# N95 Decontamination & Reuse Method Decision Matrix

N95DECON

The purpose of this tool is to provide a high-level comparative overview of methods for the decontamination and reuse of N95 respirators during the COVID-19 pandemic.
These methods should only be employed in crisis shortages and should be part of a PPE conservation strategy. Each method requires detailed protocol implementation for operator and user safety;
This tool is not intended to provide all information for implementation, but rather to allow quick comparison for decision-makers to select methods that best fit the local setting prior to detailed investigation for effective implementation [Version 1.0, published Aug. 8, 2020]
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| Method | Reprocessing Method Level of Decontamination | Demonstrated SARS-CoV-2 Viral Inactivation | Effect on N95 FFR Filtration Efficiency (FE) & Fit | Removal of Chemical Residue Required? | Regulatory Guidance for N95 FFRs*** | LMIC Availability | Operator Hazard# | Startup Costs | Recurring Costs | Time per cycle | Protocol Available | Typical Scale of Operation | Requires electricity | Use for surgical masks | Number of Studies## | Scientific References | Implementation References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Methods being implemented in hospitals** | | | | | | | | | | | | | | | | | |
| Vaporized Hydrogen Peroxide | * | | | Yes | FDA EUA[1], CDC[2], NIOSH FE pass[3] | Low | Chemical# | $$$ | $$$ | 4-8 hours | Hospital- implemented | Facility | Yes | | ++++ | 4### | 5, 6, 7 |
| Hydrogen Peroxide Gas Plasma | * | | | Yes | FDA EUA[1], CDC[2], NIOSH FE pass[3] | Low | Chemical# | $$$ | $$ | 2-6 hours | Hospital- implemented | Facility | Yes | | +++ | 4### | 8 |
| UV-C Room | ** | | | No | CDC[2], NIOSH FE Pass[3] | Mid | Direct exposure# | $$$ | $ | System-dependent& | Hospital- implemented | Facility | Yes | | +++ | 9### | 10‡, 11, 12 |
| UV-C Cabinet | ** | | | No | CDC[2], NIOSH FE Pass[3] | Mid | Direct exposure# | $$ | $ | System-dependent& | Generic SOP | Facility | Yes | | +++ | 9### | 10‡, 13‡, 14‡ |
| Humid Heat Oven | ** | | | No | FDA EUA[15], CDC[2] | High | # | $ | $ | 60 min | Generic SOP | Facility | Yes | Possibly; sparse data | ++ | 16### | 17‡, 18‡ |
| **Methods not well-established, but under investigation** | | | | | | | | | | | | | | | | | |
| Microwave Generated Steam | ** | | | No | - | High | # | $ | $ | 2-3 min | Generic SOP | Individual | Yes | | + | 16### | 19, 20 |
| Room Temperature Waiting Time | ** | | | No | CDC[3] | High | # | $ | $ | 7 days | Generic SOP | Both | No | Yes | ++ | 21### | |
| Liquid Hydrogen Peroxide | ** | | | Yes | CDC[3] | High | Chemical# | $ | $ | 24 hours | None | Individual | No | | + | 4### | 22, 23, 24 |
| Steam Autoclave | * | | | No | NIOSH FE pass[3] | High | # | $$$$ | $ | <60 min | None | Facility | Yes | | ++ | 16### | 23, 25, 26 |
| Dry Heat Oven | ** | | | No | NIOSH FE pass[3] | High | # | $$ | $ | >60 min | Generic SOP | Facility | Yes | | ++ | 16### | 23 |
| Container Immersion in Boiling Water | ** | | | No | - | High | # | $ | $ | 45 min | Generic SOP | Individual | No | | + | 16### | 27‡ |
| Multicooker | ** | | | No | - | High | # | $ | $ | 30 min | Generic SOP | Individual | Yes | | + | 16### | 28, 29 |
| Chlorine Dioxide commercial system | * | | | Yes | NIOSH FE pass[3] | Low | Chemical# | $$$$ | $ | 1-12 hours | Generic SOP | Facility | Yes | | ++ | 30, 31 | |
| Chlorine Dioxide small scale | * | | | Yes | NIOSH FE pass[3] | High | Chemical# | $ | $ | 1-12 hours | Generic SOP | Both | No | | ++ | 30, 31 | |
| Ozone | * | | | Yes | NIOSH FE pass[3] | Low | Chemical, environmental# | $ | $ | 3-6 hours | None | Both | Yes | | + | 32 | |
| **Methods that are NOT recommended for use** | | | | | | | | | | | | | | | | | |
| Alcohol submersion | | | | Yes | Not recommended | - | # | - | - | - | - | - | - | | +++ | 22, 23 | |
| Bleach submersion | | | | Yes | Not recommended | - | Chemical# | - | - | - | - | - | - | | +++ | 22, 23 | |
| Soapy water submersion | | | | No | Not recommended | - | # | - | - | - | - | - | - | | ++ | 23 | |
| Sunlight | | | | No | Not recommended | - | # | - | - | - | - | - | - | | ++ | 9###, 21###, 33 | |
| Ethylene Oxide | * | | | Yes | CDC Caution | Low% | Chemical, carcinogen# | - | - | - | - | - | - | | ++ | 22, 23, 24 | |
| Formaldehyde Vapor | | | | Yes | Not recommended | - | Chemical, carcinogen# | - | - | - | - | - | - | | + | 35 | |
| Gamma Ray | | | | No | Not recommended | - | Direct exposure# | - | - | - | - | - | - | | + | 36‡ | |

