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Technical Bulletin

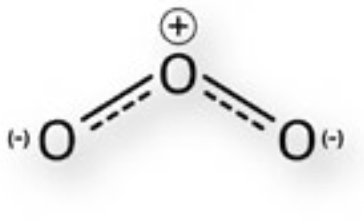
May 2024

# Respiratory Protection for Ozone

## Background

The purpose of this bulletin is to give a very brief overview of Ozone and respiratory protection. This bulletin details how 3M has assessed the performance of its Disposable Respirators and its Reusable Respirator and Powered and Supplied Air Respirator filters against Ozone.

Ozone (or trioxygen) is an inorganic molecule with the chemical formula $O_3$.




Ozone is a pale blue gas with a distinctively pungent smell. Ozone's odour is reminiscent of chlorine, and detectable by many people at concentrations of as little as 0.1 ppm in air.

Ozone is formed naturally from dioxygen ($O_2$) by the action of ultraviolet (UV) light and electrical discharges within the Earth's atmosphere.

### Exposure to ozone

According to the US National Institute for Occupational Safety and Health (NIOSH), ozone “is used for purifying air and drinking water, in industrial waste treatment, oils, bleaching and waxes, and to make other chemicals.” It is also present during welding applications.

### Health effects

Ozone can cause irritation to the eyes, nose and throat, and at higher concentrations can lead to headache, upset stomach, shortness of breath and lung damage (https://www.cdc.gov/niosh/topics/ozone/).

## Respiratory Protection Against Ozone

### Exposure limit for Ozone

Occupational exposure limits (OELs) for ozone vary by country or region. The Safe Work Australia Workplace Exposure Standard (WES) and future Workplace Exposure Limit (WEL) is a Peak Limit of 0.1 ppm. The WorkSafe New Zealand WES is a Ceiling Limit of 0.1 ppm. Therefore, service life testing was carried out at approximately 1 ppm ozone (10 times the OEL/WES/WEL).

### Ozone test method

Pure oxygen was passed through a mass flow controller (Brooks Model GC-1 00CXXC) to an ozone generator (Oxidation Technologies HTU-500) creating ozone at approximatively 1 ppm. This was mixed with humidified air and then passed through the respirator cartridge/filter. The sample stream was plumbed using fluorinated ethylene propylene tubing to ensure that the ozone did not react with the tube surface. Reusable respirator cartridges and filters were tested at approximately 64 L/min which is the test flow used by NIOSH for gas/vapor cartridges. This flow rate also corresponds to breathing during heavy work (Nelson, 1 976). PAPR cartridges were tested at flow rates similar to the PAPRs in use. Humidity was controlled to approximately 30%, 50% or 70% RH using a 3M propriety controller. A limited amount of testing was also carried out at 85% RH to investigate the effect of high relative humidity. Both the cartridge challenge and exit concentration were monitored with ozone detectors (2B Technologies 1 06-L) which have a 3 part per billion (ppb) limit of detection and accuracy of 1 .5 ppb or 2% of the reading, whichever is greater

### Results/Recommendations

The following 3M products are 3M recommended for use against up to 1 ppm ozone with an estimated service life of up to 40 hours.

- 3M™ Adflo™ Gas Filter PAPR-A1 , 837542
- 3M™ Adflo™ Gas Filter Nuisance Level Organic Vapour, Inorganic and Acid Gas, 837242
- 3M™ Versaflo™ PAPR-A1 P3, TR-631 0ANZ
- 3M™ Particulate Filter, P2, 21 28
- 3M™ Particulate Filter, P3, 21 38
- 3M™ Secure Click™ Particulate Filter P2 with Nuisance Level Organic Vapour/Acid Gas Relief, D31 28
- 3M™ Secure Click™ Particulate Filter P3 with Nuisance Level Organic Vapour/Acid Gas Relief, D31 38
- 3M™ Maintenance Free Half Facepiece Respirator, A1 P2 Filters, 4251 +*
- 3M™ Maintenance Free Half Facepiece Respirator, A2P3 R D Filters, 4255+*
- 3M™ Reusable Respirator Gas and Vapour Filter A1 , 6051
- 3M™ Reusable Respirator Gas and Vapour Filter A2, 6055*
- 3M™ Secure Click™ Gas and vapour Filter A1 , D8051
- 3M™ Secure Click™ Gas and vapour Filter A2, D8055
- 3M™ Secure Click™ Combination Filter A2P3, D8095
- 3M™ Gas & Vapour Filter GF22 A2 DT-4001 E
- 3M™ Combination Filter CF22 A2P3 D DT-4031 E

*Available only in Australia

The following cartridges or filters are not recommended for hazardous levels of ozone, but may instead be used for nuisance odour relief ( below OEL/WES/WEL):

- 3M™ Adflo™ Odour Filter, 83711 0
- 3M™ Versaflo™ Particulate + Nuisance Odour Organic Vapour and Acid Gas Filter TR-6820ANZ
- 3M™ Reusable Respirator Particulate Filter P3, Hydrogen Fluoride and Nuisance Level Organic Vapour/Acid Gas Relief, 6038
- 3M™ Secure Click™ Hard Case Particulate Filter P3, Hydrogen Fluoride and Nuisance Level Organic Vapour and Acid Gas Relief, D9038

To investigate any potential oxidation effects, reusable respirator cartridges and filters were tested at approximately 1 0 ppm at 70% RH for 4 hours. No noticeable increase in temperature was observed in the air stream nor any physical markings on the outside of the cartridge or filter due to the removal of ozone.

### Disposable Respirator Ozone Performance

Previous testing by Johnston et al. demonstrated the ability of a welding particulate respirators to remove ozone through activated carbon (1 989). The test confirmed the capability by introducing a 5 ppm ozone challenge using breathing machine set to NIOSH specifications for air flow (64 LPM), air temperature (20-25 C) & relative humidity (50 +/- 5%). Each respirator is tested for 0.8 hours.

The following products are 3M recommended for ozone protection up to 1 0X OEL/WES/WEL for up to 8 hours.

- 3M™ Welding Particulate Respirator, 821 4, N95, with Faceseal and Nuisance Level Organic Vapour Relief

## Conclusion

3M reusable respirator and PAPR organic vapor or type A cartridges may be used to filter ozone up to 1 ppm. At this level of Ozone, the service life was >40 hours with no significant ozone breakthrough detected. 3M reusable respirator and PAPR particle filters with a thin layer of carbon for “nuisance organic vapors” had variable performance and must be considered individually. No noticeable oxidation reaction (e.g. increased temperature) was noticed as a result of filtering ozone.

"Ozone Removal Capability of a Welding Fume Respirator Containing Activated Charcoal." A.R. Johnston, J.F Dyrud and Y.T. Shih. American Industrial Hygiene Association Journal, 50:451 -454 (1 989).

"Respirator Cartridge Efficiency Studies VIII. Summary and Conclusions." G.O. Nelson and A.N Correia. American Industrial Hygiene Association Journal, 36:51 4-525 (1 976).

**3M Australia Pty Ltd**
**Personal Safety Division**
Bldg A, 1 Rivett Road
North Ryde NSW 2113
Customer Service: 131 772
Email: Email: 3msupport.safety.au@mmm.com
Web: 3M.com/au/ppesafety

**3M New Zealand Ltd**
**Personal Safety Division**
94 Apollo Drive, Rosedale
Auckland 0632
Customer Service: 0800 252 627
Web: 3M.com/nz/ppesafety