## A new protocol for screening PHEAF units

PHEAF units are tested for effectiveness based on 9 sectors on the face of the box, and the overall effectiveness is based on the average effectiveness over the 9 sectors. This is considered the gold standard. In this study, we looked at 324 measurements of 83 units, of which 26 measurements passed the HEPA standard of 99.97% effectiveness.

The center sector typically showed effectiveness above the average effectiveness, and compared to the gold standard measure, a test just seeing if the center sector passes has a negative predictive value (NPV) of 99.3%. So it would be an effective way to screen for bad units, but not really a good way to test for passing units, since it only had a positive predictive value (PPV) of 13.81%.

Next, we looked at a test based on the lowest computed effectiveness across sectors, i.e., the minimum value of the 9 sectors. We did a ROC (receiver operating curve) analysis, varying the threshold that we would consider “passing”, to see if we could find a good test to identify good units. The ROC curve is shown below. This curve has an area under the curve of 0.994, showing that it is a good discriminative test. The optimal cut-off was determined from the curve to be 99.8. Using that as a cut-off for a test, i.e., a unit is called passing if the lowest sector-wise effectiveness is at least 99.8, has a PPV of 65% and a NPV of 100%.



If we combined these two tests, i.e., call a unit passing if both the center sector has at least 99.97% effectiveness and all the sectors have at least a 99.83% effectiveness, gives us a PPV of 69.4% and a NPV of 99.65%.

Finally, we realized that a test that passed a unit if at least 7 of 9 sectors passed would give a PPV of 61.53% while maintaining a NPV of 99.30%. Combining this with the previous test, i.e. a unit is called passing if (a) the center sector passes, and (b) all sectors have at least 99.8% effectiveness, and (c) at least 7 of 9 sectors pass, has a PPV of 92.31% and a NPV of 99.33%. What is the implication of this as a screening test? This means that if either (a) the center sector doesn’t pass, or (b) one sector has less than 99.83% effectiveness, or (c) 3 or more sectors fail, we can call the unit a “fail”. This has the potential to reduce the time for a test, since a failure could be called without testing all of the sectors – it is effectively an early stopping rule. To call a unit passing, however, you would still need to test all the sectors.

The reason we didn’t stop just at testing the center sector is the low PPV of that test. Just because the center sector passes does not assure us of a passing unit, so even with a passing center sector the unit could be a failure. We needed to ensure a high PPV as well to ensure that the screening test would effectively screen for a bad unit.