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THEATRICAL FOG AND HAZE AEROSOL MONITOR INSTRUMENT COMPARISON STUDY

RAMBOLL

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1. INTRODUCTION

Actors' Equity Association (AEA) represents professional stage actors and stage managers and promotes safe working conditions across Broadway, touring, and regional theater productions. To do this, AEA supports research and guidance intended to protect the health of performers exposed to theatrical fog, haze, and related special effects.

In 1997-99, at the request of AEA and the League of American Theaters and Producers (now The Broadway League) and with the support of the Equity-League Pension and Health Trust Funds, investigators from the Mount Sinai School of Medicine (Mt. Sinai) and ENVIRON International Corporation (now Ramboll) conducted a study to evaluate whether the use of fog, haze, and pyrotechnics special effects in theatrical musical productions is associated with a negative health impact in actors. This effort was initiated in response to ongoing concerns by actors that the use of these theatrical effects may have an impact on their health. The results of this study were presented in the report *Health Effects Evaluation of Theatrical Smoke, Haze, and Pyrotechnics* (Mt. Sinai and ENVIRON 2000).

The results of the Mt. Sinai/ENVIRON study indicate that there are certain irritant health effects associated with actors exposed to elevated or peak levels of glycol fog and mineral oil. However, as long as peak exposures are avoided, actors' health, vocal abilities, and careers should not be harmed. Pyrotechnics as used on Broadway at the time of the study did not have an observable effect on actors' health.

Mt. Sinai and ENVIRON recommended the following peak guidance levels with respect to glycols and mineral oil:

- The use of glycols should be such that an actor's exposure does not exceed **40 milligrams per cubic meter (mg/m^3)**.
- Mineral oil should be used in a manner such that an actor's exposure does not exceed a peak concentration of **25 mg/m^3**.
- For chronic exposures to mineral oil, the existing standards established for oil mists (**5 mg/m^3** as an eight-hour time-weighted average) should also be protective for actors in theatrical productions.

Comparable guidance levels were developed for glycerol in a subsequent study (ENVIRON 2001b):

- Glycerol should be used in a manner such that an actor's exposure does not exceed a peak concentration of **50 mg/m^3**.
- For chronic exposures to glycerol, the existing standards established for glycerin mists (**10 mg/m^3** as an eight-hour TWA) should also be protective for actors in theatrical productions.

To ensure that peak fog and haze levels are below these guidelines, one option available to productions is to conduct production-specific testing at their theatres using an aerosol monitor. In order to conduct this testing, calibration data must be developed for each equipment/fluid combination. These calibration data are necessary to convert the readings of the aerosol monitor to glycol, mineral oil, or glycerol concentrations. A compilation of calibration factors approved for use in evaluating compliance with the peak guidance levels is provided on the Actors' Equity website (https://www.actorsequity.org/resources/Producers/safe-and-sanitary/smoke-and-haze/).

The calibration factors that have been developed to date are based on studies using the Thermo Scientific PDR-1000 as the aerosol monitor. The PDR-1000 is a passive (no pump) high sensitivity (i.e., photometric) monitor that uses a light scattering sensing chamber to measure the concentration of airborne particulate

matter (liquid or solid), providing a direct and continuous readout as well as electronic logging of the data. However, the PDR-1000 has been discontinued and is no longer being serviced by the manufacturer. Furthermore, the data communications technology used by the PDR-1000 has become outdated and is not compatible with current computer hardware. As the availability of the legacy instruments has declined, AEA recognized the need to better understand how different commercially available instruments might be able to be used for measuring theatrical fog and haze aerosols.

The purpose of this study is to collect data to allow the previous calibration factors for the PDR-1000 to be applied to other portable aerosol monitors, either directly or with the application of an adjustment factor. This involves operating other aerosol monitors side-by-side with the PDR-1000 under controlled theatrical fog and haze conditions to develop instrument calibration adjustment factors.

The primary objectives of this study were to:

- Compare the real-time response of multiple portable aerosol monitors when exposed to theatrical fog and haze generated by a range of commonly used machines and fluids;
- Evaluate the consistency and relative bias among instruments when operated under identical conditions;
- Develop instrument-specific calibration adjustment factors that allow aerosol monitor readings to be interpreted relative to a reference instrument;
- Validate the calibration factors for the new instruments using the established testing protocol using laboratory reference (i.e., NIOSH) methods for a subset of machine-fluid combinations; and
- Generate a robust dataset to inform future AEA guidance on the use of aerosol monitors for production-specific testing.

The intent of this study was not to develop a complete set of new machine–fluid–specific calibration factors tied to laboratory reference methods. Instead, the focus was on instrument-to-instrument comparison and normalization. However, as noted above, machine-fluid-specific calibration factors were developed for a subset of machine-fluid combinations in order to base certain calibration factors on an established NISOH protocol.

