



# The National Institute for Occupational Safety and Health (NIOSH)

Promoting productive workplaces  
through safety and health research 

## Projectile Fluid Penetration and Flammability of Respirators and other Head/Facial Personal Protective Equipment (FPFPPE)

NIOSH DATASET RD-1010-2019-1

JUNE 1, 2019

### Introduction

The U.S. Food and Drug Administration (FDA) requires surgical masks (SMs) and surgical N95 respirators used in healthcare to meet certain fluid resistance and flammability levels. NIOSH's National Personal Protective Technology Laboratory (NPPTL) investigated the fluid penetration and flammability of respirators and other head/ facial personal protective equipment to determine their efficacy in reducing healthcare workers' risk for occupational exposures to infectious microorganisms and injury due to accidental fires in surgical settings. The results from this study showed that FDA cleared SMs and surgical N95 respirators were resistant to synthetic blood penetration (Rengasamy et al. 2014) and met the flammability levels (Rengasamy et al. 2018) as expected. Seven out of eleven non-FDA cleared NIOSH-approved N95 filtering facepiece respirator models also passed the synthetic blood penetration and flammability tests. NPPTL tested five models of powered air-purifying respirator (PAPR) hoods and all models showed resistance to synthetic blood penetration and flammability levels. This may be important to ensure protection to healthcare workers since the use of PAPRs in healthcare is likely to increase because of their higher protection levels. None of the surgical head cover models tested in the study showed resistance to synthetic blood penetration, but they did meet flammability levels. Further tests on the rigidity of six surgical N95 respirators showed that flat fold models might collapse at high breathing flow rates, and high temperature and relative humidity conditions (Rengasamy and Niezgod, 2019). Healthcare workers may need to be aware of this as penetration of infected bodily fluids may spread diseases.

### Download Data

The primary data pertaining to projectile fluid penetration and flammability of respirators and other head/ facial personal protective equipment (FPFPPE) research are available in CSV format. The data are presented in eleven tables. The data dictionary is available in PDF format.

- [FPFPPE Dataset](#)  [CSV – 6 KB]
- [FPFPPE Dataset](#)  [XLS – 19 KB]
- [FPFPPE Dictionary](#)  [PDF – 33 KB]

### Data Collection Methods

**Blood penetration resistance:** Resistance to a synthetic blood penetration of respiratory devices was evaluated using the ASTM F1862 method (ASTM, 2000). Fluid penetration was measured at 450 cm/sec and/or at 635 cm/sec velocities.

**Flammability:** The flammability level of N95 FFRs and other PPE was evaluated following the Consumer Product Safety Commission (CPSC) CS-191-53 flammability (Federal Register 2008) method. The burn time for five samples of each N95 FFR model was measured and the average burn time was calculated. The average burn times of >3.35 to 7.0 and <3.0 seconds

model was measured, and the average burn time was calculated. The average burn times of 7.0, 5.0 to 7.0, and 15.0 seconds represent flammability class 1, class 2 and class 3, respectively.

Detailed descriptions of the methods are provided here: [Methods.pdf](#)  [PDF – 134 KB]

## Citations

Samy Rengasamy, Deborah Sbarra, Julian Nwoko and Ron Shaffer (2015) Resistance to synthetic blood penetration of national Institute for Occupational Safety and Health-approved N95 filtering facepiece respirators and surgical N95 respirators. *Am. J. Infection Control*. 2014; 43: 1190-1196.

Samy Rengasamy, George Niezgoda and Ron Shaffer (2018) Flammability of Respirators and other Head and Facial Personal Protective Equipment. *J. Int. Soc. Res. Prot.* 2018; 35: 1-13.

Samy Rengasamy, and George Niezgoda (2018) Flammability of Respirators and other Head and Facial Personal Protective Equipment. *J. Int. Soc. Res. Prot.* 2019; 36: 18-27.

American Society for Testing and Materials (ASTM) (2000). F1862: Standard test method for resistance of medical face masks to penetration by synthetic blood (Horizontal projection of fixed volume at a known velocity). In *Annual book of ASTM Standards*. Philadelphia, PA: ASTM 2000. P1340-1348

Federal Register (2008). Standard for the flammability of clothing textiles. Consumer Product Safety Commission. 16 CFR Part 1610. US Government Printing Office, Office of Federal Register, Washington, D.C. 73:15636 – 15661

## Acknowledgements

When a publication makes use of this dataset, acknowledgement of the development of the dataset should be attributed to NIOSH NPPTL.

## Contact

For further information, contact:

NIOSH/NPPTL  
(412) 386-6111

Page last reviewed: August 5, 2019