



ANSI E1.5 – 2009 (R2018)

**Entertainment Technology—
Theatrical Fog Made With Aqueous
Solutions Of Di- And Trihydric Alcohols**

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The ESTA Technical Standards Program

The ESTA Technical Standards Program was created to serve the ESTA membership and the entertainment industry in technical standards related matters. The goal of the Program is to take a leading role regarding technology within the entertainment industry by creating recommended practices and standards, monitoring standards issues around the world on behalf of our members, and improving communications and safety within the industry. ESTA works closely with the technical standards efforts of other organizations within our industry, as well as representing the interests of ESTA members to ANSI, UL, and the NFPA. The Technical Standards Program is accredited by the American National Standards Institute.

The Technical Standards Council (TSC) was established to oversee and coordinate the Technical Standards Program. Made up of individuals experienced in standards-making work from throughout our industry, the Council approves all projects undertaken and assigns them to the appropriate working group. The Technical Standards Council employs a Technical Standards Manager to coordinate the work of the Council and its working groups as well as maintain a “Standards Watch” on behalf of members. Working groups include: Control Protocols, Electrical Power, Event Safety, Floors, Fog and Smoke, Followspot Position, Photometrics, Rigging, and Stage Machinery.

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The Fog & Smoke Working Group, which authored this Standard, consists of a cross section of entertainment industry professionals representing a diversity of interests. ESTA is committed to developing consensus-based standards and recommended practices in an open setting.

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1 Scope

This standard describes the composition of theatrical fogs or artificial mists that are not likely to be harmful to otherwise healthy performers, technicians, or audience members of normal working age, which is 18 to 64 years of age, inclusive. This standard makes no statement about appropriate exposure limits for theatrical fogs or artificial mists with other populations, and no limits, higher, lower, or the same as these limits, for other populations should be inferred from it. This standard is limited to those fogs and mists made from a solution of water and one or more dihydric or trihydric alcohols. These fogs are commonly called "glycol fogs," although only those that use dihydric alcohols are technically made with glycol.

This standard is intended to be applied in theatres, arenas, and other places of entertainment or public assembly where theatrical fogs and mists are often used as visual effects or to enhance lighting effects in live performances such as dramatic productions, musicals, and popular music concerts. It may be used as a guidance document in other venues where the exposed population is similar to that defined in this scope and where the respiratory and vocal demands on the population are not greater than those placed on performers, technicians, or audience members participating in dramatic productions, musicals, or popular music concerts.

2 Definitions

2.1 aerosol: a suspension of small particles in a gas or air.

2.2 CAS number (CAS #): a Chemical Abstracts Service number that identifies a specific chemical or mixture of chemicals.

2.3 dihydric alcohol: an alcohol that has two hydroxyl groups.

2.4 fog: a liquid aerosol in air that reduces visibility and reflects light.

2.5 glycerin: a trihydric alcohol composed of a chain of three carbon atoms linked by single covalent bonds, with each carbon atom linked to one hydroxyl group and one or more hydrogen atoms. Also called "glycerol."

2.6 glycol: a dihydric alcohol, an organic compound with a molecular structure having two hydroxyl groups.

2.7 hydroxyl group: a molecular group containing one hydrogen and one oxygen atom.

2.8 mist: a liquid aerosol, not as optically dense as fog, but with larger droplets.

2.9 STEL: Short Term Exposure Limit. The maximum exposure level averaged over a short term, generally 15 minutes.

2.10 trihydric alcohol: an alcohol that has three hydroxyl groups.

2.11 TWA: Time Weighted Average. Exposure level averaged over an 8-hour period.

3 Requirements

3.1 Components

The following dihydric and trihydric alcohols are components that may be used with water in a fog or mist that meets the requirements of this standard:

Name	CAS #
triethylene glycol	112-27-6
monopropylene glycol (propylene glycol; 1,2-propanediol)	57-55-6
diethylene glycol	111-46-6
dipropylene glycol	25265-71-8, 106-62-7, 110-98-5, 108-61-2
1,2-butylene glycol (1,2-butanediol)	584-03-2
1,3-butylene glycol (1,3-butanediol)	107-88-0
glycerin (glycerol; 1,2,3- propanetriol)	56-81-5

Fogs produced with chemicals not on the above list, including coloring agents, scents, and bactericide additives, are not necessarily considered a health risk, but do not meet the requirements of this standard.

3.2 Concentrations

3.2.1 Long-term exposure

A theatrical fog produced with a mixture of deionized water and one or more dihydric or trihydric alcohols shall be considered to meet the requirements of this standard if the concentration of alcohols breathed by a worker or audience member is no greater than 10 milligrams per cubic meter, time weighted average (TWA), and if the alcohols used are from the list in Section 3.1. This maximum TWA concentration level applies to the total alcohol concentration, whether one or several alcohols are used.

3.2.2 Peak exposure

A theatrical fog produced with a mixture of deionized water and one or more dihydric or trihydric alcohols shall be considered to meet the requirements of this standard if the concentration of alcohols in the air breathed by a worker or audience member is never higher than 40 milligrams per cubic meter, and if the alcohols used are from the list in Section 3.1. This maximum concentration level applies to the total alcohol concentration, whether one or several alcohols are used.

A theatrical fog produced with a mixture of deionized water and trihydric alcohol (glycerin) alone shall be considered to meet the requirements of this standard if the concentration of alcohol in the air breathed by a worker or audience member is never higher than 50 milligrams per cubic meter.

3.3 Decomposition products

The maximum TWA and STEL of formaldehyde, acrolein, acetaldehyde and other possible hazardous products of thermal degradation of the above compounds shall be present only at levels below the lowest permissible level set by governing occupational health and safety authority, such as the Occupational Safety and Health Administration in the United States of America or the Health and Safety Executive in the United Kingdom.

3.4 Contaminants

Contaminants, such as acetone and ethylene glycol, which may be present in bulk alcohol stock and thus may be in fog fluid, shall be present in fog only at levels below the lowest permissible level set by governing occupational health and safety authority, such as the Occupational Safety and Health Administration in the United States of America or the Health and Safety Executive in the United Kingdom.