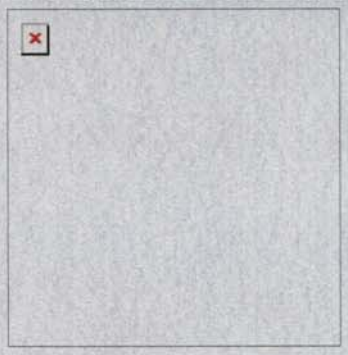
Miller, Diane M.

From: Goran Berndtsson [goran@sea.com.au]
Sent: Friday, February 27, 2004 11:11 PM
To: NIOSH Docket Office
Cc: Boord, Leslie F.
Subject: Comments to CBRN PAPR Standard

Hi Les,
I have made some comments on the latest CBRN PAPR standard, see attached PDF file.
Please don't hesitate to contact me to discuss.

Regards **Göran Berndtsson**



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Att NIOSH Docket office; Draft CBRN PAPR Concept Paper.

The over all comments are that we are heading towards a functional standard for First responders.

Background statements such as "**Filter capacity and particulate efficiency testing is done at flow rates determined by the maximum flow rate of the respirator**." It is encouraging for the overall functionality of the standard.

In paragraph 3.2 Respirator Use: The statement in paragraph A, (Warm Zone/Cold Zone Use:) **"Concentrations above acceptable exposure limits, but less than IDLH concentrations, to REL"** and in paragraph B (Crisis (Panic/Demand) Provision Mode) **"Egress and escape from above IDLH concentrations, high physiological (flow) demand possible: contingency for unforeseen factors such as secondary devise or pockets of entrapped hazard",** makes the RPD who complies with this standard functional for the First Responders.
If, during this situation the battery, the motor or other electronic failure occur, it should be possible to use the RPD as a negative pressure RPD.
With other words I would suggest that the PAPR meets some minimum performance requirement with power off.

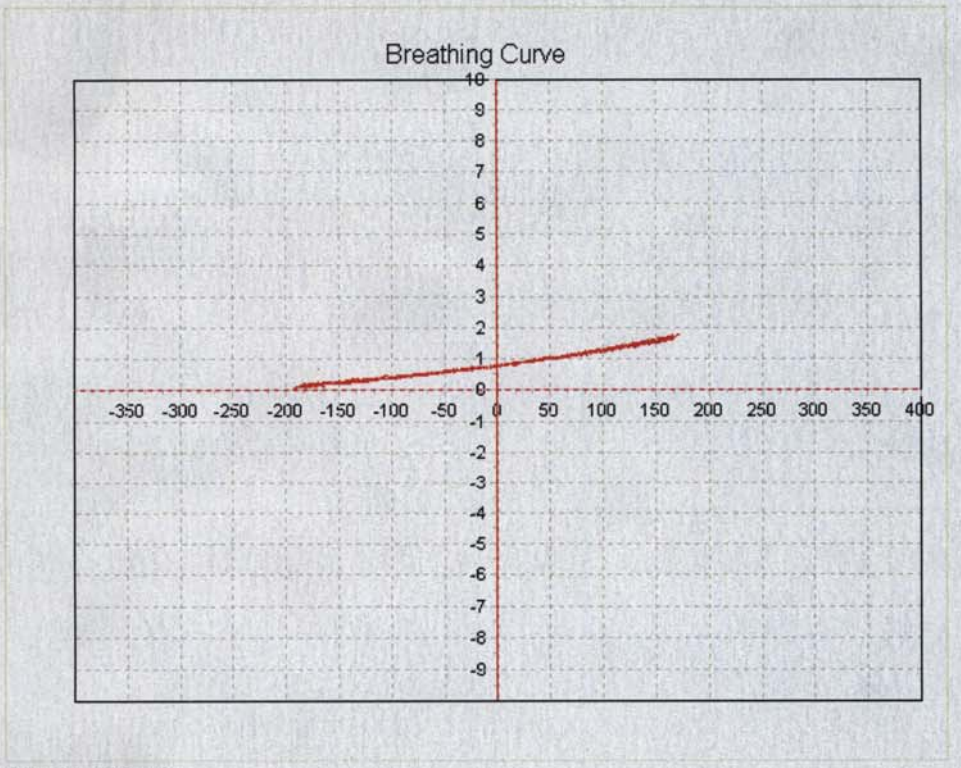
Paragraph 5.2.1- I believe that here we try to find a means to inform the user of the capacity (length the PAPR can be used limited by the battery). To make this useful we also need to inform the user of the consumption (ampere) at different work rates.
Example; A test we recently performed in Sydney;