2. TESTING METHODOLOGY

2.1 Test Location and General Setup

Testing was conducted at J&M Special Effects in Brooklyn, New York in their indoor studio suitable for controlled theatrical fog and haze generation. The studio space had ample ventilation and large fans that were used to clear the room of fog/haze after tests were completed.

In order to generate as consistent an aerosol environment as possible, fog and haze machines were positioned to discharge aerosol into a defined test corridor, allowing fog/haze generation to be controlled and aerosol monitors to be co-located. Between test runs, ventilation and/or fans were used to clear residual aerosol from the test area, ensuring independence between successive runs. The setup is shown in **Figure 1**.

Figure 1. Intercomparison testing setup

2.2 Fog and Haze Machines and Fluids

A selection of fog and haze machines and fluids representative of those commonly used in theatrical productions were evaluated. The machines and fluids included in the study are provided in **Table 1**.

Table 1. Summary of fog and haze machines and fluids evaluated

Manufacturer	Fog Machine	Fluid Name	Fluid Type
Look Solutions	Cobra 1.8	Regular-, quick-, and slow-fog fluids	Glycol
Look Solutions	Viper NT	Regular-, quick-, and slow-fog fluids	Glycol
Look Solutions	Power Tiny	Tiny-Fluid	Glycol
Hazebase	Piccola	BaseB fluid	Glycol
Reel FX	DF-50	Original DF50 fluid	Mineral oil
Antari	DNG-250 series low foggers	FLL4 Low Fog Effects Fluid	Glycol
Ultratec Special Effects	LSG (CO_2 low fog system)	Molecular Low Fog Fluid	Glycol

Fluids evaluated included both glycol and mineral oil-based formulations. Machine output settings, burst patterns, and fan configurations were varied to produce a broad range of aerosol concentrations and operating conditions.

2.3 Aerosol Monitoring Instruments

Multiple portable, real-time aerosol monitors were operated simultaneously during each test run. Instruments were zeroed in accordance with manufacturer recommendations and configured to be consistent with the settings used by the PDR-1000.

The PDR-1000 was used as a reference instrument for the purpose of developing relative calibration adjustment factors. Other instruments were selected that were portable and generally available from commercial equipment rental companies, as shown in **Table 2**. The Sensirion HazeWatch was also considered for this study but was eliminated because its maximum concentration reading of 4 mg/m^3 was concluded to be too low for the purposes of this testing.

Table 2. Aerosol monitors evaluated and measurement characteristics

Manufacturer	Model	Maximum Concentration Reading
Thermo Scientific	PDR-1000	400 mg/m^3
Thermo Scientific	PDR-1500	1,000 mg/m^3
TSI	DustTrak DRX 8534	150 mg/m^3
TSI	SidePak AM 520	100 mg/m^3

Thermo Scientific PDR-1000	Thermo Scientific PDR-1500
	
TSI DustTrak DRX 8534	**TSI SidePak AM520**
	

In contrast to the PDR-1000, the three new aerosol monitors tested are active monitors that use pumps to draw air past the sensor. The DustTrak DRX 8534 has a factory-set flow rate of 3 L/min total flow that cannot be changed; 2 L/min of the total flow is measured aerosol flow and 1 L/min of total flow is split off, filtered, and used for sheath flow (TSI 2021). The SidePak AM520 has an adjustable flow rate ranging from 0.7 to 1.8 L/min, with a default factory setting of 1.7 L/min which is recommended for use with the

monitor's bujilt-in impactors (TSI 2025). The PDR-1500 has a flow rate range of 1.0 to 3.5 L/min (Thermo Fisher Scientific 2014). For this study, a flow rate of 2.0 L/min was selected, which is consistent with the measured aerosol flow of the DustTrak DRX 8534 and comparable to the flow rate of 1.7 L/min used by the SidePak AM520.

2.4 Testing Setup

The first round of testing involved the use of a long cardboard tunnel to funnel fog through and into the aerosol monitoring instruments. One set of instruments was placed inside the box (termed Set 1), and the second set was placed outside at the back of the box (termed Set 2), as shown in **Figures 2, 3, and 4**. Set 2 instruments were held within the stream of fog for 30 seconds at a time during the fog machine runs, rotating through the entire set of instruments each run (this procedure was not performed for the low foggers). The PDR-1000, the reference instrument, was held within the stream of fog for the entire duration of each run.

Figure 2. Testing setup with tunnel on table, instrument set 1 inside back of the box and set 2 outside the exit of the tunnel on the right (fog machine on left hand side out of frame).

Figure 3. Closeup photo of testing setup of Set 1 instruments inside tunnel. This configuration was used for most foggers/hazers (excluding the low foggers).

