SUPPLEMENTARY INFORMATION

Table I. Decontamination Methods Summary Table

Method	Concentration/Dose	FFR Filtration Performance	FFR Fit Performance	Other Observations	Biological Organism Tested	Efficacy	Reference*
Dry Heat (70–80°C)	~77°C (up to 10 cycles, each for 30 min)	—	Two N95 FFR models tested on a manikin using 10 Lpm constant inhalation flow. One model showed <5% inward leakage after 10 cycles. The other model showed <5% inward leakage after 3 cycles but could not proceed with additional cycles because inner nose pad peeled off.	One N95 FFR model only evaluated for three cycles because the inner nose pad peeled off.	—	—	Yan et al. (2020)
	70°C (treatment time not specified for fit evaluation)	—	Three treatment cycles caused the mean of fit factors of six tests to fall slightly below 100	—	SARS-CoV-2 spotted (pipetted 50 µL droplets) onto N95 FFR coupons	4-5 log reduction of active titers after 60 min	Fischer et al. (2020)
	75°C for 30 min	Evaluated sheets of meltblown polypropylene filter media (media they report to be used in N95 FFRs) for filtration efficiency for up to 20 cycles. Efficiency measured as >95% after 20 treatment cycles.	—	—	—	—	Liao et al. (2020)
Liquid hydrogen peroxide	30 min submersion in 6% (one part hydrogen peroxide to four parts of deionized water) solution of hydrogen peroxide	6 of 6 models met NIOSH requirement after 3 cycles of contamination	—	—	—	—	Bergman et al. (2010)
	3%, 1 second	Met NIOSH requirement	—	—	—	—	Viscusi, et al. (2007)
	6%, 1 second	Met NIOSH requirement	—	—	—	—	Viscusi, et al. (2007)

Microwave Generated Steam	Microwave oven with revolving glass carousel, 1100 W (manufacturer rated); 750 W ft^3 experimentally measured; 2 min total exposure. FFR placed outer-side down and centered on top of two side-by-side pipette tip boxes, containing 50 ml room temperature tap water (~20°C).	6 of 6 models met NIOSH requirement after 3 cycles of contamination	—	slight separation of inner nose pad in one model. Slight melting of head straps in one model.	—	—	Bergman, et al. (2010)
	Microwave oven with revolving glass carousel, 1100 W (manufacturer rated); 750 W ft^3 experimentally measured; 2 min total exposure. FFR placed outer-side down and centered on top of two side-by-side pipette tip boxes, containing 50 ml room temperature tap water (~20°C).	—	Human subjects: 95% passing rate after 3 cycles for all models tested.	slight separation of inner nose pad in one model. One model had melted head strap.	—	—	Bergman et al. (2011)
	26mW/cm^3, 40 sec; water reservoir to generate steam.	—	—	—	MS2 bacteriophage	>90% reduction for all cycles	Fisher et al. (2010)
	Commercially available 2450 MHz, Sharp Model R-305KS (Sharp Electronics, Mahwah, N.J.) microwave oven with revolving glass carousel, 1100 W (manufacturer rated); 750 W/ft^3 experimentally measured; 2 min total exposure at a power setting of 10 (maximum power). FFR placed outer-side down on top of two side-by-side pipette tip boxes, centered, (each box 11.7 cm × 8.0 cm × 5.0 cm) with 50 ml room temperature tap water (~20°C). Following treatment, FFRs dried overnight on a laboratory benchtop	—	Human subjects: post-decontamination mean fit factors >100.	slight separation of inner nose pad in one model.	—	—	Viscusi et al. (2011)
	1250 W, 2 min; water reservoir to generate steam.	—	—	slight separation of inner nose pad in one model.	H1NI	>4-log reduction of viable H1N1 virus	Heimbuch et al. (2011)