Power/Performance test

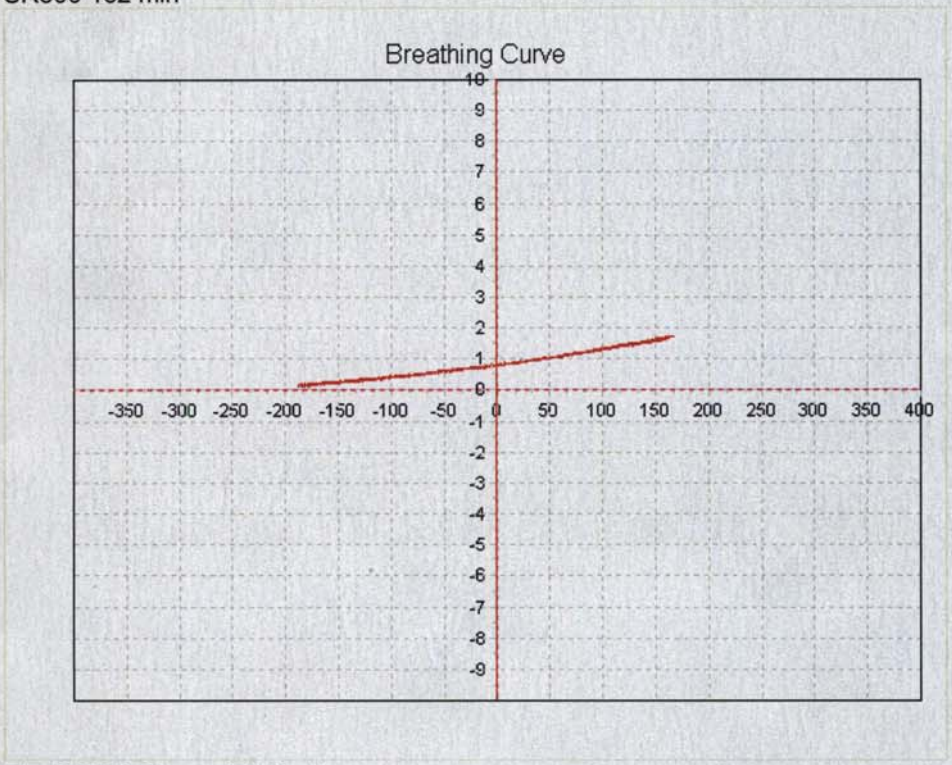
The purpose of the test is to ensure that unit does not change the performance due to battery discharging. The performance is measured by the units ability to maintain the positive pressure throughout the battery life time until the unit stops due to battery discharging.
Also, this test allows comparing battery consumption in the same conditions.

The BM settings: 35 breaths per min, Tidal volume 1.46 liter.

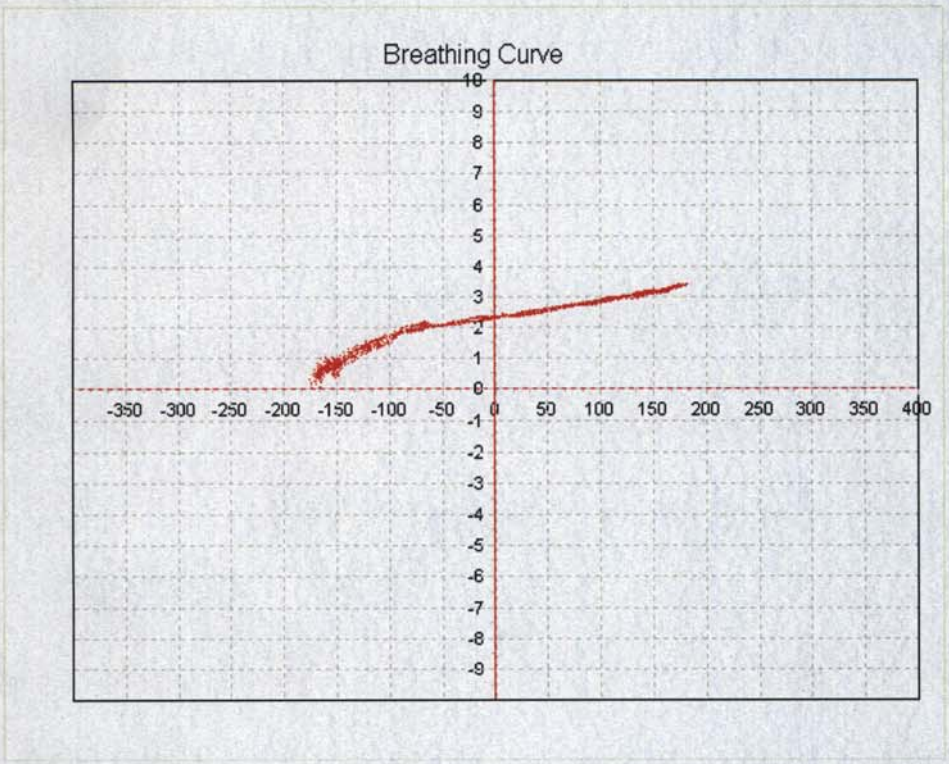
SR500 (constant flow PAPR) Power supply test
SR500 start



