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

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Durability Testing Includes: Environmental, Transportation and Rough Handling

- Purpose/Goal
- Assumptions
- Types of Tests
- Rationale for the Test
Purpose/Gold

**Purpose of Tests:** 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.
Assumptions

- Tests represent conditions induced by the user that a CBRN PAPR may experience from the point of issue.

- CBRN PAPR will be subjected to the test conditions in the “Ready-to-Use” configuration as recommended by the manufacturer. (e.g., loose, in carrier or storage container) Filter unit will not be mounted on the PAPR unless specified by the manufacturer.

- Maintenance and inspection shall be performed IAW applicable Department of Labor, OSHA Title 29 CFR 1910.134(h).

- Non-industrial use scenario – for CBRN emergency use only.
Assumptions (Continued)

- Test conditions tailored to realistic U.S. meteorological weather conditions, U.S. roadway transportation conditions and typical first responder use rough handling conditions (i.e., not worst case).

- Tests not intended to represent entire life cycle but rather to identify potential initial life cycle failures.

- Mil-Spec 810-F used as principle guidance document.
Draft Test Protocol

A. Environmental Storage Conditions:

1. High Temperature
   - Mil-Std-810F, Method 501.4, Table 501.4-II, Hot-Dry Diurnal Cycle, Hot-Induced Conditions 35 °C (95 °F) to 71 °C (160°F), 24 Hour Cycle, 3 Weeks

2. Low Temperature
   - Mil-Std-810F, Method 502.4, Basic Cold, Constant Temperature at −31 °C (-24 °F), 3 Days (72 Hours)

3. Humidity
   - Mil-Std-810E, Method 507.3, Figure 507.3-I (cycle 1), Natural Diurnal Humidity Cycle, 5 Days ("quick look")
     (range 88°F @ 88%RH − 105°F @ 59%RH, 24 hr period)
B. Transportation:

Vibration

MIL-STD-810F, Method 514.5, Vibration, Annex A, Category 4, Over U.S. Highways, 60 minutes per 1,000 miles of road travel per axis, 3 Axis, 12 Hours per axis (36 hours total = 12,000 miles), Unrestrained
C. Drop Test: Filters Only

Drop 3 feet onto a concrete surface; Each canister dropped once; canisters dropped on each of the following axis:

(1) Major axis vertical, air outlet port.
(2) Major axis horizontal.
(3) Major axis vertical, air inlet port
Rationale for the Test

**High Temperature:** Simulates storage in trunk of vehicle; Induced conditions: solar loading/diurnal profile representative of southwest U.S. climates; Duration based on prior ARDEC (Formerly SBCCOM) experience with mask testing.

**Low Temperature:** Representative of minimum temperature in U.S. intermediate zones per Mil-Std-810F (Basic Cold); Duration is minimum 810F recommended exposure period.

**Humidity:** Represents natural temperature humidity profile in humid regions of U.S. per Mil-Std-810F; Duration is minimum 810F recommended exposure period.

**Vibration:** Simulates vehicle transport of total of 12,000 miles on U.S. roadways in a unrestrained configuration.

**Rough Handling:** Simulates drop or fall from vehicle or table-top.
Flow Diagram of Durability Test

PAPRs and Canister
  ↓
High Temperature
  ↓
Low Temperature
  ↓
Humidity
  ↓
Vibration
  ↓
IAW CBRN PAPR Performance Requirements

Canisters
  ↓
Rough Handling/Drop Test

IAW, CBRN PAPR Gas Service Life, Filtration (P100) and Filtration (P100) after Cyclohexane (OV) Requirements
## Durability Test Matrix

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Test Conditions</th>
<th>Duration</th>
<th>Pass/Fail Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Diurnal</td>
<td>Mil-Std-810F 501.4</td>
<td>(35 °C/ 95 °F) to (71 °C/ 160 °F), 24 Hour cycle</td>
<td>3 Weeks</td>
<td>Filters + PAPRs</td>
</tr>
<tr>
<td>Cold Constant</td>
<td>Mil-Std-810F 502.4</td>
<td>Basic Cold, -32 °C (-24 °F), Constant</td>
<td>3 Days</td>
<td>NIOSH CBRN PAPR requirements</td>
</tr>
<tr>
<td>Humidity</td>
<td>Mil-Std-810E 507.3</td>
<td>Realistic, Natural Cycle Humidity Profiles in the U.S.</td>
<td>5 Days “quick look”</td>
<td>Mil-Std-810E Table 507.3-II</td>
</tr>
<tr>
<td>Transportation Vibration</td>
<td>Mil-Std-810F 514.5</td>
<td>U. S. Roadway Vibration, Unrestrained</td>
<td>12 hours/axis, 3 Axes</td>
<td>Total duration = 36 hours = 12,000 miles</td>
</tr>
</tbody>
</table>

Drop Test: In Ready To Use Condition
- Canisters Only: 3 axes, 1 drop/filter per axis
- Height of 3 feet
- Gas Service Life, Filtration (P100) and Filtration After OV Gas Life