	2 min, full power, 50 ml water (5-10 cycles)	Met NIOSH requirement	The bulletin states, "This damage compromised the fit of these respirators and made them not suitable for use."	3M models 1860 and 1870. Metal nose clip and staples melted surrounding plastic, nose foams were delaminated, and straps on 1870 lost elasticity.	—	—	3M (2020)
Microwave steam bags	Instructions were the same for each steam bag brand. Individual FFRs were placed inside separate bags filled with 60 ml of tap water. The bags were sealed, using the bag's integrated zipper lock seal and placed in a commercially available Sharp Model R-305KS (2450 MHz, 1100 W) microwave oven (Sharp Electronics, Mahwah, NJ, USA). The FFRs in the sealed steambags were irradiated on high power for 90 s; the prescribed time for a microwave with a rating of 1100 W.	Met NIOSH requirement	—	—	MS2 bacteriophage	99.90% reduction	Fisher et al. (2011)
Moist Heat Incubation	30 min incubation at 60°C/80% RH	6 of 6 models met NIOSH requirement after 3 cycles of contamination	—	slight separation of inner nose pad in one model.	—	—	Bergman et al. (2010)
	15 min incubation at 60°C/80% RH	—	Human subjects: 95% passing rate after 3 cycles for all models tested.	slight separation of inner nose pad in one model.	—	—	Bergman et al. (2011)
	FFRs incubated for 30 min at 60°C (upper temp. limit), 80% RH in a Caron Model 6010 laboratory incubator (Marietta, Ohio). Following treatment, FFRs dried overnight on a laboratory benchtop.	—	Human subjects: post-decontamination mean fit factors >100.	slight separation of inner nose pad for 3M 1870 model.	—	—	Viscusi et al. (2011)
	65°C / 85% RH, 30 min	—	—	—	H1NI	>4-log reduction of viable H1N1 virus.	Heimbuch et al. (2011)

	30 min, 60°C, 80% RH oven (5-10 cycles)	Met NIOSH requirement	The bulletin states, "This damage compromised the fit of these respirators and made them not suitable for use."	3M models 1860 and 1870. Metal nose clip and staples melted surrounding plastic, nose foams were delaminated, and straps on 1870 lost elasticity.	—	—	3M (2020)
Ultraviolet germicidal irradiation (UVGI)	45 min exposure at intensity 1.8 mW/cm^2 (simulation of 3, 15 min exposures)	6 of 6 models met NIOSH requirement after 3 cycles of contamination	—	—	—	—	Bergman et al. (2010)
	15 min exposure to outer side of FFR (performed 3 times), 40 W UV-C bulb. Intensity 1.8 mW/cm^2.	—	Human subjects: 90-100% passing rate after 3 cycles depending on model.	—	—	—	Bergman et al. (2011)
	15 min exposure to each side (outer and inner), 176–181 mJ/cm^2 exposure to each side of FFR.	Met NIOSH requirement	—	—	—	—	Viscusi et al. (2009)
	120–950 J/cm^2	Met NIOSH requirement	—	burst strength of individual respirator layers was decreased. Varies by model.	—	—	Lindsley et al. (2015)
	30 min (15 min each FFR side). 1.8 mW/cm^2	—	Human subjects: post-decontamination mean fit factors >100.	—	—	—	Viscusi et al. (2011)
	(0.24mW/cm^2) 480 minutes	Met NIOSH requirement	—	—	—	—	Viscusi et al (2007)
	260–285 nm, 5 µW/cm2 (treatment time not specified for fit evaluation)	—	mean fit factor of six tests remained acceptable (>100) following three cycles	—	SARS-CoV-2 spotted (pipetted 50 µL droplets) onto N95 FFR coupons	3-log reduction of active titers after 60 min	Fischer et al. (2020)

	0.004 to 4.7 J/cm^2	—	—	—	MS2 bacteriophage	>3-log reduction for models exposed to 0.1 J/cm^2 quantified as the dose to the internal filter medium	Fisher and Shaffer (2010b)
	1.6-2.0 mW/cm^2 (254 nm)	—	—	—	H1NI	>4-log reduction of viable H1N1 virus.	Heimbuch et al. (2011)
	30-min, 254nm (15-min per side) (5-10 cycles)	Met NIOSH requirement	The bulletin states, "This damage compromised the fit of these respirators and made them not suitable for use."	3M models 1860 and 1870. Straps on 1870 lost elasticity; strong burnt odor; nosefoam compressed on 1860.	—	—	3M (2020)
Vaporized hydrogen peroxide (VHP)	Bioquell Clarus C HPV generator: The HPV cycle included a 10 min conditioning phase, 20 min gassing phase at 2 g/min, 150 min dwell phase at 0.5 g/min, and 300 min of aeration.	Met NIOSH requirement after 50 cycles	Passing fit factors using a manikin headform	degradation of straps after 30 cycles	Geobacillus stearothermophilus spores	99.9999% reduction	Battelle (2016)