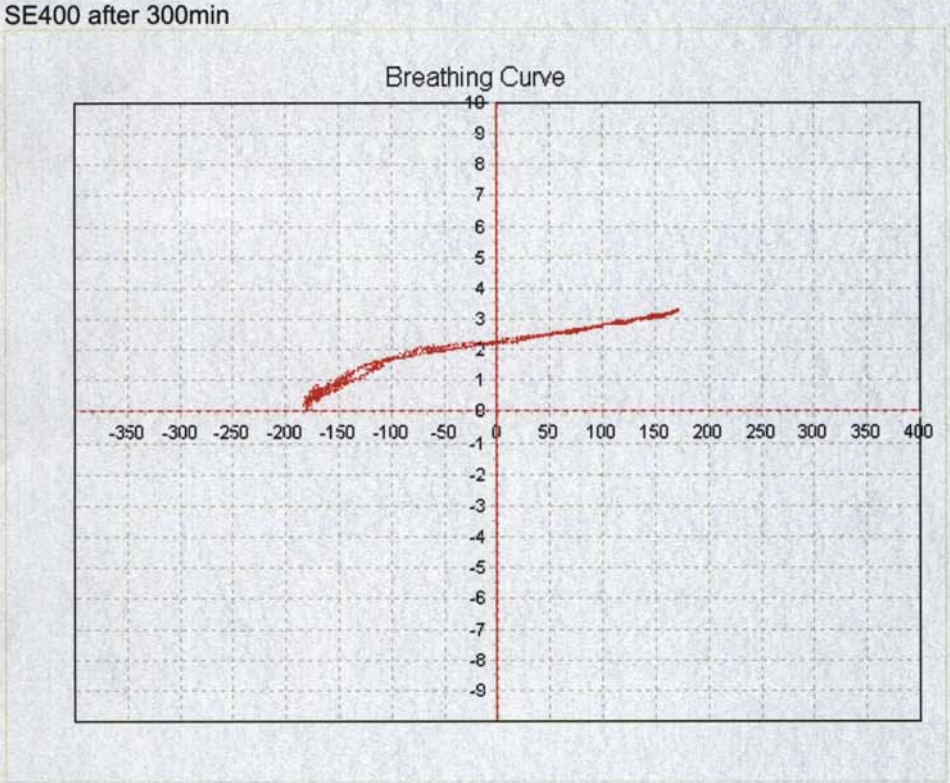
SR500 162 min



The SR500 Stops at 172 min
SE400 Power supply test (positive pressure demand PAPR)
SE400 start



