“Decontaminating N95 respirators during the Covid-19 pandemic: simple and practical approaches to increase decontamination capacity, speed and lessons learned”

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What was the situation?

- In light of COVID, we needed to support University Hospital
- Could a large scale decontamination be done to replenish PPE stock?
- If so, how?
  - Where could it be done?
  - How many masks per day?
  - What type of masks?
  - Fit test?

How to Decontaminate?

- Formaldehyde?
- UV?
- Heat?

Why VHP?

- No toxic residues
- Time and training constraints also pointed to VHP
- No need for construction (only equipment rental)
- Already using it at Rutgers and in same facility

Why VHP (continued)?

- *"Final Report for the Bioquell Hydrogen Peroxide Vapor (HPV) Decontamination for Reuse of N95 Repsirators" – July 2016*
  - https://www.fda.gov/media/136386/download

30 Control tests

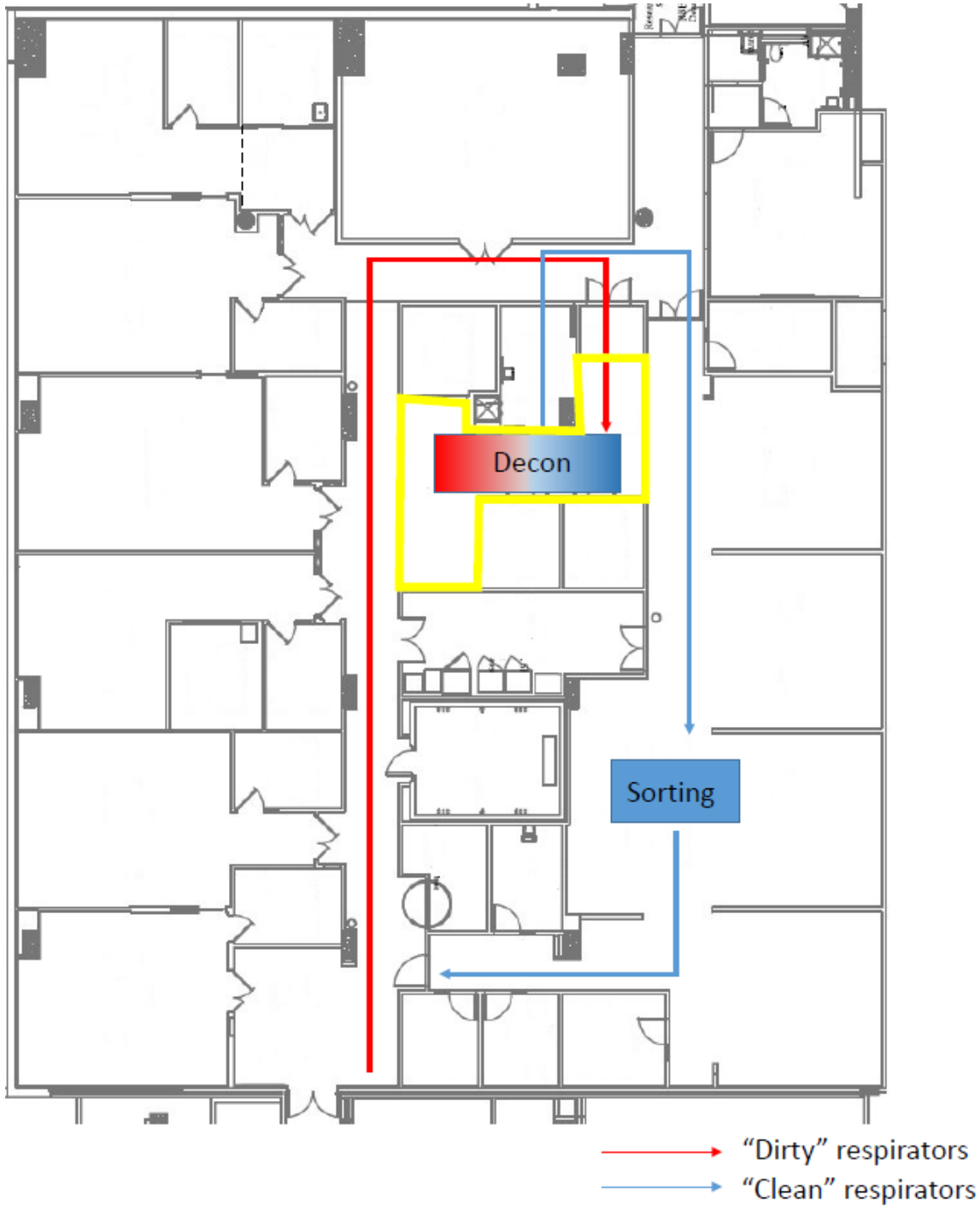
30 HPV tests

What are the requirements?

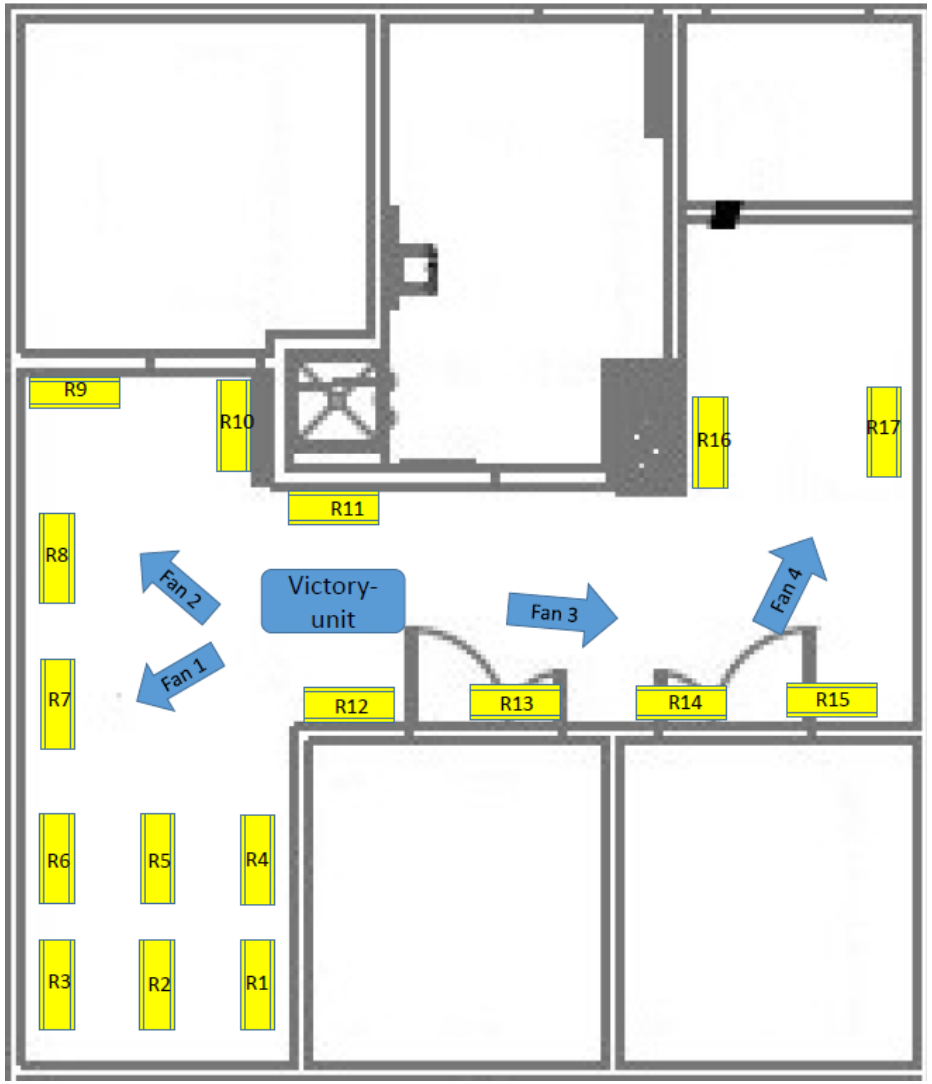
- How many masks?
- How often will we need to decon?
- What equipment is needed for masks? (Racks, hangers, paperclips?)
- What PPE? How much personnel?
- What approvals do we need? IBC, UH, etc.
  - IBC required validated testing (again, BSL3 manager already had this)

What is the game plan?