**Legend**

GREY = Unknown due to insufficient or conflicting data

| | | | |
|---|---|---|---|
| RED = Not expected to yield appreciable decontamination | RED = unlikely to inactivate SARS-CoV-2 to 3-log levels on N95 FFR material | RED = <95% Filtration Efficiency or poor N95 fit after method use | RED = Residue removal required and safe removal has NOT been clearly demonstrated on N95 FFRs. |
| YELLOW = Some level of decontamination. Demonstrated to inactivate SARS-CoV-2 or similarly-resistant viruses by at least 3-log. Will NOT inactivate bacterial spores. | YELLOW= Likely to inactivate SARS-CoV-2 to at least 3-log, demonstrated only with similar pathogens on N95 FFR material | YELLOW = Mixed or limited results for fit/filtration after method use | YELLOW = Residue removal required but safe removal for N95 FFRs demonstrated in literature. |
| GREEN = High-level disinfection (Validated process used to render a product free of all forms of viable microorganisms to $10^{-6}$ sterility assurance level) (37, 38, 39) | GREEN= Demonstrated to inactivate SARS-CoV-2 to at least 3-log levels on N95 FFR material | GREEN = >95% Filtration Efficiency and passing fit test after method use | GREEN = No residue removal required |

* N95 respirators reprocessed with high-level disinfection techniques can be returned in a pooled fashion to any new user
** N95 respirators reprocessed with low-, or intermediate-level disinfection techniques must be returned to the initial user to prevent cross-contamination of other pathogens (e.g. bacteria, bacterial spores)
*** Refers to regulatory approval specific to the use of this method for N95 decontamination and reuse, including methods for removal of potential toxic residues. The existence (or lack thereof) of an FDA EUA is not a definitive statement about effectiveness (or ineffectiveness) of a treatment method.
% EtO more common in Latin America, low availability in sub-Saharan Africa
& UV-C decontamination depends on dose; at least 1J/cm$^2$ must be applied to all N95 surfaces for 3-log inactivation of enveloped viruses. Because dose = irradiance x time, and irradiance of UV-C systems can vary widely, the time per cycle will vary but is typically on the order of minutes to hours.
# Operator Hazard = ALL methods carry risk of self-contamination to the operator. PPE for droplet & contact precautions should be worn (Mask, gloves, long-sleeved gown, eye protection) while reprocessing PPE
$ **Startup Costs**: $$$$ = >$50,000, $$$ = $5,000 - $50,000, $$ = $500 - $5,000, $ = <$500
$ **Recurring Costs**: $$$$ = >$10 per respirator, $$$ = $1-$10 per respirator, $$ = $0.10 - $1 per respirator, $ = <$0.10 per respirator
## Studies refer to peer-reviewed literature on specific method use (both supporting and controverting) for decontamination of N95 respirators (including pre-print studies closely reviewed by N95DECON)
### Citation refers to N95Decon Technical Report (summary report with multiple citations therein)
‡ At least one author is affiliated with N95Decon

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