SE400 after 300min



The SE400 stops at 310 min

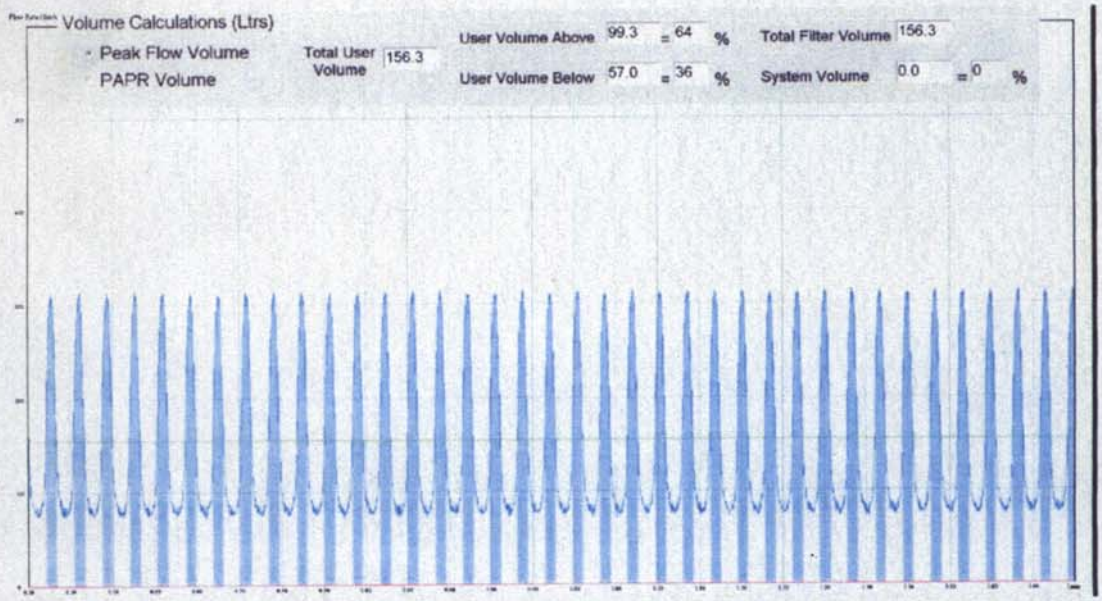
Conclusion: The absolute value shows at the same condition (maximum flow performance for low flow performed unit SR500) of 180 l/min max flow the SE400 units operation duration is 310

min vs 172 min for SR500, which is 1.8 times longer.
At maximum SE400 performance the condition is over performance of the SR500 capability. The relative result (duration from the same power supply) shows the units relative power consumption. It shows that the SE400 with the batteries 3.7 Ah (12V) or 44.4W/h outperform SR500 with 2.2Ah (14.5V) or 31.9W/h. The correction factor is 1.39. So, SR500 will be working from the SE400 batteries 1.39 times longer or 240 min. The relative power consumption performance of SE400 is 310/240=1.3 times better that SR500.

As seen above looking at the voltage and the amperage only, you would have expected a 39% difference, but in this case it is an 82% different performance length between the two PAPR's.
We need to make this requirement useful for the user so the information provided means something to the user.

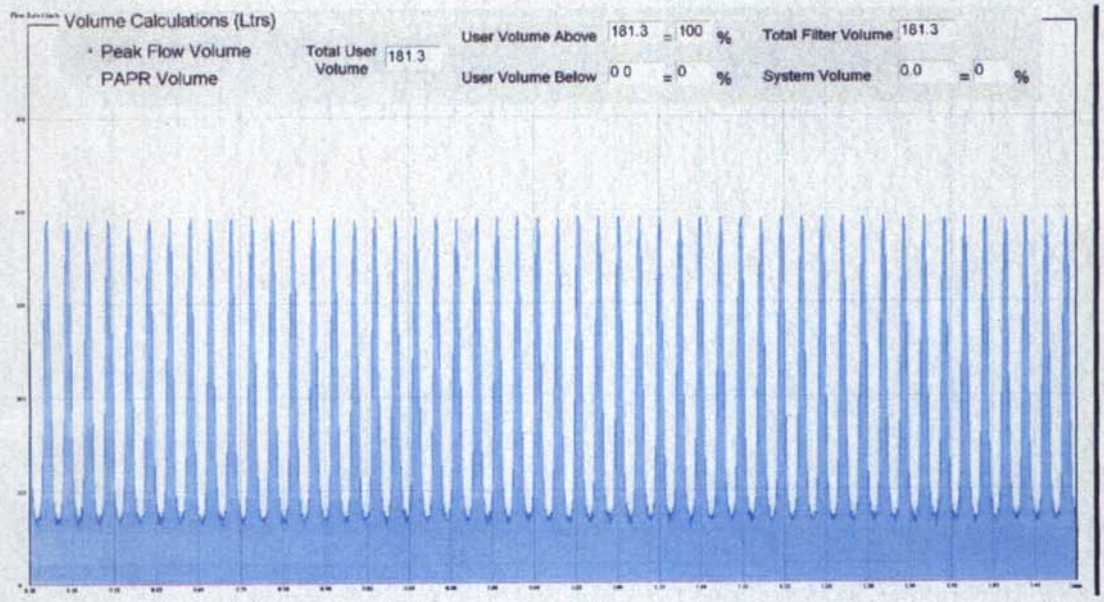
Paragraph 6.2 Filter Canister Capacity: I assume that the purpose of this test is to establish that the canister can handle high peak flows, and establish capacity over time at the flow rate required to meet the peak flow at moderate or high breathing rate.
To maintain positive pressure with a constant flow PAPR at moderate breathing rate requires 115 lit/min flow, this is equal with 115 min liters volume, and at high breathing rate 314 lit/min flow equal to 314 liters volume.
With a positive pressure demand PAPR such as SE400AT-2 to maintain positive pressure in the nose cup (inner mask) it requires 157 liter volume (see graph 1). The breathing machine is set at 2.6 liter volume 38 breaths = 98.9 liter minute volume at a sinus curve multiply by pi (3.14) = 310.2 lit/min peak flow.
This is an additional volume of 57% over and above 100 liter the breathing machine is set at, in order to maintain positive pressure at 314 lit/min flow rate.

