Evaluation of Decontaminated N95 Respirators

NPPTL
National Personal Protective Technology Laboratory

Date Tested: 9/4/2020 – 9/8/2020

Respirator Model(s): 3M 1860S

Tests: Filtration with NaCl (modified version of STP-0059) and Strap Integrity with Tensile Testing

Decontamination Method: Broadband UVC (DECON95). DECON95 is a field deployable, benchtop, conveyorized process that uses an electrodeless medium pressure mercury vapor lamp to expose all surfaces of the N95 respirator to broadband ultraviolet energy, especially in the UVC band (200-280nm). The respirator is placed on a specially designed carrier and placed on a conveyor belt that passes below the lamp. For these assessments, the conveyor was run at 2.4 fpm. At this speed, the underside (inside) of the respirator is exposed to 500 mJ/cm^2 UVC.

Decontamination Cycles: 1 cycle; 3 cycles; 5 cycles

While decontamination and reuse of FFRs are not consistent with standard and approved usage, these options may need to be considered when FFR shortages exist. This assessment was developed to quantify the filtration efficiency of an N95 respirator that has been decontaminated. This assessment is not to determine the effectiveness of the decontamination procedure at killing pathogenic microorganisms. The results provided in this report are specific to the subset of samples that were provided to NPPTL for evaluation. These results may be used to update the CDC guidance for Crisis Capacity Strategies (during known shortages).

Seventeen respirators that were unworn and not subjected to any pathogenic microorganisms were submitted for evaluation. This included 5 respirators that were subjected to 1 cycle of the Broadband UVC decontamination process, 5 respirators subjected to 3 cycles, 5 respirators subjected to 5 cycles, and an additional 2 respirators that served as controls. Figure 1 photos document the procedures used. The samples were tested using a modified version of the NIOSH Standard Test Procedure (STP) TEB-APR-STP-0059 to determine particulate filtration efficiency. The TSI, Inc. model 8130 using sodium chloride aerosol was used for the filtration evaluation. Additionally, tensile strength testing of the straps was performed to determine changes in strap integrity. The Instron® 5943 Tensile Tester was used for this evaluation. The full assessment plan can be found here.

Filtration Efficiency Results: The minimum and maximum filter efficiencies were 97.96% and 99.24%, respectively. All respirators measured more than 95%. See Table 1.

Strap Integrity Results: No visual degradation of the straps was observed. The samples treated with 1 cycle of Broadband UVC showed mixed results with recorded force between top and bottom straps. The samples treated with 3 and 5 cycles of Broadband UVC showed an increase in recorded force for both top and bottom straps. See Table 2.

