

## COMPARISON OF CONCEPTS FOR POWERED, AIR-PURIFYING RESPIRATOR (PAPR) STANDARDS FOR INDUSTRIAL, WMD, AND CBRN CLASSIFICATIONS

5/30/05

<b>PAPR STANDARD</b>	<b>INDUSTRIAL</b>	<b>WMD (name to change)</b>	<b>CBRN</b>
PAPR types	Respiratory inlet covering: (Tight fit or loose fit) @ 3 flow rates: Low, Moderate, High	Tight fit or loose fit @ 2 flow rates (Low and Moderate)	Tight fit only @ 2 flow rates (Moderate and High)
Approval types	Approved per : Protections as requested + inlet covering (Tight or loose fit) + IDLH w. O <sub>2</sub> , , non-IDLH escapes + Flow rates (Low, Med, High)	Approved Per : Single protection- CBRN + Tight or loose fit + NOT for IDLH escape + Flow rates (Low, Med)	Approved Per : Single protection- CBRN + Tight fit only + IDLH w. O <sub>2</sub> , non-IDLH escapes + Flow rates (Med, High)
Environments	TIGHT FIT Entry in characterized Escape from characterized or uncharacterized with sufficient O <sub>2</sub>  LOOSE FIT Entry in characterized Escape with only from characterized- unit must be removed	TIGHT FIT Entry in characterized Escape only from characterized  LOOSE FIT (same as TIGHT) Entry in characterized Escape only from characterized	TIGHT FIT Entry in characterized Escape from characterized or uncharacterized with sufficient O <sub>2</sub>  No LOOSE FIT
Pressure type	Positive or non-positive pressure	Positive or non-positive pressure	Positive pressure only
General test condition	Test at max flow	Same	Same
Filter type	Hi efficiency filter (PAPR 100) Base filter (PAPR 95)	PAPR 100 only	PAPR 100 only
Cartridge/canister usage	Cartridges, canisters, or filters sealed in original packaging until	Same	Same

	used		
Agent exposure	Not Applicable Not approved for any agent exposure	Not designed for liquid agent expose If exposure occurs, dispose of immediately	If liquid agent exposed- disposed of after use
Gas/vapor approval categories	Approved for gas families via TRAs (Test Representative Agents) + additional industrial chemicals	Approved for gas families via TRAs (Test Representative Agents) only	Approved for gas families via TRAs (Test Representative Agents) only
Part 84 requirements	General provisions Subparts A, B, C (fees), D, E, F, G unless specified	Same except subpart C Fees specified separately	Same except subpart C Fees specified separately
Containers/packaging conditioning	No environmental conditioning	No environmental conditioning	Environmental conditioning in min packaging
Rough handling	No rough handling requirement	Canister rough handling since uses CBRN canister	Canister rough handling
Labeling	Label- Battery part number on battery pack AND other suitable location if not visible + list battery service life (run time)	Same	Same
Labeling- additional	Label- Additional C&L's as required	Same	Same
Battery life use time	Battery life in 60 min increments	Same	Same
Battery indicators	Battery life indicator- may be passive	Same	Same
Battery life	None	None	Battery- expiration date
Battery alert	Low Battery- 15 min low battery life alert- Must readily detectable without manipulation of the respirator	Same	Same
Battery operation time	Continue to perform properly 15 minutes after rated time at min. specified op. temp.	Same	Same
Low air flow or low pressure indicator	Must readily detectable without manipulation of the respirator Test at min specified op temp & 25C	Same	Same
System flow – minimum flow requirements	CONSTANT FLOW Light flow (work) rating Tight fit >= 85lpm????	Low and Moderate only	Moderate and High only