Graph 1.



At SE400AT-2 max capacity (approximately 390-400 lit/min PIAF) the volume is approximately 181-190 liter per minute volume Graph 2.

Graph 2.



These two graphs are measured with external flow meters.

How this can be used in a standard; I propose that all PAPR's tested for this new standard are operated for a minimum period of 5-10 minutes on a breathing machine with an external flow meter attached either to the inlet of the filter (equal resistance has to be applied to all filters) or in line on the supply hose as

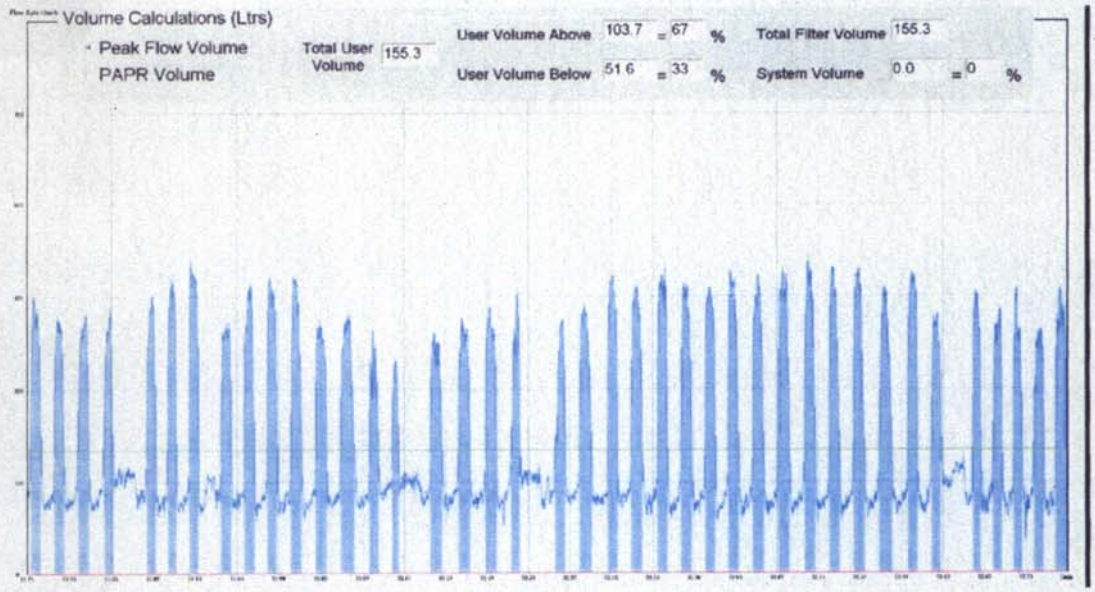
attached photos (Photo 1 and 2). This will establish the over all air consumption required to maintain the required positive pressure in the inner mask. Then that number is divided by the number of filters designed to be used with the PAPR.

Photo 1.	Photo 2.
	
SE400 with flow meter in hose	SR500 with flow meter in hose

What we need to remember is that no person is going to breath like a breathing machine, the human breath is much different more uneven see attached (Graph 3, 4 and 5). This is from three different people at the same external work rate 175 watt on a bicycle ergometer with no speech. Graph 6 is from the Agility test performed with the US Marines in autumn 2002. When looking at graph 3 and 4 the PIAF are around 300 l/min and total air volume is 155.3 and 147.0 lit per minute, and graph 5 approximately 350 l/min PIAF and 150.6 liter per minute in volume. Those tests have all been done in the SEA lab, graph 6 was done in the field and presents PIAF at approximately 300 l/min and a volume of 145.1 liter per minute. There is no significant difference in volume between those graphs and graph1 which is from the breathing machine.
A test as described above is representative for human breathing requiring PIAF 300 l/min, and should establish duration capacity of canisters.

