

# Safety Issues for Glycol/Glycerol Water-Based Atmospheric Effects

## 1 Overview

Atmospheric effects — fog, haze, and smoke — are commonly used in the theater. Various different mechanisms are currently used to achieve them. Among the most common and least expensive are those that create fog using a water-based fluid containing glycols or glycerol. Much has been said about their safety, and there are still no shortage of controversies. This note provides a brief overview of some of the issues related to safely using atmospheric effects. Overwhelmingly, they are quite safe. There are, however, a few issues related to irritation caused by the fog.

This report discusses glycol/glycerol water-based foggers: foggers that create a smoke-like effect by heating and vaporizing a water-based fog fluid containing glycols or glycerols, producing an opaque aerosol when mixed with the surrounding air. These are some of the most common — and most studied — foggers in use today. The resulting effect is generally a rising smoke, though they can be used to create low-lying fogs by using chiller units to chill the output.

## 2 Ingestion and Inhalation Toxicity

The chemicals used in the fog fluids are not toxic. Despite some claims to the contrary, they are not carcinogenic and they do not cause asthma. Indeed, they can be safely ingested in fairly large quantities: drinking 30 milliliters of glycerol three times a day for fifty days has been proven harmless to healthy individuals, and drinking 1 to 1.5 grams of propylene glycol per kilogram of body weight is a safe dose for medical uses

(it is sometimes used to reduce interocular pressure) [2]. This is far more than is ingested in normal use, and since most of us are not in the habit of drinking bottles of fog fluid<sup>1</sup>, there is little danger of toxicity from ingestion.

There are similarly few problems with inhalation. The Actors' Equity Association, which if anything has a conservative bias towards allowable limits, sets forth a recommended level limiting an actor's exposure to 40 milligrams per cubic meter. [3]. This is a heavy level; Ruling notes that glycol levels on Broadway stages have consistently been measured at less than 10 mg/m<sup>3</sup> [2]. The Equity report provides a summary of how long it takes for the glycol levels from various fog machines to drop below the recommended level; at three feet from the largest fog machines, the time is less than 230 seconds, and considerably less at greater distances [3]. It does not provide an analogous guideline for glycerol levels, but a similar limit would still allow for extensive use of smoke — indeed, the confusion from the dense cloud of smoke might become a danger before toxicity from the smoke itself would.

### 3 Irritation Effects

One valid concern, however, is that both glycols and glycerols have a throat-drying effect. The Cohen Group report to ESTA notes that “the chemical nature of glycols is such that prolonged or repeated contact with a glycol mist is likely to dry out moist tissues (i.e., the mucous membranes of the upper respiratory track and, possibly, the eye)” [4]. The extent to which this takes place is where controversy lies. In particular, it is a concern for singers, especially opera singers, for whom a dry throat can be especially problematic. It has unquestionably been reported that performers have complained about throat irritation due to fog [5]. This effect may also have a psychological component in addition to a physiological one.

There are some ways to, if not eliminate, at least minimize these effects. Here are some suggestions:

- The obvious first suggestion is to minimize the amount of atmospheric effects used in the production. This calls for asking “is fog really necessary here?” Of course, it does no good to simply suggest eliminating fog in all cases, but it may be helpful to limit the amount of fog used at certain times.

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<sup>1</sup>And dare I say that if you are, you have more problems than this tech note is going to be able to solve?

- The Equity report sets for time-and-distance guidelines as to how long the fog should be allowed to dissipate before an actor is required to come within a certain distance of the fogger. These should be followed.
- It may be possible to use a less-concentrated fog fluid, containing less glycol or glycerol. This can be accomplished by watering down the fluid, though this typically violates the manufacturer’s recommendations (the glycols also serve as a lubricant for the pump). Sometimes, however, “light haze” fluids are available. They tend to dissipate faster — this may even be a more desirable effect.
- Since the effects may be partially psychological, it may help to inform the performers that fog is being used, how it is being used, the reason it is called for, and the safety information for it. (This is not a bad thing to do even if they aren’t complaining!)

## 4 Other concerns

Water-based foggers do generally contain a heating element. This should not be a hazard, however, since it is enclosed within the fogger.

Though it is not directly a safety issue and we do not address it in detail, we must at least mention that glycol foggers, like all other atmospheric effects, can trigger certain types of smoke detectors. Those that detect particulate matter in the air can be affected; rate-of-heat-rise detectors are unaffected. If atmospheric effects are being used in a space that has particulate detectors, these detectors may need to be disabled for the duration of the show in order to avoid triggering the alarms. This needs to be authorized by and coordinated with the Authority Having Jurisdiction.

## References

- [1] Rosco Laboratories, Inc., “Fog products tech notes,” available at <http://www.rosco-ca.com/technotes/fog/index.html>.
- [2] K. G. Ruling, “Fake fog and ingestion,” Stagecraft mailing list posts, Dec. 2002.

- [3] Actors' Equity Association and ENVIRON, "Equipment-based guidelines for smoke and fog," 2001, available at <http://www.actorsequity.org/Library/equipment-based.pdf>.
- [4] G. E. Raymond, "Recommended exposure guidelines for glycol fogging agents," The Cohen Group, San Mateo, Research Report, 1997, available from ESTA Fog Working Group Study of Scientific Literature on Glycol and Glycerine Inhalation, <http://www.esta.org/tsp/cihintro.htm>.
- [5] K. Teschke, Y. Chow, M. Brauer, C. van Netten, S. Varughese, and S. Kennedy, "Atmospheric effects in the entertainment industry: Constituents, exposures, and health effects," University of British Columbia, School of Occupational and Environmental Hygiene, Vancouver, Research Report, Mar. 2003, available at <http://www.soeh.ubc.ca/research/>.
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- [7] Stagecraft mailing list archives, <http://www.stagecraft.org/>.