National Personal Protective Technology Laboratory

Battery Requirements

Sheraton Station Square, Pittsburgh, PA

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Battery Test Requirements

Public Comment	Disposition
Difficult tests to perform, consider standardizing	Test will be performed in standardized conditions using manufacturer submitted equipment
Test low flow indicator against both conditions (battery and clogging)	Both conditions will be tested if appropriate
Change in work rates changes battery life	Testing to a standard minimum, explanation of the effects of changing work rates on battery life required

Battery Test Requirements

Public Comment	Disposition
Require only one indicator; low flow or low battery	Both required to alert user to more fault conditions
Manufacturer should provide data on extreme temperature use and other pertinent issues	Will be required as well as some minimum testing
Indicator signaling method should be optional	Method of indicator signaling not specified, but minimum of one method is mandatory

Battery Test Requirements

- **Battery Performance Test**
  - Tested at minus 30ºC to insure the functionality of the system at this temperature
- **Low Battery Indicator Test**
  - Evaluates the PAPR ability to alert the user to a low battery condition, enabling the user to egress
- **Low Flow Alarm Test**
  - Evaluates units ability to alarm user prior to negative pressure

Battery Test Requirement

Benchmark Testing

	Battery Performance		Breathing Performance		Low Flow Alarm				Low Battery Indicator			
					25°C		-30°C		25°C		-30°C	
PAPR	Moderate	High	Moderate	High	Moderate	High	Moderate	High	Moderate	High	Moderate	High
A	Ran 72 hr cold soak	N/A	Ran 11:43	N/A	N/A	N/A	Not tested		N/A	N/A	N/A	
B	Ran 72 hr cold soak	N/A	Ran 5:58	N/A	Alarmed	N/A	Not tested		Alarmed 12 minutes	N/A	Not tested	
C	Ran 12 hr cold soak	N/A	Ran 4:14	Ran 1:36	Alarmed	Alarmed	Not tested		Alarmed 13 minutes	Alarmed 11 minutes	Not tested	
D	Ran 12 hr cold soak	N/A	Ran 10:12	N/A	N/A	N/A	Not tested		N/A	N/A	N/A	

Battery Performance Test

- **Concept Criteria**
  - Must maintain positive pressure in the breathing zone while breathing at the manufacturer selected breathing performance rate (40 or 103 L/min)
  - Each PAPR must maintain positive pressure for at least 35% of the manufacturer's specified operational battery life
  - The average life of all trials must be at least 40%
  - Tested at -30ºC
  - PAPR will be cold soaked for 4 hours prior to test

Battery Performance Test

- **Benchmark Results**
  - Breathing performance benchmark testing has been performed at 25°C, both breathing rates, on multiple PAPR systems, and using both the Posicheck and NIOSH breathing machines
  - Preliminary testing of ability to work in low temperature conditions have been performed

Battery Performance Test

- **Future Direction**
  - Perform benchmark testing on several PAPR systems
  - Finalize standard test procedure
  - Perform verification testing once the standard testing procedure is completed

Low Battery Indicator

- **Concept Criteria**
  - Moderate or high performance (25°C)
    - Passively alarms the user at least 15 minutes prior to negative pressure, but no more than 45 minutes
  - Moderate or high performance (-30°C)
    - Passively alarms the user prior to negative pressure, minimum and maximum duration after alarm are not evaluated

