

**National Personal Protective  
Technology Laboratory**

**NFPA/CBRN High-Performance  
Standard for Closed-Circuit  
Breathing Apparatus**

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**December 15, 2004**



**NPPPTL** *Research to Practice  
through Partnerships*

NPPPTL 2004.12.15.NEPA.1084

## Goal

To establish a new standard for closed-circuit self-contained breathing apparatus (CC-SCBA) by adapting the relevant sections of the NFPA 1981

# NFPA 1981 Major Performance Criterion

- Breathing circuit pressure must remain positive at a 100 L/min ventilation rate
  - NFPA 1981 Air Flow Performance Test consists of connecting an OC-SCBA to a breathing machine moving air at a rate equivalent to a  $V_e$  of 100 L/min, ambient conditions or absolute volume displacement (AVD).
  - The breathing circuit pressure in the face mask of the apparatus must remain between 0 and 89 mm H<sub>2</sub>O until the apparatus is expended, for 1200-L apparatus, in 12 minutes.

# Major Obstacles in Application to Greater-Capacity CCBA

- 100 L/min ventilation rate until CCBA is expended is not humanly possible
- Positive-pressure limitations of 0–89 mm H<sub>2</sub>O are difficult in more complicated CCBA
- NFPA 1981 standard lists no metabolic parameters

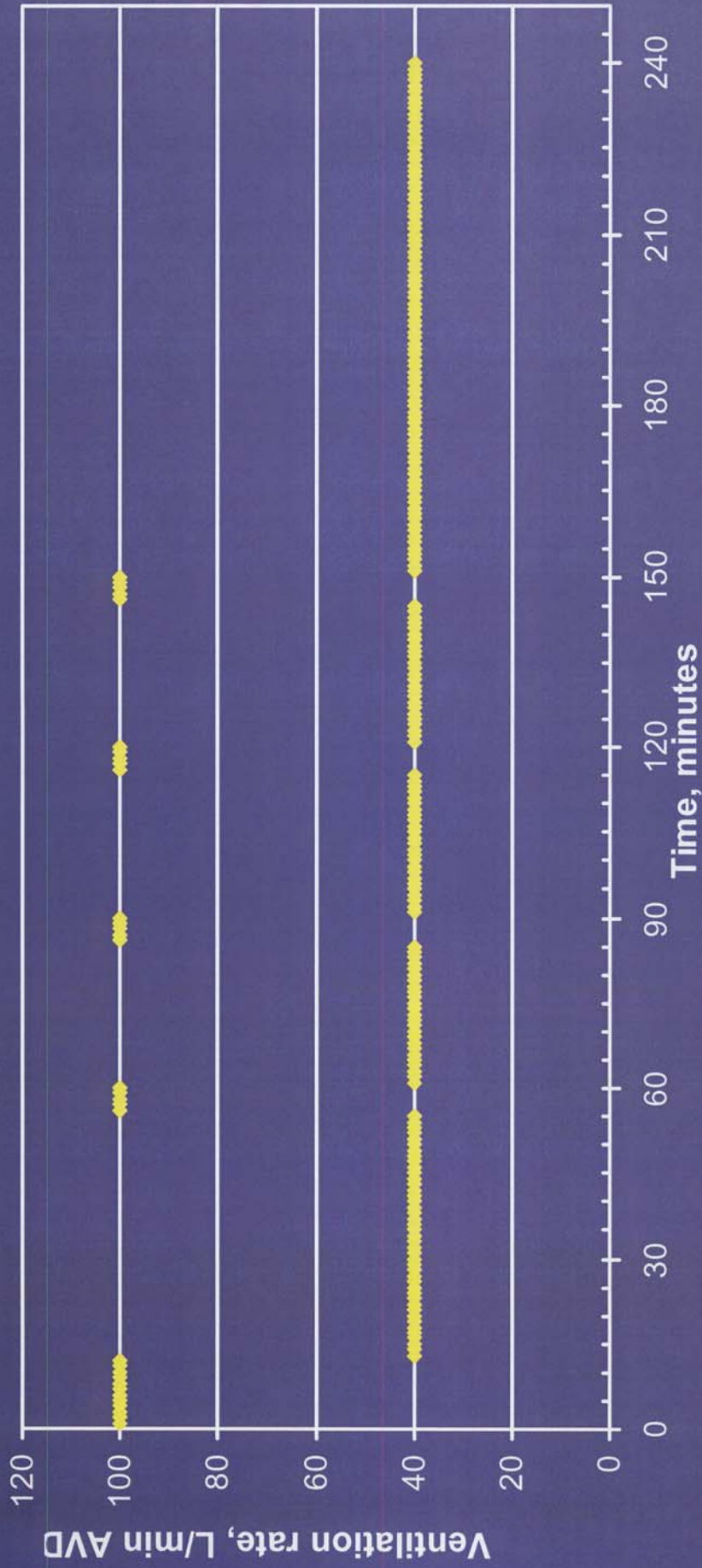
# NFPA CCBA Task Force Solution:

- Test on a breathing and metabolic simulator at two work rates, alternating between one high and one moderate
  - A has a  $V_e$  of 100 L/min (NFPA standard)
  - B has a  $V_e$  of 40 L/min (NIOSH standard)

# 1984 Test Protocol

<u>Time</u>	<u>Work Load</u>	<u>Start Time (min)</u>	<u>Duration (min)</u>
Hour 1	A	0	12
	B	12	43
Hour 2	A	55	5
	B	60	25
	A	85	5
	B	90	25
Hour 3	A	115	5
	B	120	25
	A	145	5
	B	150	until expended

# Proposed NFPA 1984 Protocol



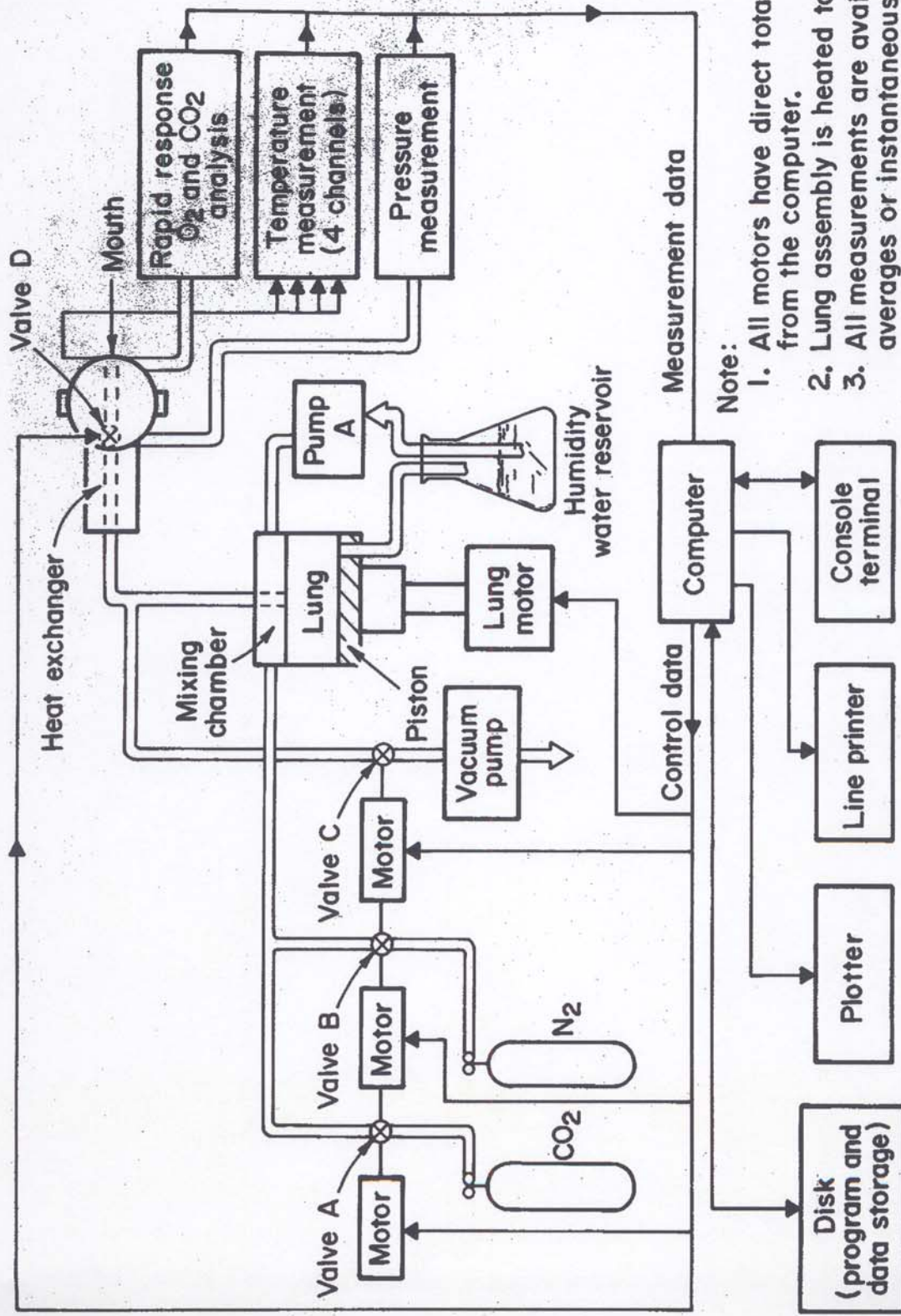
# Metabolic Parameters

<u>Work Load</u>	<u>A</u>	<u>B</u>
Ve, L/min, AVD	100	40
RF, breaths/min	30	24
VO <sub>2</sub> , L/min, STPD	3.2	1.6
VCO <sub>2</sub> , L/min, STPD	3.4	1.6



# CCBA on Breathing and Metabolic Simulator





Note:

1. All motors have direct total control from the computer.
2. Lung assembly is heated to 37° C.
3. All measurements are available as averages or instantaneous.