- Where would loading of masks take place?
- How can we separate clean from dirty?
- Personnel movement and PPE donning/doffing
- System setup



How to orient the room?



Protective Equipment

- Tyveks with booties and hood
- Double gloves
- Cover Shoes
- Apron
- Safety Glasses
- P100 respirators

Example of PPE for hanging of masks

Operation Design

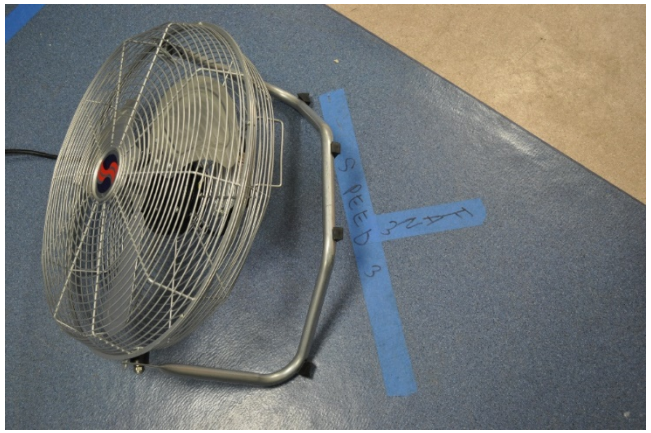
- Metal racks with 5 shelves
- Masks hung using metal hooks

- Masks did not touch adjacent masks
- Put Biological (BI) and Chemical Indicators (CI) inside masks for control

- 50 masks per shelf – 250 per rack
- 17 racks
- Total: 4,250 masks

Operation Design

- VHP® VICTORY™ unit (Steris Life Sciences) remotely controlled
- 35% aqueous hydrogen peroxide solution (Vaprox@)
- Fans to maintain air flow
- Biological and Chemical Indicators
- Run 3 cycles per week