Low Battery Indicator

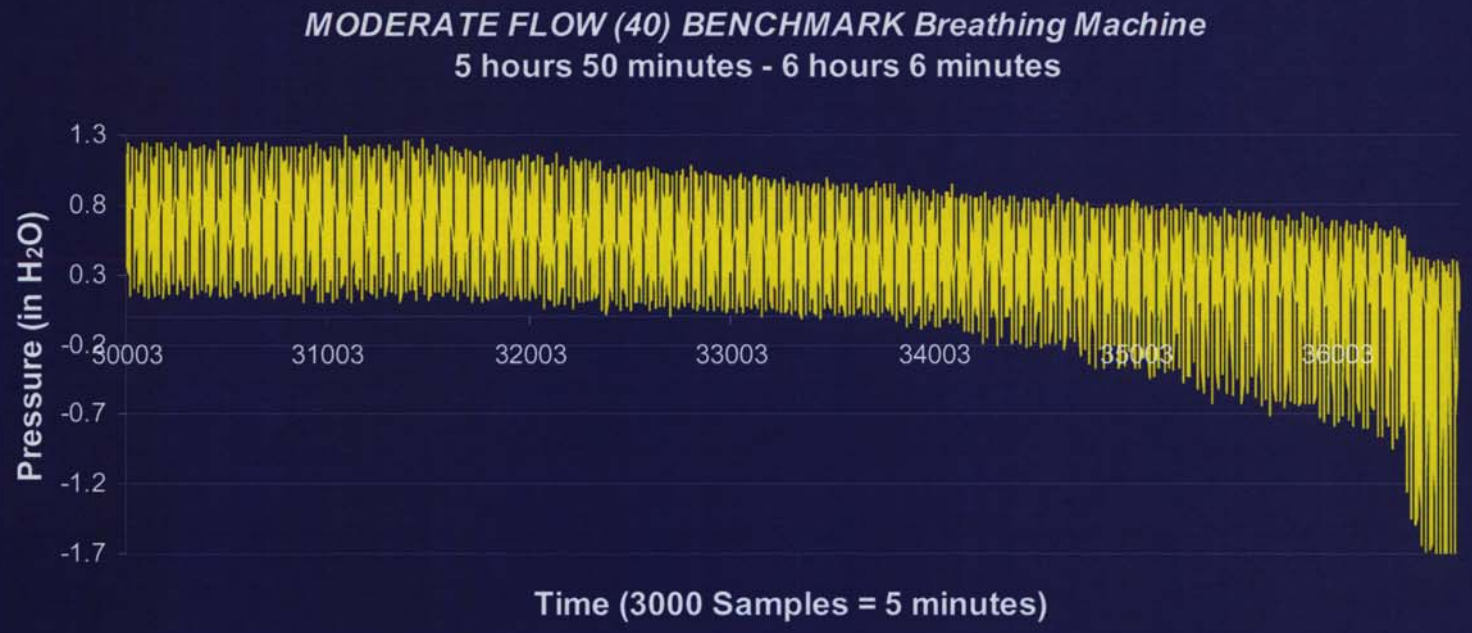
- **Test Conditions**
  - At 25ºC ± 5ºC
    - Breathing machine operated at either 40 or 102 L/min
    - Relative Humidity 50% ± 5%
  - At -30ºC ± 5ºC
    - Breathing machine operated at either 40 or 102 L/min
    - Relative Humidity 20% ± 5%

Low Battery Indicator

- **Benchmark Results**
  - Performed tests at 25ºC on multiple PAPRs
    - PAPRs with built-in alarms showed ability to pass test
      - Dependent on when alarm activates
    - PAPRs without built-in alarms could be designed to perform the same task

Low Battery Indicator

- Benchmark Results



Low Battery Indicator

- **Future Direction**
  - Perform benchmark testing at low temperature
  - Finalize the standard test procedure
  - Perform verification testing

Low Flow Alarm

- **Test Conditions**
  - Part One, the PAPR is tested in same manner as the breathing performance and battery performance at both temperatures under the same environmental conditions and equipment
  - Part Two, the PAPR is tested by adding additional resistance to simulate loading or clogging at both environmental conditions

Low Flow Alarm

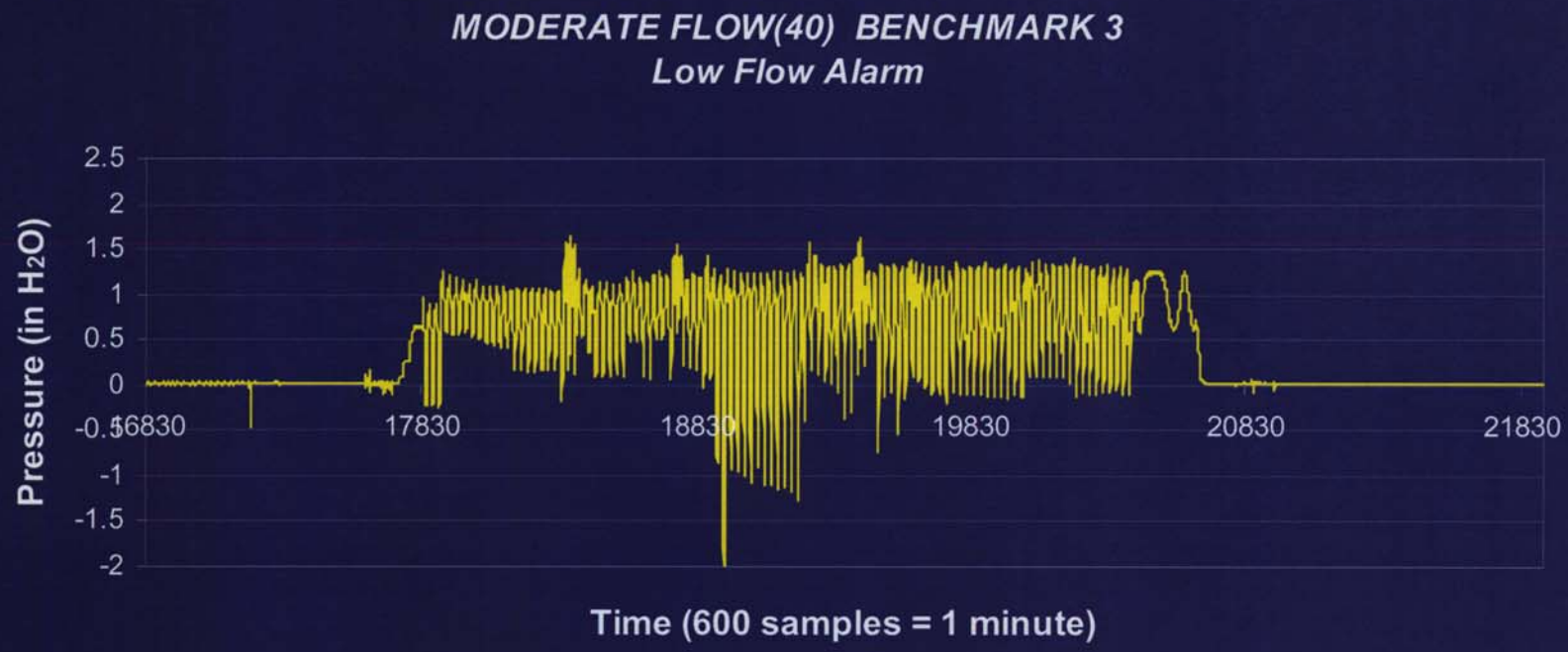
- **Concept Criteria**
  - Alarms the user upon or just prior to negative pressure in the breathing zone