Figure 4. Closeup photo of testing setup of Set 2 instruments outside the tunnel exit (not all instruments shown in frame). This configuration was used for most foggers/hazers (excluding the low foggers).

The second round of testing involved the use of low fogger machines, which required a different instrument configuration, as shown in **Figure 5**. Due to the low-lying nature of the fog emitted from low fogger machines, both sets of instruments were placed on elevated surfaces (approximately one-foot to one and a half-foot high) from the ground floor at two points: Set 1 was positioned at a distance of six feet from the fog machine, and Set 2 was positioned at a distance of 10 feet away from the machine. The boxes were slightly offset to allow for the stream of fog to reach the rear set of instruments (Set 2) and prevent any blockage of the fog flow.

Figure 5. Setup of instruments for low fogger machine testing (Set 1 at front, Set 2 at rear)

2.5 Test Runs and Data Logging

Testing was conducted over two days and consisted of a series of discrete fog and haze runs. Each run was documented with respect to:

- Machine and fluid type
- Output setting and burst pattern/frequency
- Fan configuration (e.g., 25%, 50%)
- Start and end times
- Observations regarding instrument performance (e.g., alarms or over-range conditions)

A standardized run log was maintained to ensure traceability between test conditions and instrument data. A table showing the test runs is provided in **Table 3**, and example photos are provided in **Figures 6 and 7**.

Table 3. Summary of test runs and operating conditions

Run Number	Fog/Haze Machine	Fluid	Settings
1	Viper NT	Regular fog	25% output; pulses described as “five-second pulses / 0.5-sec pulses”
2	Viper NT	Regular fog	35% output; 0.5-sec bursts
3	Viper NT	Quick fog	35% output; 0.5-sec bursts
4	Viper NT	Quick fog	50% output; 0.5-sec bursts
5	Viper NT	Quick fog	40% output; 0.5-sec bursts
6	Viper NT	Slow fog	40% output; 0.5-sec bursts
7	Viper NT	Slow fog	25% output; 0.5-sec bursts
8	Cobra 1.8	Slow fog	25% output; bursts implied similar
9	Cobra 1.8	Quick fog	25% output; 0.5-sec bursts
10	Cobra 1.8	Quick fog	10% output; 0.5-sec bursts
11	Cobra 1.8	Regular fog	10% output; 0.5-sec bursts
12	Cobra 1.8	Regular fog	25% output; 0.5-sec bursts
13	Cobra 1.8	Regular fog	10% output; pumps + XRF7 tubes; ~90 sec
14	Cobra 1.8	Regular fog	10% output; 0.5-sec bursts every ~3 sec; 2 min
15	Cobra 1.8	Regular fog	10% output; 1-sec burst every 5 sec
16	Piccolo	Base B	Handheld down tunnel; bursts (no % shown)
17	Piccolo	Base B	Button bursts; too frequent initially
18	Piccolo	Base B	1 sec on / 3 sec wait
19	Power Tiny	Tiny fluid	1-sec bursts with 3-sec intervals
20	Power Tiny	Tiny fluid	1-sec bursts with 5-sec intervals
21	Power Tiny	Tiny fluid	1-sec bursts; intended 10-sec intervals then corrected to 5-sec intervals
22	Power Tiny	Tiny fluid	1-sec bursts; 5-sec intervals; collecting media
23	Power Tiny	Tiny fluid	1-sec burst every 10 sec
24	Power Tiny	Tiny fluid	1-sec burst every 5 sec
25	DF50	ReelFX Original DF50 fluid	5 sec on / 5 sec off
26	DF50	DF50 fluid	5 sec on / 10 sec off
27	DF50	DF50 fluid	5 sec on / 5 sec off; collecting media Sample A
28	DF50	DF50 fluid	5 sec on / 10 sec off; collecting media Sample B
29	DF50	DF50 fluid	Continuous run; cycle pattern not re-stated at callout

Run Number	Fog/Haze Machine	Fluid	Settings
30	DNG 250 (low fogger)	FLL4 fog fluid	5 sec on / 5 sec off
31	DNG 250 (low fogger)	FLL4	5 sec on / 5 sec off
32	DNG 250 (low fogger)	FLL4	5 sec on / 5 sec off; less kicking
33	LSG (CO_2 low fog system)	Molecular fog fluid (Molecular Low)	Fog 50% cycle 5s on/5s off; chiller full
34	LSG (CO_2 low fog system)	Molecular fog fluid (Molecular Low)	Same as Run 33

Figure 6. Example of fog stream into test tunnel during testing

Figure 7. Example of low fogger machine run

2.6 Sample Collection and Analysis

Beyond side-to-side comparisons of data logging instruments, Ramboll collected samples for laboratory analysis for a subset of the machine-fluid combinations. A list of the fog machines and fluids is provided below in **Table 4**. All sample analyses were conducted by using validated analytical methodologies, as described in the ENVIRON Air Sampling Protocol (ENVIRON 2001a).

