National Personal Protective Technology Laboratory

Durability Testing of CBRN Powered Air-Purifying Respirators (PAPR)

Sheraton Station Square, Pittsburgh, Pa

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December 15, 2004

Durability Testing Includes: Environmental, Transportation and Rough Handling

- Purpose/Goal
- Types of Tests and Conditions of PAPR
  - Minimum Packaging Configuration (MPC)
  - Battery to undergo Environ & Trans in MPC
- Previous Public Meeting Comments

Purpose/Goal

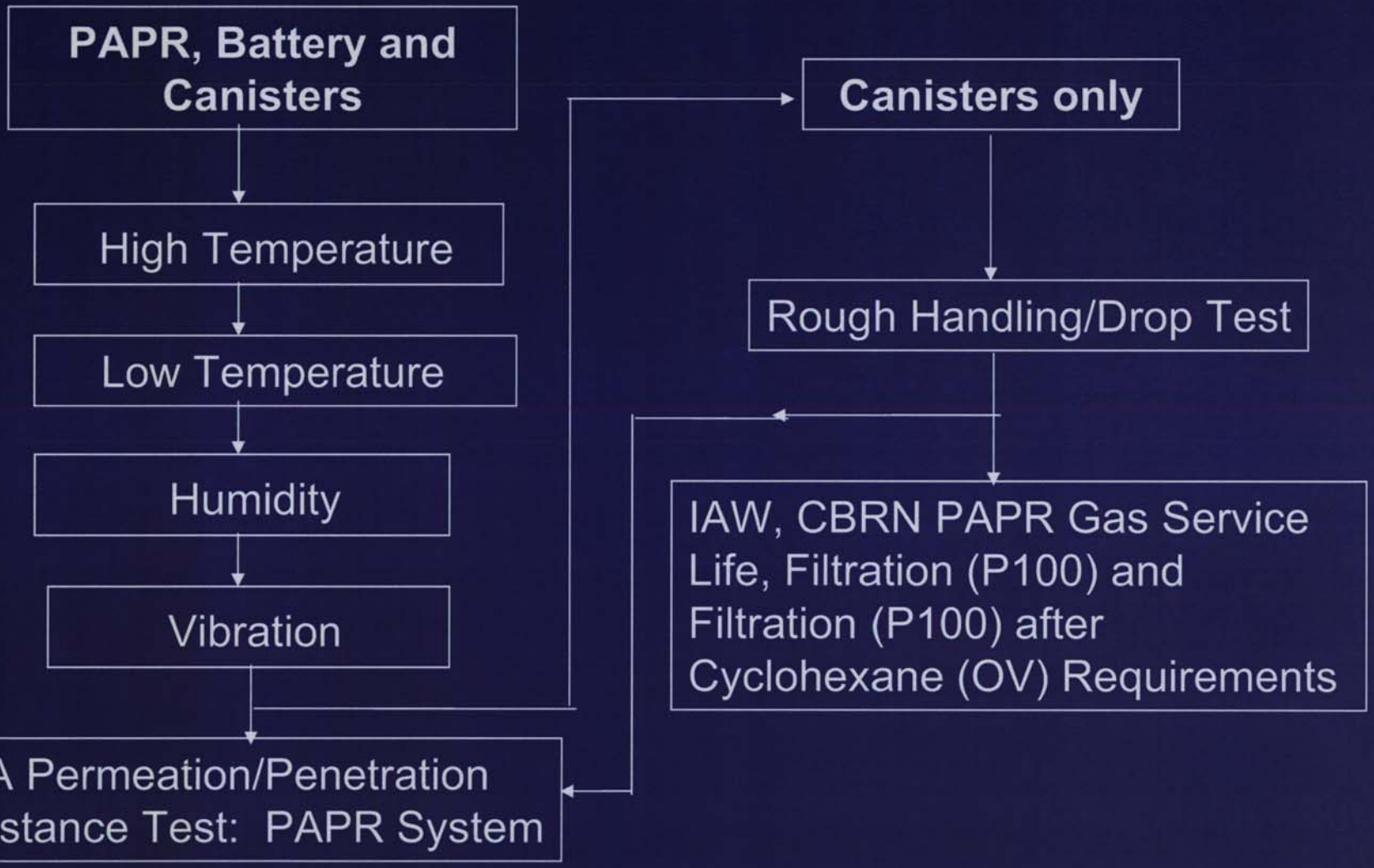
Purpose of Tests:

To perform environmental storage, transportation shock and drop tests on the CBRN PAPR to qualify durability and to detect any initial life cycle failures that may occur from typical use.