**There are two presently approved  
positive-pressure CCBA  
(Not approved for use in areas of open  
flame or high radiant heat)**



Workplace  
Safety and Health



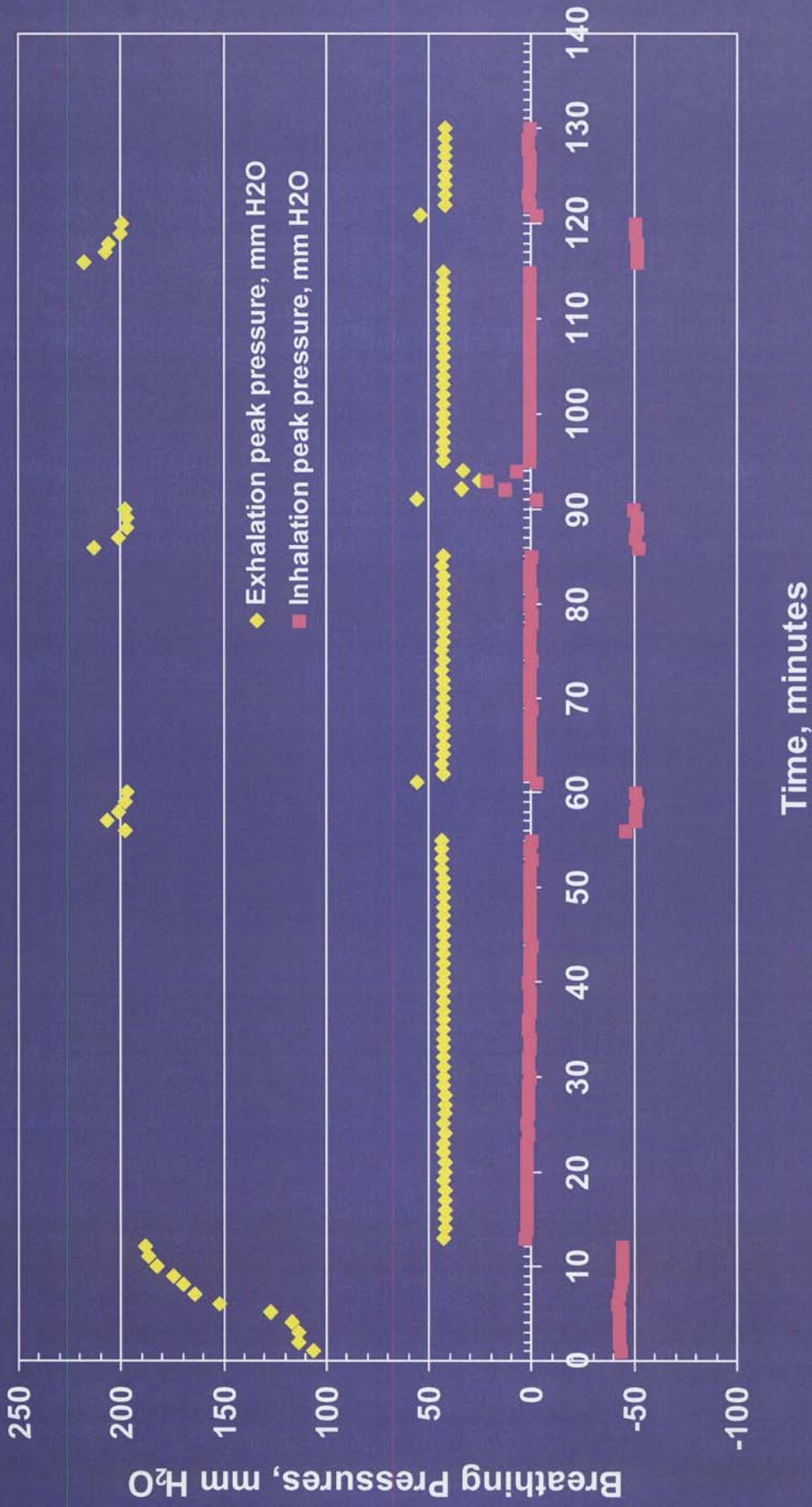
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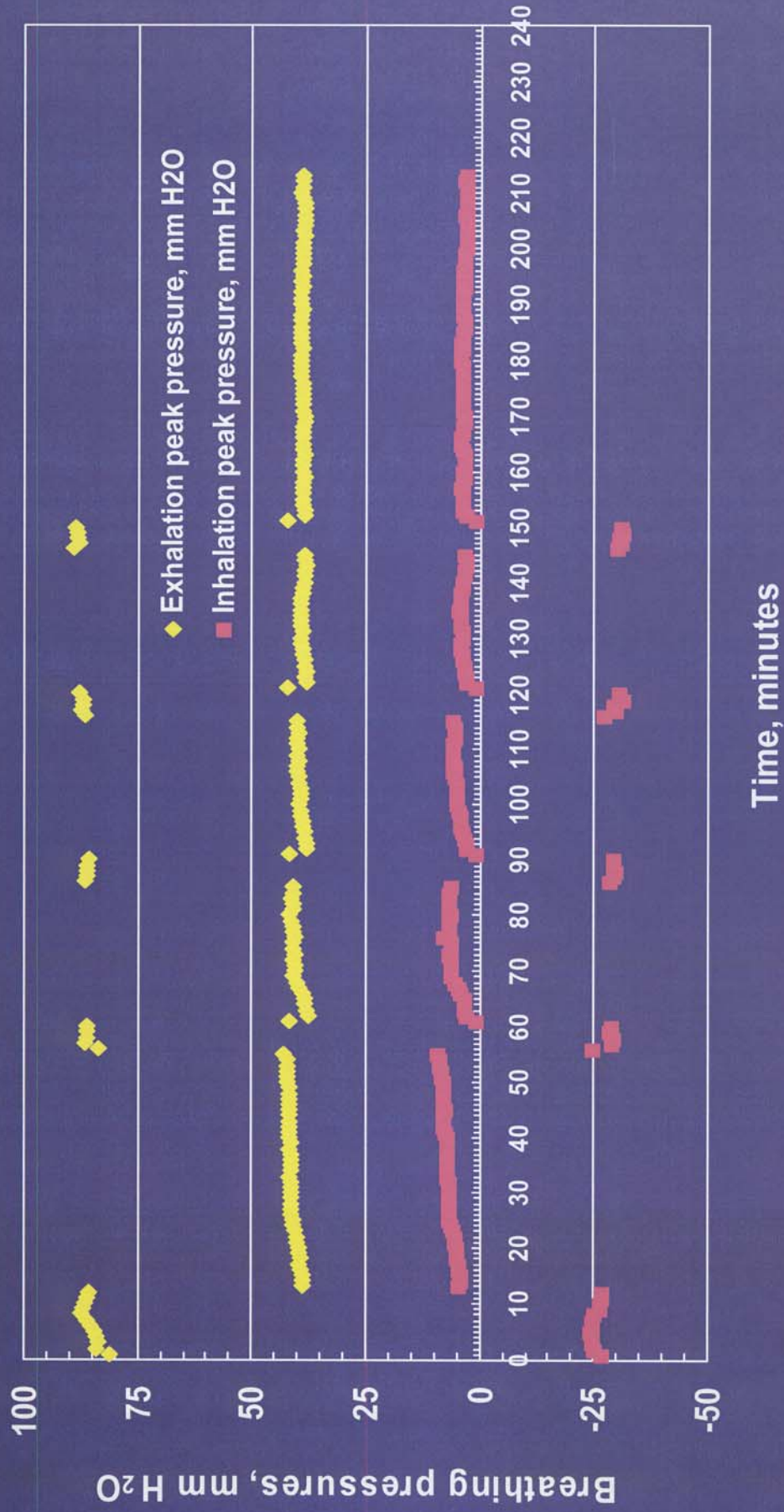
# Preliminary Test Results

- Model A – Exceeds inhalation and exhalation pressure limits immediately
- Model B – Exceeds inhalation pressure limit immediately
- *These results were expected since the apparatus were not designed to pass such a severe test.*

# Model A Breathing Pressures



# Model B Breathing Pressures



# Environmental Impact Testing

- Temperature conditioning/testing
- Vibration test
- Accelerated corrosion test
- Particulate test
- Heat and flame test

# Temperature Conditioning/Testing

- Cold soak/cold run @ -32°C
- Hot soak/hot run @ 71°C
- Cold soak/hot run @ -32°C to 71°C
- Hot soak/cold run @ 71°C to -32°C



# Vibration Test

- MIL-STD-810F; Environmental Test Methods, Method 514.5

# Accelerated Corrosion Test

- MIL-STD-810F, Environmental Test Methods, Method 509.4, Salt Fog

# Particulate Test

- MIL-STD-810F; Environmental Test Methods, Method 510.4, Procedure 1 – Blowing Dust

# Heat and Flame Test

- 15-minute exposure to 95°C at Work Load B
- Direct flame exposure for 10 seconds at Work Load A
- Dropped 6 inches at Work Load A
- No afterflame >2.2 seconds