Low Flow Alarm

- **Benchmark Results**
  - Initial evaluation of PAPRs with low flow indicators have shown the ability to provide the required warning
  - Further testing will be performed
  - Eliminate the need for both fault modes to indicate simultaneously for integrated alarm systems

Low Flow Alarm

- Benchmark Results



Low Flow Alarm

- **Future Direction**
  - Evaluate the effects of instantaneous negative peaks in the breathing pattern
  - Perform low flow testing at the low temperature condition
  - Finalize the standard test procedure
  - Perform verification testing

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Carbon Dioxide Requirements

Sheraton Station Square, Pittsburgh, PA

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December 15, 2004

CDC Workplace Safety and Health

NIOSH

NPPTL Research to Practice through Partnerships

CO_2 Test Requirements

Public Comment	Disposition
Identify the standard test procedure used for this test	The STP for the CBRN PAPR requirements will be referenced in the final standard and will be completed with the standard
What flow rate will be used for this test	The PAPR will be tested at a breathing rate of 10.5 L/min
Will the PAPR be tested in the power off mode (blower off)	The PAPR will not be tested in the blower off mode

CO_2 Machine Test

- **Concept Criteria**
  - The average carbon dioxide inhalation level must be less than 1%
  - The average oxygen level must be greater than 19.5%
  - The PAPR will be required to pass both levels to receive a passing result for this test
  - Test will be performed with the blower operating

CO_2 Machine Test

- **Test Conditions**
  - Temperature range will be 68ºF–80ºF during testing
  - The gas levels will be averaged for at least 5 breathing cycles
  - The breathing machine will run at 10.5 L/min
  - The exhalation air from the breathing machine will contain 5% CO_2
  - Equipment used will be as received

CO_2 Machine Test

- **Benchmark Results**
  - Preliminary testing performed using carbon dioxide analyzer without oxygen analyzer and pressure sensor
  - Tested four different PAPRs

CO_2 Machine Test

- **Benchmark Results**

PAPR	Blower On	Blower Off*
1	0.20	2.69
2	0.00	2.36
3	0.00	1.27
4	0.00	1.46

* Currently not part of concept criteria

PAPR not sized to fit headform

CO_2 Machine Test

- **Future direction**
  - Perform additional testing with equipment to determine repeatability and equivalency to current testing procedures
  - Finalize standard test procedure

Human Subject CO_2 Test

- **Concept Criteria**
  - The average carbon dioxide inhalation level must be equal to or less than 2%
  - The average oxygen level must be greater than 19.5%
  - The PAPR will be required to pass both levels to receive a passing result for this test
  - Test will be performed with the blower operating

Human Subject CO_2 Test

- **Test Conditions**
  - Temperature range will be 68ºF–80ºF during testing
  - The gas levels will be averaged for at least 5 breathing cycles
  - Two trials, one stationary and one walking briskly at 3.5 mph
  - Equipment used will be as received

Human Subject CO_2 Test

- **Future Direction**
  - Perform benchmark testing
  - Establish standard test procedure based on STP 0454
  - Perform verification testing