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<p>Test performed on most restrictive cartridge/canister/filter configuration</p>	<p>Loose fit <math>\geq 115</math> lpm???? to be determined  Moderate flow rating  Tight fit <math>\geq 115</math> lpm  Loose fit <math>\geq 170</math> lpm  High flow rating  Tight fit <math>\geq 261</math> lpm for final 10 minutes of specified operation time  Loose fit <math>\geq 350</math> lpm for final 10 minutes of specified operation time</p> <p><b>BREATH RESPONSE</b>  (tight fit only)  Low flow rating  <math>\geq 14.5</math> res./min @ 10.5 L/min. vol.  Moderate flow rating  <math>\geq 24</math> res./min. @ 40 L/min  High flow rating  <math>\geq 30</math> res./min. @ 86 LPM + 30 res./min @ 103 L/min for final 10 minutes of specified operation time</p>		
<p>Non-powered system resistance</p>	<p>No requirement: FMEA Failure Modes and Effects Analysis used</p>	<p>Same</p>	<p>Same</p>
<p>Vision</p>	<p>Field of View  Score <math>\geq 90</math> on med. Size</p>	<p>Same</p>	<p>Same</p>
<p>Vision- haze</p>	<p>Haze <math>\leq 3\%</math></p>	<p>Same</p>	<p>Same</p>
<p>Vision- luminous trans</p>	<p>Luminous Trans <math>\geq 88\%</math></p>	<p>Same</p>	<p>Same</p>
<p>Abrasion</p>	<p>Optional: Abrasion res-haze increase <math>\leq 4\%</math></p>	<p>Optional: Abrasion res-haze increase <math>\leq 4\%</math></p>	<p>Required</p>
<p>CO2 testing- Machine</p>	<p>CO2- Machine test  Inhaled <math>\leq 1\%</math>  14.5 res.p.m.</p>	<p>Same</p>	<p>Same</p>