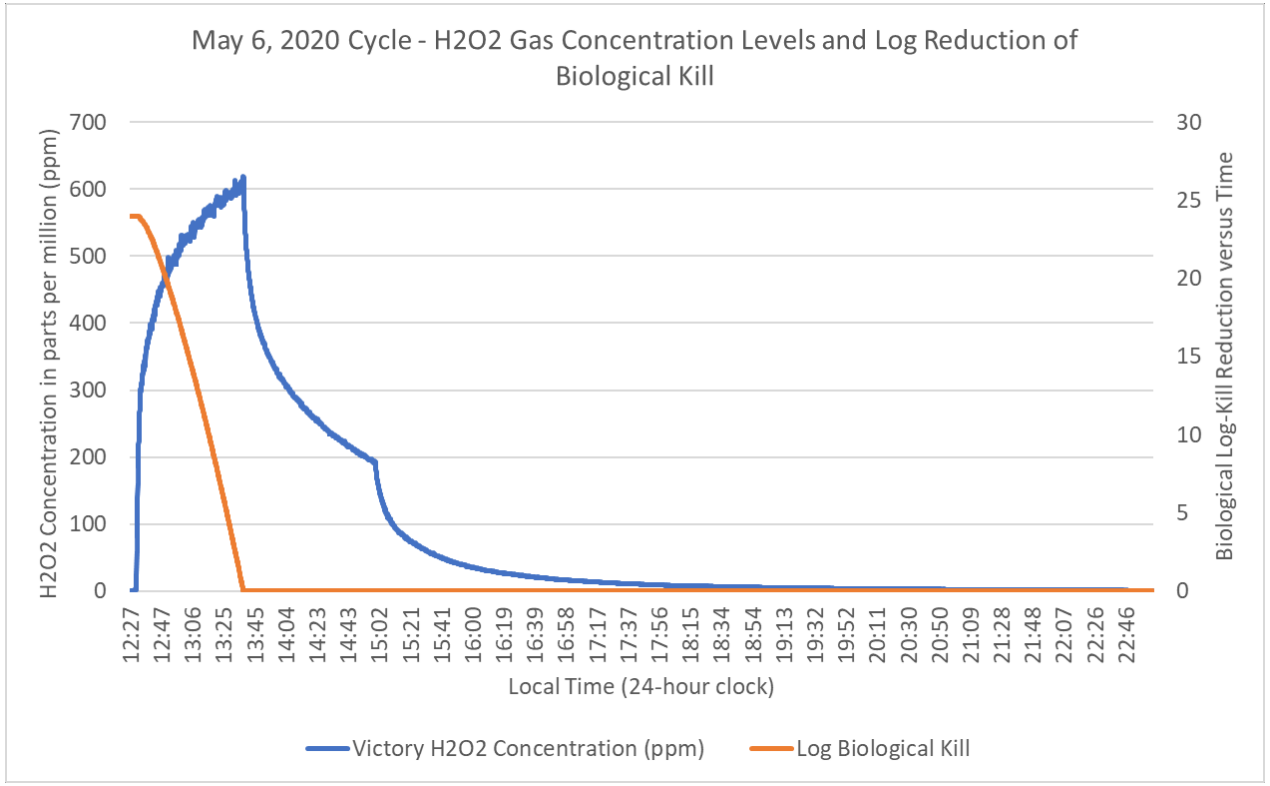


Decontamination Cycle

- Real-time calculation of VHP based on temperature, humidity
- Turn off supply/exhaust fans

- Decontamination:

1. Conditioning
2. Gassing (1 hour and 30 minutes) – VHP concentration above 400 ppm
3. Gassing-dwell (3 hours)
4. Aeration (few hours - overnight)



Decontamination Cycle

- Check concentration H_2O_2 (less than 1 ppm) before entering the facility using a Dräger x-Am 5100 (Dräger)

- Problem:
  - H_2O_2 over 1ppm with daily run

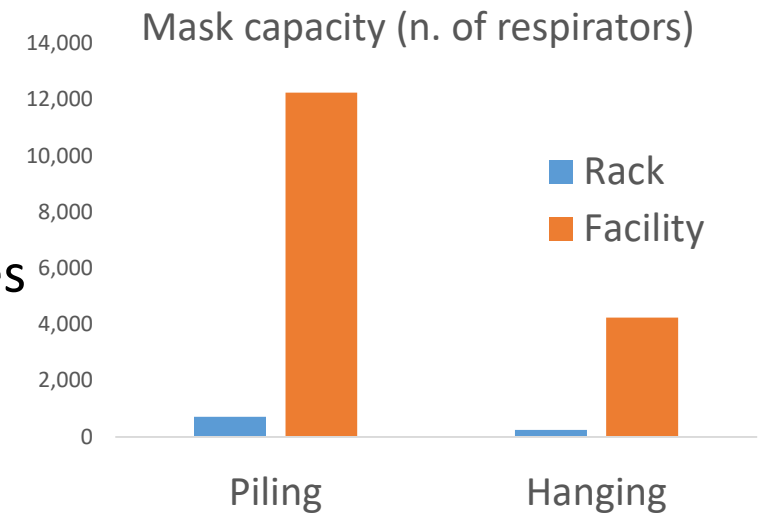
- Check Chemical Indicators
- Collect and incubate Biological Indicators