	Room Bio-Decontamination Service (RBDS™, BIOQUELL UK Ltd, Andover, UK), which utilizes four portable modules: the Clarus® R HPV generator (utilizing 30% H2O2), the Clarus R20 aeration unit, an instrumentation module and a control computer. Room concentration= 8 g/m^3, 15-min dwell, 125-min total cycle time. FFRs were hung on a string stretching across the length of room. Following HPV exposure, the Clarus R20 aeration unit was run overnight inside the room to catalytically convert the HPV into oxygen and water vapor. The treatments were performed in three consecutive days (one treatment per day).	6 of 6 models met NIOSH requirements after 3 cycles of contamination	—	—	Geobacillus stearothermophilus spores. Biological indicators containing spores were placed in five separate locations inside the room.	6-log spore reduction was measured following the 3X treatment	Bergman et al. (2010)
	1,000 ppm exposure (treatment time not specified for each cycle of fit evaluation)	—	mean fit factor of six tests remained acceptable (>100) following three cycles	—	SARS-CoV-2 spotted (pipetted 50 µL droplets) onto N95 FFR coupons	4- log reduction in virus titer after a 10 min, 1,000 ppm exposure	Fischer et al. (2020)
Hydrogen Peroxide Gas Plasma (HPGP)	STERRAD 100S H2O2 Gas Plasma Sterilizer (Advanced Sterilization Products, Irvine, CA), 59% H2O2, cycle time ~55-min (short cycle); 45°C–50°C. Treated for 3 cycles.	3 of 6 models met NIOSH requirements following 3 cycles of contamination	—	—	—	—	Bergman (2010)
	STERRAD 100S H2O2 Gas Plasma Sterilizer (Advanced Sterilization Products, Irvine, CA), 59% H2O2, cycle time ~55-min (short cycle); 45°C–50°C. Treated for 1 cycle.	Met NIOSH requirement	—	—	—	—	Viscusi et al. (2009)
	STERRAD H2O2 Gas Plasma Sterilizer NX (Standard cycle). Treated for 1 cycle.	Met NIOSH requirement	—	—	—	—	Viscusi et al. (2007)

	STERRAD 100S H_2O_2 Gas Plasma Sterilizer (Advanced Sterilization Products, Irvine, CA), 59% H_2O_2, cycle time ~55-min (short cycle); 45°C–50°C. Treated for 1 cycle.	Met NIOSH requirement	—	—	—	—	Viscusi et al. (2007)
Ethylene Oxide* * Not recommended because of known health effects.	60 min, 55°C and 736 mg/l 100% EtO gas	6 of 6 models met NIOSH requirement after 3 cycles of contamination	—	—	—	—	Bergman, et al. (2010)
	60 min, 55°C and 725 mg/l 100% EtO gas	Met NIOSH requirement	—	—	—	—	Viscusi, et al. (2009)
	725 mg/L, 55°C, 60 min	Met NIOSH requirement	—	P100 straps were slightly darkened.	—	—	Viscusi, et al. (2007)
	883mg/L, 55°C, 60 min	Met NIOSH requirement	—	—	—	—	Viscusi, et al. (2007)
Autoclave (121°C/15 psi)* *Note: Not recommended	15 and 30 min	One N95 FFR model and one P100 FFR model did not meet NIOSH requirements for both 15 and 30 min treatment.	—	—	—	—	Viscusi et al. (2007)

Dry microwave irradiation (conventional household microwave oven without the addition of a water source to generate steam)* *Note: Not recommended	2 min	Not tested due to physical damage (melting)	—	Both N95 and P100 model experienced melting	—	—	Viscusi et al. (2009)
Soap and water solution* *Note: Not recommended	Ivory bar soap, 1g/L, shaved from the bar and diluted in tap water. (2 treatment times: 2 and 20 min submersion, both followed by air drying)	N95 model (2 and 20 min treatment degraded filtration efficiency to levels <70%). P100 model (2 min treatment: filtration efficiency remained >99.97%. 20 min treatment degraded filtration efficiency to <99.97%)	—	—	—	—	Viscusi et al. (2007)
Isopropyl alcohol* *Note: Not recommended	70% isopropyl alcohol (2 treatment times: 1 sec, and 1 min)	N95 FFR and P100, both treatment level: mean filtration efficiency did not meet NIOSH requirements.	—	—	—	—	Viscusi et al. (2007)
Dry heat >100°C* *Note: Not recommended	Three treatment levels (all for 60 min): 100°C, 110°C, and 120°C	One sample of one N95 FFR model experienced filter penetration >5% at 110°C (other samples of this model melted at 100°C, 110°C, and 120°C). Mean initial penetration for two P100 FFR models was >0.03% at 100°C for one model and >0.03% at 90°C for the other model.	—	—	—	—	Viscusi et al. (2009)

*Refer to reference list for complete citation.

— not evaluated.