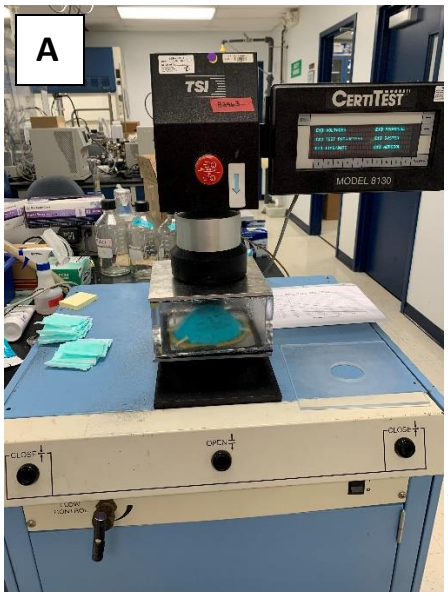

Fig 1A. TSI 8130 Filter Tester

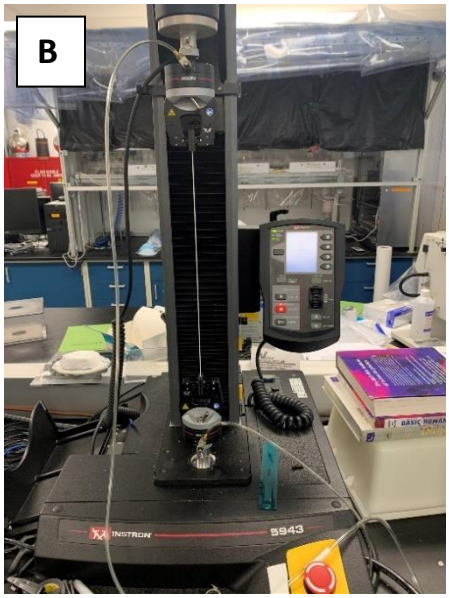

Fig 1B. Instron 5943 Tensile Tester

Table 1. Filter Efficiency Evaluation

Respirator Model, Decon Method, # of cycles	Treated Sample #	Flow Rate (Lpm)	Initial Filter Resistance (mmH_2O)	Initial Percent Leakage (%)	Maximum Percent Leakage (%)	Filter Efficiency (%)
3M 1860S, control	**Control 1**	85	11.1	0.335	0.830	99.17%
	Control 2	85	11.1	0.294	0.763	99.24%
3M 1860S, Broadband UVC, 1 cycle	**1**	85	11.7	0.366	1.42	98.58%
	2	85	12.1	0.302	0.763	99.24%
	3	85	11.5	0.500	1.08	98.92%
Min Fil Eff: 98.58%	**4**	85	10.8	0.382	0.863	99.14%
Max Fil Eff: 99.24%	**5**	85	11.7	0.408	1.10	98.90%
3M 1860S, Broadband UVC, 3 cycles	**1**	85	11.0	0.367	0.785	99.22%
	2	85	10.6	0.601	1.32	98.68%
	3	85	11.4	0.469	1.04	98.96%
Min Fil Eff: 97.96%	**4**	85	10.8	0.375	0.807	99.19%
Max Fil Eff: 99.22%	**5**	85	10.1	1.12	2.04	97.96%
3M 1860S, Broadband UVC, 5 cycles	**1**	85	11.8	0.654	1.21	98.79%
	2	85	11.4	0.664	1.11	98.89%
	3	85	12.4	0.621	1.38	98.62%
Min Fil Eff: 98.12%	**4**	85	11.0	0.745	1.88	98.12%
Max Fil Eff: 98.89%	**5**	85	11.6	0.473	1.26	98.74%

Notes:

- The test method utilized in this assessment is not the NIOSH standard test procedure that is used for certification of respirators. Respirators assessed to this modified test plan do not necessarily meet the requirements of STP-0059, and therefore cannot be considered equivalent to N95 respirators that were tested to STP-0059.

Table 2. Strap Integrity Evaluation

Tensile Force in Respirator Straps of Decontaminated N95s (recorded force values are at 150% strain)			
Respirator Model, Decon Method, # of cycles	**Straps from Treated Sample #**	**Force in Top Strap (N)**	**Force in Bottom Strap (N)**
3M 1860S, control	**Control 1**	2.658	2.818
	Control 2	2.520	2.758
	Control Strap Average	2.589	2.788
3M 1860S, Broadband UVC, 1 cycle	**1**	2.617	2.904
	2	2.542	2.854
	3	2.543	2.821
	Decontaminated Strap Average	2.567	2.860
	% Change ((Deconned - Controls)/ Controls)	-0.85%	2.58%
3M 1860S, Broadband UVC, 3 cycles	**1**	2.540	2.752
	2	2.678	2.760
	3	2.562	2.975
	Decontaminated Strap Average	2.593	2.829
	% Change ((Deconned - Controls)/ Controls	0.15%	1.47%
3M 1860S, Broadband UVC, 5 cycles	**1**	2.754	2.979
	2	2.709	2.949
	3	2.702	3.073
	Decontaminated Strap Average	2.722	3.000
	% Change ((Deconned – Controls)/ Controls)	5.14%	7.60%