Evaluation of Decontaminated N95 Respirators

NPPTL
National Personal Protective Technology Laboratory

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Respirator Model(s): 3M 8200, Prestige Ameritech RP88020, and BYD DE2322

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

Decontamination Method: Respirator model 3M 8200 was decontaminated using an Electron Beam Irradiation method. Both the Prestige Ameritech RP88020 and BYD DE2322 respirator models were decontaminated using a Plasma Discharge reactive oxygen species (ROS) method, which involved a surface dielectric barrier discharge technique for plasma ROS generation.

Decontamination Cycles: 1 cycle (Electron Beam Irradiation); 1 cycle and 3 cycles (Plasma Discharge ROS)

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 and manikin fit factor[1] 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).

20 respirators that were unworn and not subjected to any pathogenic microorganisms were submitted for evaluation. This included 1 respirator that was subjected to 1 cycle of the electron beam irradiation decontamination process, 6 respirators subjected to 1 cycle of the plasma discharge ROS decontamination method, 6 respirators subjected to 3 cycles of the plasma discharge ROS decontamination method, and an additional 7 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 respirator subjected to electron beam irradiation (1 cycle) measured an efficiency less than 95%. All samples treated with plasma discharge ROS (1 and 3 cycles) measured efficiencies greater than 95%. See Table 1.

Strap Integrity Results: No visual degradation of the straps was observed. The sample treated with electron beam irradiation (1 cycle) showed a decrease in recorded force. The Prestige Ameritech RP88020 treated with plasma discharge ROS (1 and 3 cycles) showed an increase in recorded force. The BYD DE2322 treated with plasma discharge ROS showed a decrease in recorded force at 1 cycle and mixed results between top and bottom straps at 3 cycles. See Table 2.