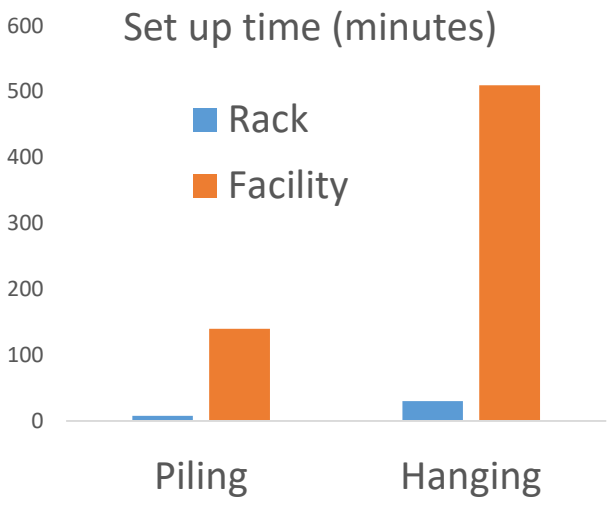
Optimizing the decontamination cycles

- Piling 4 to 12 masks using four different respirators models
- Insert BI & CI in the middle of the pile
- **Optimal pile size for successful decontamination: 6-8 masks** *[based on our operation design]*

Results piling vs hanging

- **Increase masks capacity of 3 times**
  - Rack: 720 units vs 250 units
  - Facility: 12,240 vs 4,250 units
- **Decrease set up time of 4 times:**
  - Rack: 8 minutes per rack vs 30 minutes
  - Facility: 2 hrs 20 min vs 8 hrs 30 min



