to applicant's identified duration plus one hour
†† Decay rate of vapor challenge will follow the same profile as the decay rate of the NIOSH CBRN Standard for an Open-Circuit SCBA
§§ Standard Temperature 0oC and Pressure Dry 760 mm HG (STPD)

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Continued Discussions of Concepts for Standards for Approval of Respirators for Use Against Chemical, Biological, Radiological and Nuclear Agents (CBRN) and Concepts for Standards for Industrial Powered Air Purifying Respirators

Sheraton Station Square, Pittsburgh, PA

December 13, 2005

CBRN Standards Implementation

***CBRN PAPR Step 1*:**

Continue with approach to implement the standard though policy regulatory authorities during 2QFY2006

Complete development of high flow aerosol test capability by the end of calendar year 2006

Accept applications for CBRN PAPR approval 30 days after the release of the standard

CBRN Standards Implementation

CBRN PAPR Step 2:

Complete technology benchmarking evaluations by end of 2006

CBRN Step 2 will be an Advanced Specific Requirement in the new Industrial PAPR Standard

- **Target date to begin rulemaking process by end of 2006**
- **18 to 21 months to implementation following initiation of rulemaking processes**

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CC-SCBA, SAR, and Combination Units (SCBA/PAPR and SCBA/APR) to be finalized in one CBRN module to be released through formal rulemaking processes

Follow on public meeting to address content of CBRN module late spring 2006

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Information Docket
CBRN PAPR

- **Mail:**

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  4676 Columbia Parkway
  Cincinnati, OH 45226

- **Email: niocindocket@cdc.gov**
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