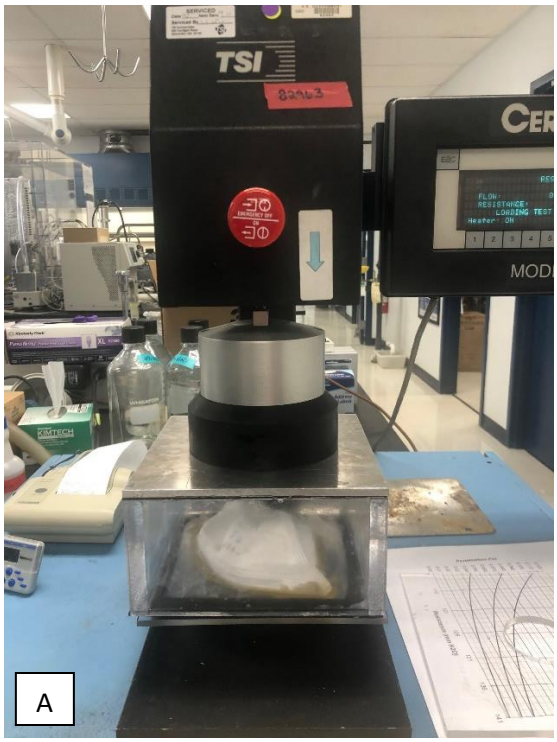

Figure 1A. TSI 8130 Filter Tester

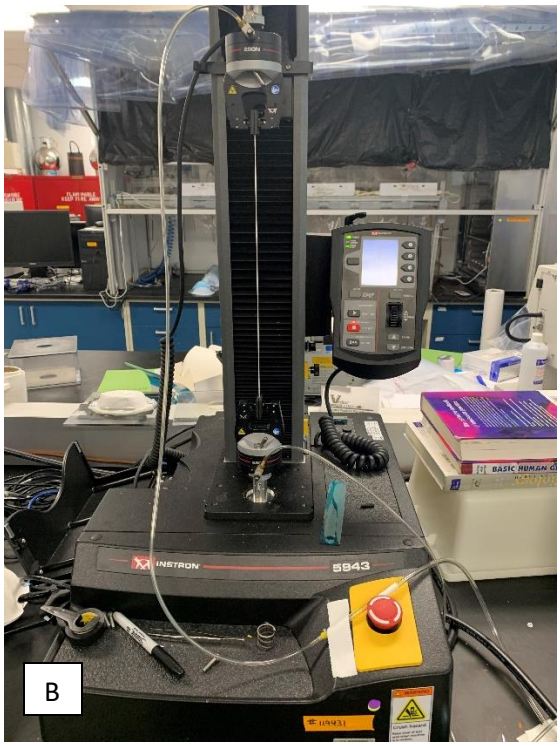

Figure 1B. Instron 5943 Tensile Tester

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 8200, control	**Control 1**	85	12.0	1.10	1.11	98.89
3M 8200, Electron Beam Irradiation, 1 cycle	**1**	85	12.3	36.4	36.4	**63.6**
Prestige Ameritech RP88020, control	**Control 9**	85	7.6	0.657	0.657	99.34
	Control 10	85	7.4	2.21	2.21	97.79
	Control 11	85	7.8	1.34	1.38	98.62
Prestige Ameritech RP88020, Plasma Discharge ROS, 1 cycle Min Fil Eff: 99.35% Max Fil Eff: 99.56%	**1**	85	7.5	0.468	0.483	99.52
	2	85	7.6	0.425	0.441	99.56
	3	85	7.7	0.649	0.649	99.35
Prestige Ameritech RP88020, Plasma Discharge ROS, 3 cycles Min Fil Eff: 99.50% Max Fil Eff: 99.59%	**5**	85	7.7	0.400	0.414	99.59
	6	85	7.4	0.442	0.470	99.53
	7	85	7.7	0.495	0.502	99.50
BYD DE2322, control	**Control 9**	85	14.0	2.35	2.35	97.65
	Control 10	85	13.0	1.53	1.53	98.47
	Control 11	85	14.7	1.75	1.75	98.25
BYD DE2322, Plasma Discharge ROS, 1 cycle Min Fil Eff: 97.79% Max Fil Eff: 98.04%	**1**	85	10.8	2.21	2.21	97.79
	2	85	13.5	1.96	1.96	98.04
	3	85	14.4	2.21	2.21	97.79
BYD DE2322, Plasma Discharge ROS, 3 cycles Min fil Eff: 97.10% Max Fil Eff: 98.69%	**5**	85	15.4	1.31	1.31	98.69
	6	85	13.3	2.90	2.90	97.10
	7	85	14.1	2.24	2.24	97.76

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.
- **BOLD** filter efficiencies < 95%.

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 8200, control	Control 1	4.682	4.888
3M 8200, Electron Beam Irradiation, 1 cycle	1	4.116	4.520
	% Change ((Deconned - Controls) / Controls)	-12.1%	-7.53%
Prestige Ameritech RP88020, control	Control 9	2.574	3.010
	Control 10	2.663	2.798
	Control 11	2.514	2.937
	Control Strap Average	2.584	2.915
Prestige Ameritech RP88020, Plasma Discharge ROS, 1 cycle	1	2.553	2.876
	2	2.693	2.966
	3	2.832	3.234
	Decontaminated Strap Average	2.693	3.025
	% Change ((Deconned - Controls) / Controls)	4.22%	3.77%
Prestige Ameritech RP88020, Plasma Discharge ROS, 3 cycles	5	2.687	3.079
	6	2.600	3.026
	7	2.599	2.853
	Decontaminated Strap Average	2.629	2.986
	% Change ((Deconned - Controls) / Controls)	1.74%	2.44%
BYD DE2322, control	Control 9	4.564	4.628
	Control 10	5.501	4.736
	Control 11	4.666	5.005
	Control Strap Average	4.910	4.790
BYD DE2322, Plasma Discharge ROS, 1 cycle	1	4.721	4.506
	2	4.686	4.387
	3	4.800	4.795
	Decontaminated Strap Average	4.736	4.563
	% Change ((Deconned - Controls) / Controls)	-3.54%	-4.74%
BYD DE2322, Plasma Discharge ROS, 3 cycles	5	4.915	4.492
	6	5.012	4.485
	7	5.087	4.693
	Decontaminated Strap Average	5.005	4.557
	% Change ((Deconned - Controls) / Controls)	1.93%	-4.86%