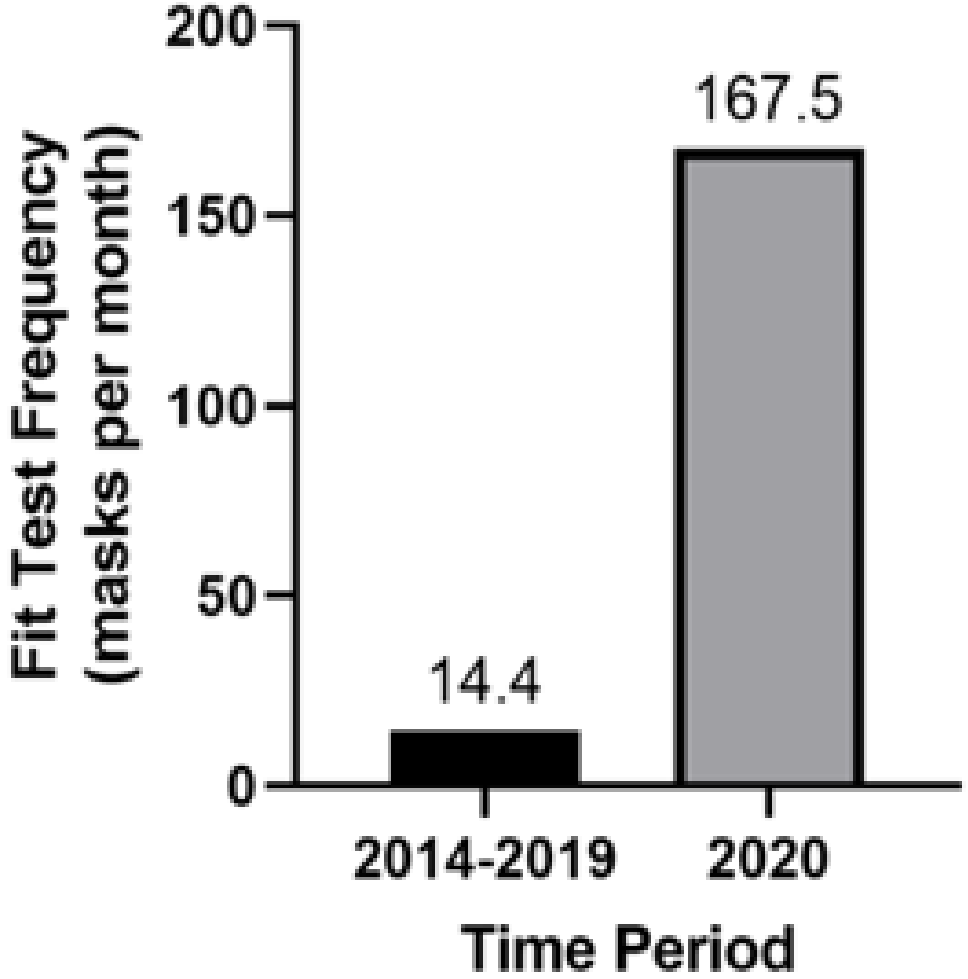


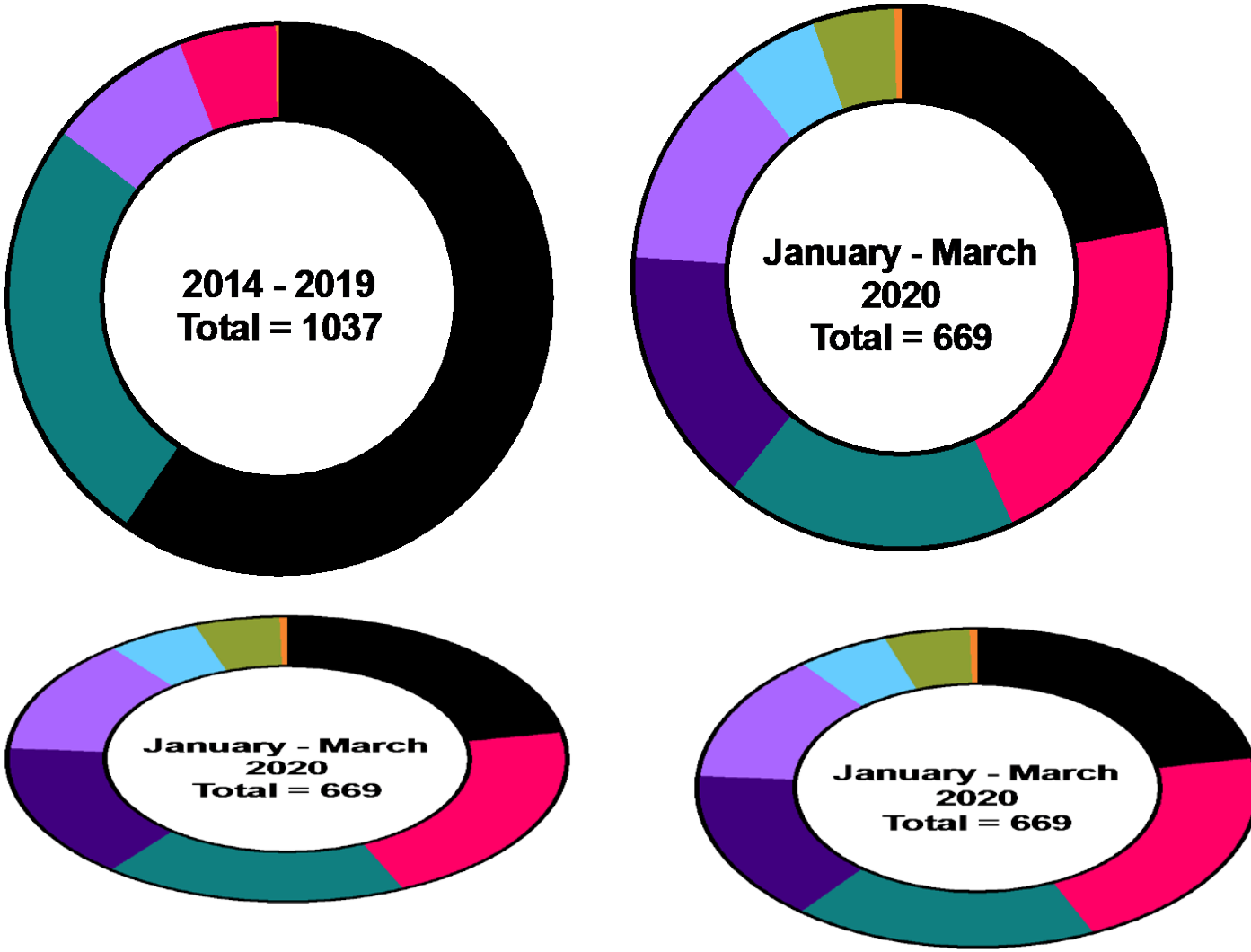
Optimizing the decontamination cycles

- Masks in Paper Bags
  - Facilitate operation work flow (respirators go back to original owner)
  - Slight lower capacity as hanging masks