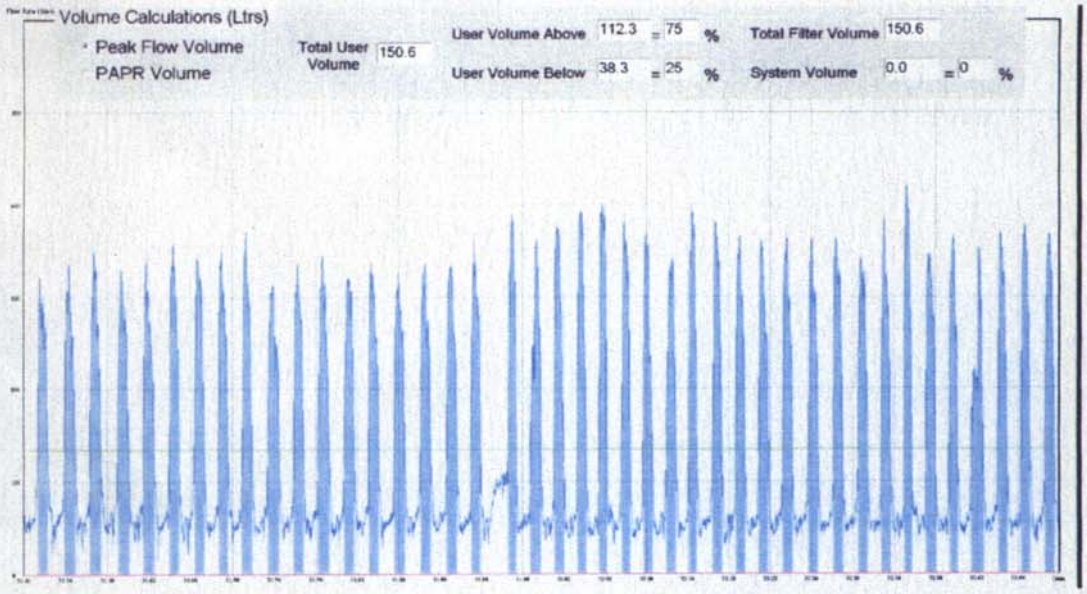
For example a SEA SE400AT-2 with Domestic preparedness filters (2), the SE400AT-2 can maintain positive pressure up to 390 l/min PIAF (Graph 2) at that breathing rate it uses 181.3 liter per minute in volume (181.3liter divided by 2=90.65 liter per minute). The flow rate used for gas capacity should in this case be 90.65 l/min. In regards to particulate filter testing se below.

Graph 3.