	10.5L 5% CO2 inhaled.																																																					
CO2 and O2- Human subject	CO2 & O2 Human Subject <=2% O2 >= 19.5% @ 3.5 mph walk	Same	Same																																																			
Hydration devices (optional)	Hydration (if present) 75mm H2O suction Leakage <= 30 mL/min	Same	Same																																																			
Sound	Noise <= 80 dBA	Same	Same																																																			
Gas/vapor testing concentration: per system  Testing per cartridge or canister performed at highest flow rate of respirator system on which cartridges or canisters will be used divided by number or cartridges or canisters  Concentration calculation: Test concentration= PEL X APF of 50 X safety factor of 10.  Breakthrough = PEL. Ethylene Oxide calculated at 10 X concentration and 10X	<table border="0"> <thead> <tr> <th>Gas/Vapor</th> <th>Test ppm</th> <th>Break Through ppm</th> </tr> </thead> <tbody> <tr> <td>-</td> <td></td> <td></td> </tr> <tr> <td>Ammonia</td> <td>2500</td> <td>25</td> </tr> <tr> <td>Cyanogen Chl.</td> <td>300</td> <td>1</td> </tr> <tr> <td>Cyclohexane</td> <td>2600</td> <td>10</td> </tr> <tr> <td>Formaldehyde</td> <td>500</td> <td>1</td> </tr> <tr> <td>Hyd. Cyanide</td> <td>940</td> <td>4.7</td> </tr> <tr> <td>Hyd Sulfide</td> <td>1000</td> <td>10</td> </tr> <tr> <td>Nitrogen Dio</td> <td>200</td> <td>1NO2, 25 NO</td> </tr> <tr> <td>Phosgene</td> <td>250</td> <td>1.25</td> </tr> <tr> <td>Phosphine</td> <td>300</td> <td>0.3</td> </tr> <tr> <td>Sulfur Dio</td> <td>1500</td> <td>5</td> </tr> <tr> <td colspan="3">-----</td> </tr> <tr> <td colspan="3">INDUSTRIAL ONLY</td> </tr> <tr> <td>Carbon Mon.</td> <td>18000</td> <td>35</td> </tr> <tr> <td>Ethylene Oxi.</td> <td>5000</td> <td>1</td> </tr> <tr> <td>Methyl Amine</td> <td>5000</td> <td>10</td> </tr> </tbody> </table> <p>NOTE: Industrial may choose any combinations of protections.</p>	Gas/Vapor	Test ppm	Break Through ppm	-			Ammonia	2500	25	Cyanogen Chl.	300	1	Cyclohexane	2600	10	Formaldehyde	500	1	Hyd. Cyanide	940	4.7	Hyd Sulfide	1000	10	Nitrogen Dio	200	1NO2, 25 NO	Phosgene	250	1.25	Phosphine	300	0.3	Sulfur Dio	1500	5	-----			INDUSTRIAL ONLY			Carbon Mon.	18000	35	Ethylene Oxi.	5000	1	Methyl Amine	5000	10	<p>Same Except for Carbon Mon. Ethylene Oxide Methyl Amine</p> <p>NOTE: CBRN must be approved for all protections above dashed line shown in industrial column</p>	<p>Same Except for Carbon Mon. Ethylene Oxide Methyl Amine</p> <p>NOTE: CBRN must be approved for all protections above dashed line shown in industrial column</p>
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breakthrough for laboratory purposes.			
Gas/vapor test conditions	Gas/Vapor Test conditions Not preconditioned Tested at 25% & 85% RH	Same	Same
Gas/vapor test time	Test concentration X rated minutes (in 60 min intervals)	Gas/Vapor Test Time: 60 min	Gas/Vapor Test Time: Test concentration X rated minutes (in 15 min intervals)
Gas/vapor test flows	Performed on cartridge or canister at max flow rate of system on which it will be used divided by number of cartridges or canisters	Performed at max flow rate of system on which it will be used	Gas/Vapor Test Flow (canister system) Constant , Moderate 100 lpm Constant, High 261 lpm Demand, Moderate 115 lpm Demand ,High 300 lpm
Particulate testing concentration: per system	Particulate PAPR 95 & PAPR 100 PAPR 95- DOP –initial penetration PAPR 100- DOP- 200 mg loading 20 canisters tested 95.0% or 99.97% efficiency +6 after cyclohexane if used in conjunction with OV protection	Particulate DOP- 200 mg 20 canisters 99.97% eff. after cond. +6 after cyclohexane	Particulate PAPR 100 only plus +6 after cyclohexane
Particulate test conditioning	Tested as received	Test following environmental conditioning	Test following environmental conditioning
Particulate test time	PAPR 95- DOP -instantaneous PAPR 100- DOP- 200 mg loading then test until no further degradation	PAPR 100- Same	PAPR 100- Same
Particulate test flows	Performed at max flow rate of system on which it will be used	Same	Same
Crisis Provision	Not required	Not required	Panic demand - Canister Hi flow :5 min @ 100-135 lpm (note: would be the same as constant moderate w.

			1-canister PAPR -OR- Br. Machine @ 114 lpm & peak flow rate @ 360 lpm
Resistance of Cartridge/canister/filter	Resistance in parallel: +-10%	Same	Same
Canister uniformity system service test	None	System service Test w. cyclo., SO2, Cyan. Chl. & Phos. On manifold	System service Test w. cyclo., SO2, Cyan. Chl. & Phos. On manifold
Fogging	Fogging- low temp VAS >= 75 at min temp specified by applicant	Same except at -21C	Same except at -21C
Communications	None required	Communications: >=70%	Communications: >=70%
Agent testing	None required	LAT (same)	LAT
Fit testing	LRPL value of 2000 proposed	Same but value may be revised	Same but value may be revised
Environmental conditioning	None	None	Durability Hot, cold, vibration, drop
QA	QA per 42 CFR 84	Same	Same
Practical Performance	Determined as part of LRPL	Same	Same
Electronic component analysis	FMEA (Failure Modes and Effects Analysis)	Same	Same
Intrinsic safety (optional)	Intrinsic safety- Part 18 or recognized independent lab	Same	Same
ESLI (optional)	ESLI- per present requirement	Not applicable	Not applicable
Shelf life (optional)	Mfr. may list shelf life of components	Same	Same
Valve leakage	Per Part 84 existing requirements	Same	Same
Total system leakage	Determined via LRPL	Same	Same