- Makeup, moisturize cream or lipstick
  - Covered the side of respirators toward face
  - Inserted BI & CI inside closed respirators
  - No effect observed on sterilization

Making an Impact with VHP Decontamination





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Mask Fit and Manufacturer

- In the absence of decontamination, mask fit success varies between different mask types
- Different mask shapes were tested across multiple participants

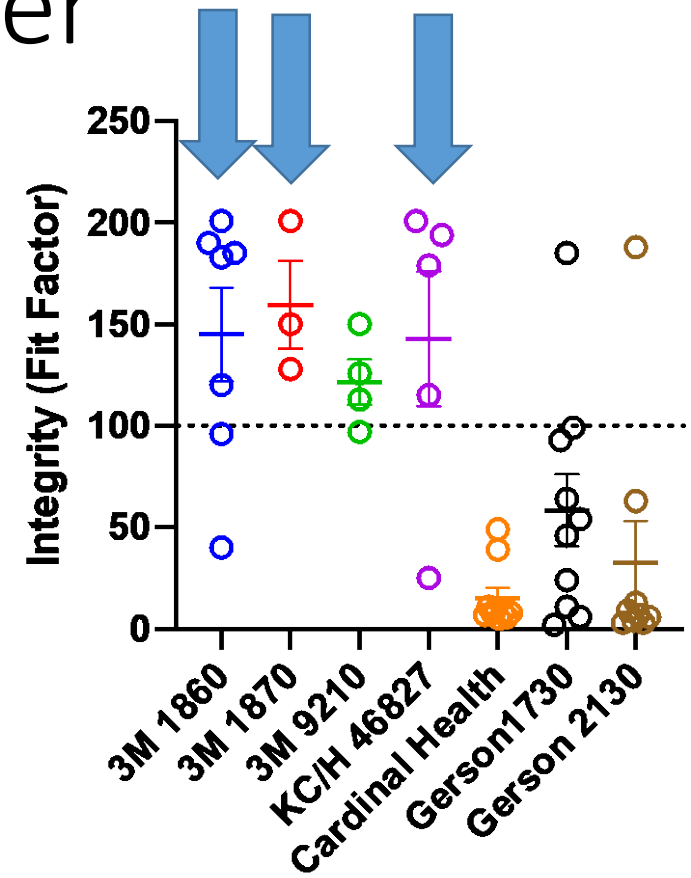







Image credit: manufacturer images

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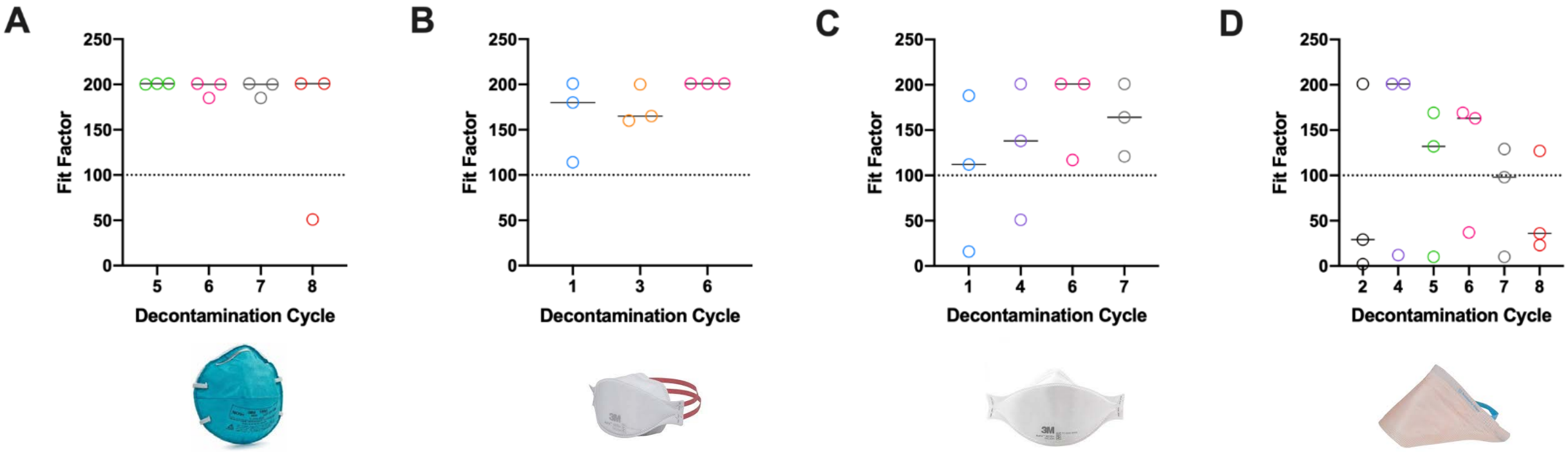
Repeat Decontamination Cycles: Differential effects on respirator integrity

- Data from masks part 2



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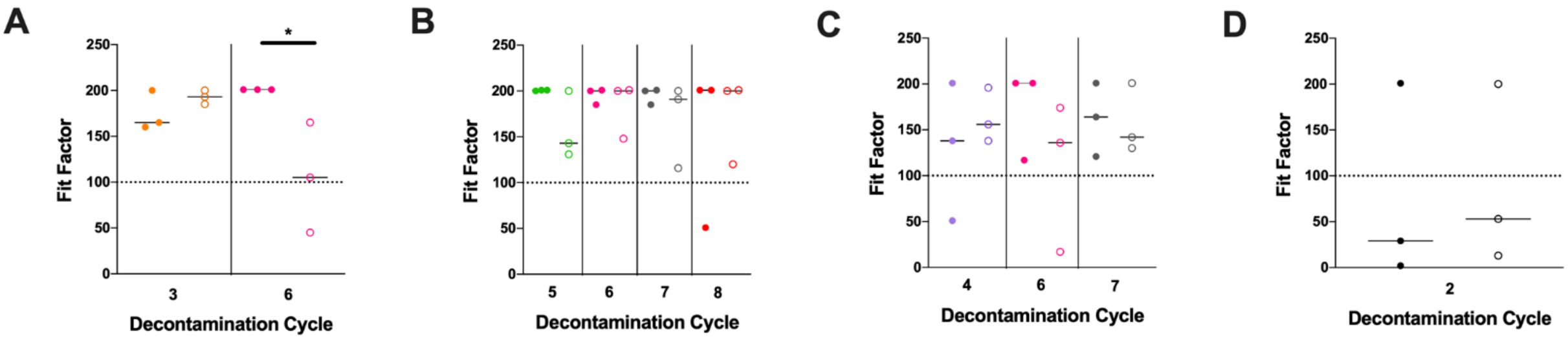
Mask Return: logistics vs safety



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Conclusions

- Successfully **designed an inexpensive reproducible operation** for the decontamination of N95 respirators using VHP. The operation required a small facility
- **Piles** of up to six N95 respirators can be **successfully decontaminated**
- Stacking **reduced the time** to arrange N95 respirators by approximately **two-thirds** while almost **tripling facility capacity**.
- N95 respirators were also **successfully decontaminated when placed in closed paper bags** reducing handling time and allowing the return of N95 respirators to their original user.
- **Makeup and moisturizer creams** did not interfere with the decontamination process
- Our data revealed **variability in the integrity of different N95 models after VHP decontamination** and exposed potential limitations of N95 decontamination and reuse programs.

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