Goal:

To ensure CBRN PAPR provides adequate respiratory protection after being subjected to normal environmental storage, transportation and rough handling conditions by the user.

Types of Durability Tests



Durability Test Matrix

Test	Test Method	Test Conditions	Duration	Pass/Fail Threshold
Hot Diurnal	Mil-Std-810F 501.4	(35^{0}C/ 95^{0}F) to (71^{0}C/ 160^{0}F), 24 Hour cycle	3 Weeks Diurnal Cycle	PAPR, Battery and Canisters
Cold Constant	Mil-Std-810F 502.4	Basic Cold, -32^{0}C (-24^{0}F), Constant	3 Days	
Humidity	Mil-Std-810E 507.3	Realistic, Natural Cycle Humidity Profiles in the U.S. (range 88^{0}F @ 88%RH– 05^{0}F @ 59%RH, 24 hr period)	5 Days "quick look" Mil-Std-810E Table 507.3-II	NOTE: Batteries in MPC as indicated by Users Instructions.
Transportation Vibration	Mil-Std-810F 514.5	U. S. Roadway Vibration, Unrestrained	12 hours/axis, 3 Axes Total duration = 36 hours = 12,000 miles	Applicable NIOSH CBRN PAPR requirements
Drop Test: In Minimum Packaging Configuration	**Canisters Only**	**1 drop per filter (on one of the 3 axis)**	**Height of 3 feet**	**Gas Service Life, Filtration (P100) and Filtration After OV Gas Life**

Test Conditions of PAPR

- **CBRN PAPR and Canisters will be subjected to the test conditions in the Minimum Packaging Configuration (MPC) as recommended by the manufacturer in the User Instructions.**
- **Batteries will be conditioned in the MPC:**
  - After Durability testing in ambient conditions, conditioned batteries will be installed in blower (if UI indicate separate storage configuration) and PAPR will be checked for functionality (No Time Limit).
  - Batteries will be Recharged/Replaced after being checked for functionality and before performing the subsequent GB and HD testing.

Bench Mark Durability Testing

- **Testing:**
  - Bench Mark Tested: 3 PAPRs / Manufacturer
  - Tested PAPRs from three different Manufacturers

Address Public Meeting Comments

Explanation:

Comment: NIOSH should consider Durability test conditions that shall be set by the manufacturer.

- The current NIOSH Durability Test establishes standardized test conditions; If the durability test conditions were set by the manufacturer, it would defeat the spirit of a standardized durability test and would be difficult for the user community to keep track of various storage conditions for the various PAPR models.

Comment: It may be unrealistic to expect a PAPR to function after the environmental conditioning test.

- Batteries will be replaced or recharged before the subsequent CWA Agent Permeation Tests. Durability testing will challenge the PAPR materials and construction for initial life cycle failures.

Continuation

Explanation:

Comment: Important to perform leak testing on PAPR due to cracking potential of different types of polymers.

- The standard test procedure for GB and HD Permeation/ Penetration Resistance tests require a leak test to be performed.

Comment: Concerned that extreme temperatures in the durability test requirements will adversely effect sensor calibration and battery performance.

- Batteries and pressure sensors are available on the open market to withstand temperature extremes. Also, batteries will be replaced or recharged before subsequent tests.

Continuation

Explanation:

Comment: Recommends drop testing the entire PAPR without packaging (more severe) by performing multiple drops.

-Dropping the entire unit multiple times without packaging to make the test more severe is border-line abuse plus there are alarms to indicate if the PAPR isn't functioning properly if accidentally damaged.

