

## **Fog Monitoring Equipment: What ESTA Is Making Available and Why**

*Revision of Thursday, 10 May 2007.*

### **Glycol, Glycerin, and Mineral Oil Fog**

Among the major concerns with glycol, glycerin, and oil fogs are the peak levels. The report Health Effects Evaluation of Theatrical Smoke, Haze, and Pyrotechnics, written by researchers from the Mt. Sinai School of Medicine and ENVIRON International Corporation for Actors' Equity and the League of American Theatres and Producers, concludes with the recommendation that performers' exposure to glycol fog should not exceed  $40 \text{ mg/m}^3$  and that the exposure to oil fog should not exceed  $25 \text{ mg/m}^3$ . These are peak levels, levels that should not be exceeded even for an instant, according to the recommendations. An additional report by the ENVIRON International Corporation, Theatrical Haze and Fog Testing for Mamma Mia! Winter Garden Theatre, written for Mamma Mia! Broadway and Nina Lannan Associates, recommends a peak exposure for glycerin fog of  $50 \text{ mg/m}^3$ . This recommendation was accepted by Actors' Equity to allow use of glycerin fog in the production.

Because peak levels are a major concern, only a device that measures and reports real-time readings is appropriate, and only aerosol monitors do this. There are several aerosol monitors on the market that are up to the task, and from that group, ESTA selected the pDR-1000AN aerosol monitor for monitoring peak glycol and mineral oil fog levels. The main reason we selected the pDR-1000AN is that ENVIRON used this monitoring device in developing the Equipment-Based Guidelines that supplement the Health Effects report, and all the calibration factors we have at this time for fog machine/fluid combinations are based on readings taken with pDR-1000AN meters. Additional reasons are that the pDR-1000AN is portable and relatively easy to use.

In addition to measuring the current level (so users can track peak levels), the pDR-1000AN displays time-weighted-average levels of aerosols during a sampling run. This is also useful with mineral oil, glycol, and glycerin fogs. The Health Effects report recommends that the existing OSHA standard for oil mists, which is  $5 \text{ mg/m}^3$  time-weighted-average (TWA) over an eight-hour period, be observed. ENVIRON International's Theatrical Haze and Fog Testing for Mamma Mia! Winter Garden Theatre recommends that the existing American Conference of Governmental Industrial Hygienists recommendation for glycerin, which is 10

mg/m<sup>3</sup> time-weighted-average (TWA) over an eight-hour period, be observed. ANSI E.1.5-2003 also recommends limiting the TWA readings for glycerin and the commonly used glycols to 10 mg/m<sup>3</sup>. The TWA function on the pDR-1000AN is useful for meeting these recommendations.

The aerosol monitor was purchased from the manufacturer, which has been purchased and gone through a number of name changes and is now called Thermo Fisher and is part of Thermo Fisher Scientific. Contact Peter Pepe in Pennsylvania (1-610-954-8596, mobile 1- 484-269-1363, peter.pepe@thermofisher.com) to find out who your regional sales manager is. The Thermo Fisher website can be accessed at <http://www.thermo.com/>.

The pDR unit is popular among industrial hygienists, and several companies have it available for rent. One popular rental company is US Environmental Rental Corporation (phone 1-888-550-8100 or 1-781-899-1560). Others include Geotechnical Services, Inc. in Tustin, California (phone 1-714-832-5610 or 1-800-524-9111) and Ashtead Technology Rentals. Ashtead has offices all over the United States. Visit <http://www.ashtead-technology.com/home.aspx?PageID=-1> for a listing of offices. Pine Environmental in New Jersey has more than 75 pDR units for rent. They can be reached at 1-800-301-9663, 1-609-371-9663, or <http://www.pine-environmental.com>. Less than 10 minutes of searching the Web with any popular search engine will net you many more vendors.

Please note that the corporate mergers and name changes have resulted in different brand names on the pDR 1000AN. The unit ESTA owns says it's an MIE pDR 1000AN, which is a reference to the name of the manufacturer before its purchase by ThermoAnderson, which then became Thermo Fisher. Some rental companies may offer the MIE pDR 1000AN for rent; others may offer the Thermo pDR-1000AN. It doesn't matter; it's the same machine.

## **Dry Ice and Liquid CO<sub>2</sub> Fog**

The major concern with dry ice fog and liquid CO<sub>2</sub> fog effects is the amount of carbon dioxide they put into the air. Carbon dioxide is toxic, so OSHA limits the eight-hour, TWA exposure to 0.5%. There is an additional OSHA standard of 3% for a short-term TWA exposure over a 15-minute interval. This short-term standard is relevant because theatrical productions tend to use these fog effects for short durations. The long-term standard is important as well, particularly when dry ice is stored on-site.

ESTA is using a Safeguard CO<sub>2</sub> gas detector for monitoring carbon dioxide. It was chosen because it is reasonably priced, is portable, can be calibrated in the open air, and covers the range of concern up to 5%. Other CO<sub>2</sub> detectors could be used, but most on the market are designed for monitoring industrial environments where only the long-term 0.5% limit is a concern and not the short-term 3% limit. These do not cover the range of carbon dioxide levels that are likely to be encountered in dry ice fog effects.

ESTA purchased the Safeguard CO<sub>2</sub> gas detector from AFC International, Inc. of DeMotte, Indiana. The company can be reached by telephone, 800-952-3293, or online at [www.afcintl.com](http://www.afcintl.com). The unit is manufactured by Crowcon Detection Instruments Ltd. of Abingdon, England. Its listed phone number is 44(0)1235 553057. Crowcon's email and website are [crowcon@crowcon.com](mailto:crowcon@crowcon.com) and <http://www.crowcon.com> respectively.

CO<sub>2</sub> gas detectors by various manufacturers are available on the market and may be rented from a variety of companies.

### **Liquid Nitrogen Fog**

Liquid nitrogen fog puts nitrogen into the air. Although nitrogen is an inert gas, the added nitrogen displaces air and can result in hazardously low oxygen levels. OSHA has set a minimum oxygen standard of 19.5%.

ESTA is using an IST-Aim Series 450 Personal Oxygen Detector for monitoring oxygen levels. It was chosen because it is reasonably priced, is portable, can be calibrated in the open air, and covers the range of concern all the way from 30% down to 0%. More information about the detector can be obtained from the IST-Aim Web site, [www.aimsafeair.com/aim/aim\\_450.html](http://www.aimsafeair.com/aim/aim_450.html).

ESTA purchased the IST-Aim Personal Oxygen Detector from AFC International, Inc. of DeMotte, Indiana. The company can be reached by telephone, 800-952-3293, or online at [www.afcintl.com](http://www.afcintl.com).

O<sub>2</sub> gas detectors by various manufacturers are available on the market and may be rented from a variety of companies.