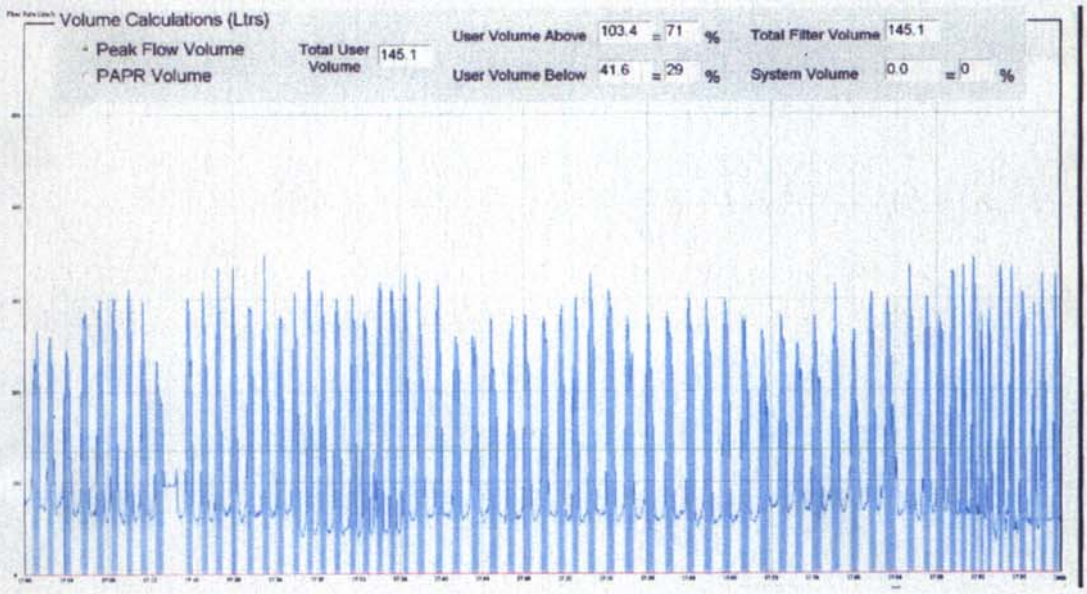


Graph 4.

Graph 5.



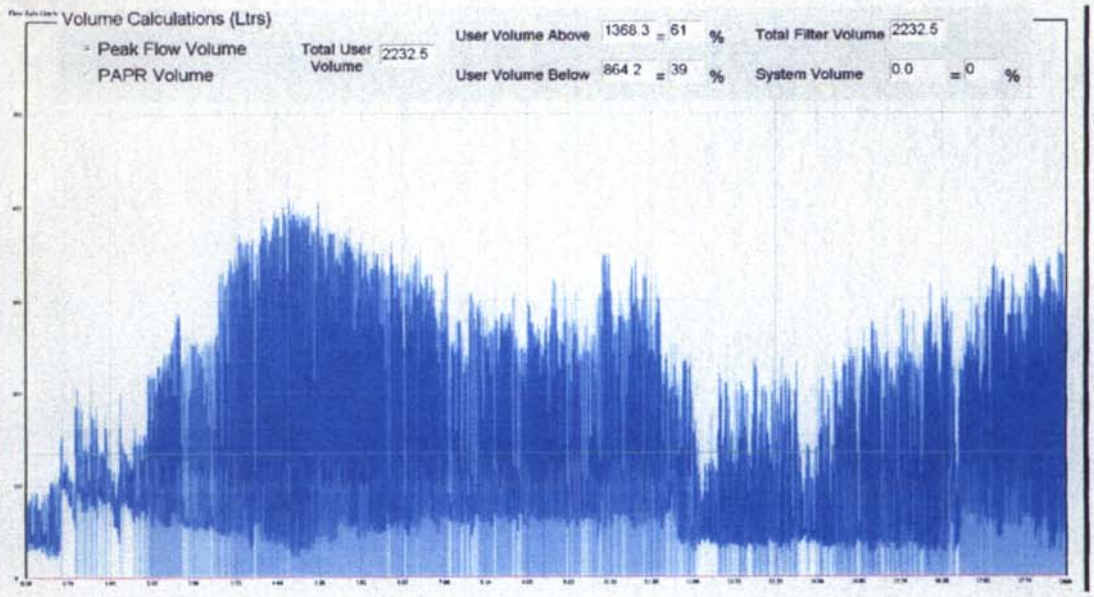
Graph 6.



To establish that the canisters bed depth is high enough, a short term 5 min test should be required at the maximum flow rate the PAPR is capable to produce and still maintain positive pressure. This flow rate should be divided by the numbers of filters designed to be used with the PAPR.
This test would establish short term escape type scenario capability. Humans performing work are not going to breath at the highest work rate all the time (see graph 7), even when the agility test where performed which stresses people to

perform at there best the breathing rated varied dramatically, this is the first 17 minute of the test.

Graph 7.



Paragraph 6.3.4 Particular filter testing, I don't understand what is meant with; "where multiple filter elements are used, the test-aerosol airflow rate shall be reduced in proportion to the number of filter elements". If test-aerosol is deleted then the sentence makes sense.
The rest of the paragraph is harder to understand, is this to try to simplify the testing?
If that's the case we need to be careful so we don't lose the important phenomenal that filters are velocity dependent and should be tested at the highest flow rate the PAPR can deliver divided by the filters.

In the same scenario as above; For example a SEA SE400AT-2 with Domestic preparedness filters (2), the SE400AT-2 can maintain positive pressure up to 390 l/min PIAF (Graph 2). In regard to the particle filters we use 390 l/min divided by the filters (2), this means that each filter shall, for particle penetration, be tested at 195 l/min constant flow. The filters need to meet the P100 penetration requirement at this flow rate it should possibly also include a loading test.

I hope the comments in this letter make sense. I am available to discuss any of the points at your convenience.

Regards Göran Berndtsson
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