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CBRN PAPR
Human Factor Requirements

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CBRN PAPR
Human Factor Requirements

- Field of view (FOV)
- Fogging
- Communications
- Haze, luminous transmittance and abrasion resistance

Field of View (FOV)

- **Requirement:**
  - Visual field score (VFS) ≥ 90
  - One respirator that anatomically best fits the head form of the apertometer of EN 136: 1998 or equivalent with VFS = average score of three fittings
  - Derived from: AMA *Guides;* Functional impact of VFS ≥ 90 translates to normal vision

Fogging Resistance Requirement

- Requirement: Each subject's average visual acuity score (VAS) ≥ 75 points.
- Number of tests: two human test subjects
- Three VAS will be taken: (1) post chamber don; (2) after 5 minutes of exercise; (3) after another 5 min. of exercise

Communication Requirement (Speech Intelligibility)

- **Requirement:**
  - Overall performance rating (PR) ≥ 70%
- **PAPR motor blower shall be operating**
- **Voice conveyance system shall be operating at maximum**

Primary Lens: Haze, Luminous Transmittance and Abrasion Resistance

- **Requirement:**
  - Initial haze requirement: ≤ 3.0%
  - Initial luminous transmittance (LT) ≥ 88.0%
  - Abrasion Resistance:
    - Haze not to increase > 4.0%
    - LT not to decrease > 4.0%

Field of View Benchmark Testing Results

- **Test Results:**
  - Tested 3 full facepiece and 1 hood type PAPRs (NIOSH-certified) from 4 different manufacturers.

PAPR Type	Requirement	Full Face A	Full Face B	Full Face C	Hood Type A
FOV Score	90	105.6	110	103.6	102.6

  - Average of 3 fittings

Fogging Benchmark Testing Results

- **Test results:**
  - Tested 3 full facepiece and 1 hood type PAPRs (NIOSH-certified) from 4 different manufacturers.

PAPR Type	Requirement	Full Face A	Full Face B	Full Face C	Hood Type A
Subject 1 Avg. Score	OPR ≥ 75	87.5	82 81	81	88.3
Subject 2 Avg. Score	OPR ≥ 75	80.5	86.7	85	81.7

Communication Benchmark Testing Results

- **Test Results:**
  - –Tested 3 full facepiece and 1 hood type PAPRs (NIOSH-certified) from 4 different manufacturers.

PAPR Type	Requirement	Full Face A	Full Face B	Full Face C	Hood Type A
Average Score	OPR ≥ 70%	60.3 (F) Passive	80.6 (P) Passive	71.1 (P) Active	59.3 (F) None

  - –Data with background noise generator operating at 60 dBA + PAPR noise; Changed requirement to a minimum of 60 dBA

Address Public Meeting Comments

- **Field of view (FOV):**

  - No comments provided on current FOV requirement and test method.

- **Fogging requirement:**

  Comment: There was a concern that the batteries would not function after the 4 hours of cold soaking at -21°C.

  - Batteries worked adequately in all PAPR models after the initial 4 hour cold soaking period when performing the fogging test.

- **Communications requirement:**

  Comment: During testing, the 4 PAPRs will generate excessive noise thus making the requirement more difficult to pass than the APR.

  - NIOSH changed the test procedure to have a minimum background noise level of 60 dBA: the noise generator will be activated if the 4 PAPRs do not generate noise levels of 60 dBA.

(Continued)

- **Haze, luminous transmittance and abrasion resistance**

Comment: Eliminate the Abrasion Requirement for flexible lens materials that will be used in disposable (one time use) hood type facepieces.

- NIOSH is considering eliminating the Abrasion Resistance requirement, but would retain the Haze and Luminous Transmittance requirements for disposable hood type facepieces.

Comment: How will coverings such as lens protective covering and over-shields be handled for haze and luminous transmission testing?

- This requirement is for primary lenses only, not for protective coverings and over-shields that are replaceable.

(Continued)

- **Haze, luminous transmittance and abrasion resistance**

Comment: NIOSH should consider changing the LT and Haze requirements to an absolute value (LT 84%; Haze 7%) instead of the current requirement (LT decrease ≤ 4% or Haze increase ≤ 4%)

- NIOSH will not adopt an absolute value for abrasion test: The purpose is to test the abrasion resistance characteristics of lens material which is independent of the initial LT and Haze Values.

Comment: Manufacturers should not have to provide abraded lenses

- NIOSH is considering waiving the requirement for requiring abraded specimens; however, It is currently required to determine consistent abrasion resistance characteristics of the material.