Table 4. Machine and fluid combinations for laboratory analysis.

Manufacturer	Fog Machine	Fluid Name	Fluid Type
Look Solutions	Cobra 1.8	Regular fog fluid	Glycol
Look Solutions	Power Tiny	Tiny fog fluid	Glycol
Reel FX	DF-50	Original DF50 fluid	Mineral oil

Monitoring of short-term concentrations was performed using portable real-time aerosol monitors, including PDR-1000s, PDR-1500s, TSI SidePak AM 520s, and TSI DustTrak DRX 8534s.

The maximum readings of each instrument are provided above in **Table 2**.

For developing the calibration factors, Gillian GilAir3 sampling pumps were used to draw air through collection media. The calibration sampling was conducted in conjunction with operating the aerosol monitors. Consistent with NIOSH methodologies, the sampling pumps were calibrated to 2 liters per minute (LPM) for glycol samples and 3 LPM for mineral oil samples using a BIOS DryCal DC-Lite calibrator. The aerosol monitors were zeroed, the data logging function of the aerosol monitors was turned on, and the data logging time for the aerosol monitors were synchronized.

OSHA Versatile Sampler (OVS) traps were used as the collection media for glycol samples, each containing two sections of XAD-7 resin (200-mg front section, 100-mg back section, separated by a polyurethane foam [PUF] plug). The XAD-7 resin was used to collect both the particulate and vapor phase of the glycol

aerosol. A 13-mm glass fiber filter (GFF) plug precedes the front section and a PUF plug follows the back section. This sampling is based on a variation of NIOSH Method 5523 (NIOSH 1996; Pendergrass 1999).

For mineral oil samples, air samples were collected on 37 mm 2-piece cassettes containing tared 5µm polyvinyl chloride (PVC) filters. The sampling method is based on NIOSH Method 500.

The collection media, along with appropriate field blanks, were submitted for analysis to Eurofins of Raleigh, North Carolina, an American Industrial Hygiene Association (AIHA) accredited laboratory.

A set of samples was analyzed for glycols using a variation of NIOSH Method 5523, which involves the use of a gas chromatograph with a flame ionization detector (GC/FID). The NIOSH Method 5523 was extended to a validated level of quantification (LOQ) of 5.0 to 15.0 µg of each individual glycol per sample. Another set of samples was analyzed for mineral oil using NIOSH Method 5026.

2.7 Data Processing and Analysis

Time series data from each instrument were imported and processed using the R programming language (R Core Team, 2025), including over 290,000 rows of data from 78 data files. The data were parsed into runs using start and end times from experimental notes (**Table 3**). Instrument data were then grouped for comparison according to their position for each run – for example, grouping position 1 or 2 instruments together with co-located instruments for the appropriate time periods.

For instruments in position 1, instrument- and experiment-specific lag periods were identified for each data series, and time series were aligned based on when the measurable signal was first observed (i.e., defining run time = 0 as the time when each instrument's signal began). Signal start times were initially flagged as the moment measurements reached at least 5% of the maximum value for that instrument/run and remained there for at least five seconds; these start times were then reviewed and adjusted manually to ensure appropriate comparisons between instruments. For instruments in position 2, since the non-PDR-1000 instruments were rotated in 30-second phases, 30-second measurement increments were identified for each instrument, and the data series were aligned accordingly.

Once the time series data were properly aligned, they were reviewed to identify which experiments should be included in subsequent analysis. Data points at or very near the limit of measurement for each instrument were removed, while data points were retained within the following instrument-specific limits: DustTrak DRX 8534 ≤ 149 mg/m3, SidePak AM520 ≤ 99 mg/m3, PDR-1500 ≤ 999 mg/m3, and PDR-1000 ≤ 399 mg/m3. Experimental data were excluded for any instrument test where the measured values were not below the instrument's maximum for at least 30 seconds. Additionally, PDR-1000 data were removed from experiments 30, 31, 32, 33, and 34 since the data for those tests did not appear to accurately reflect the test conditions based on contemporaneous data from other instruments.

Ten-second average measurements were calculated for each instrument and experiment. Scatterplots and linear regression models were then prepared to compare measurements from each instrument against matched PDR-1000 readings from the same run time interval and experiment. Regressions were constructed using robust linear models (Venables and Ripley, 2002) to minimize the influence of potential outliers on the instrument relationships. These scatterplots were generated independently for each experiment and regression models were constructed by combining 10-second average values for all

included experiments into a single scatterplot per instrument. An example of raw data and aligned data for run 1 is provided in **Figure 8** and the combined scatterplots are shown in **Figure 9**.

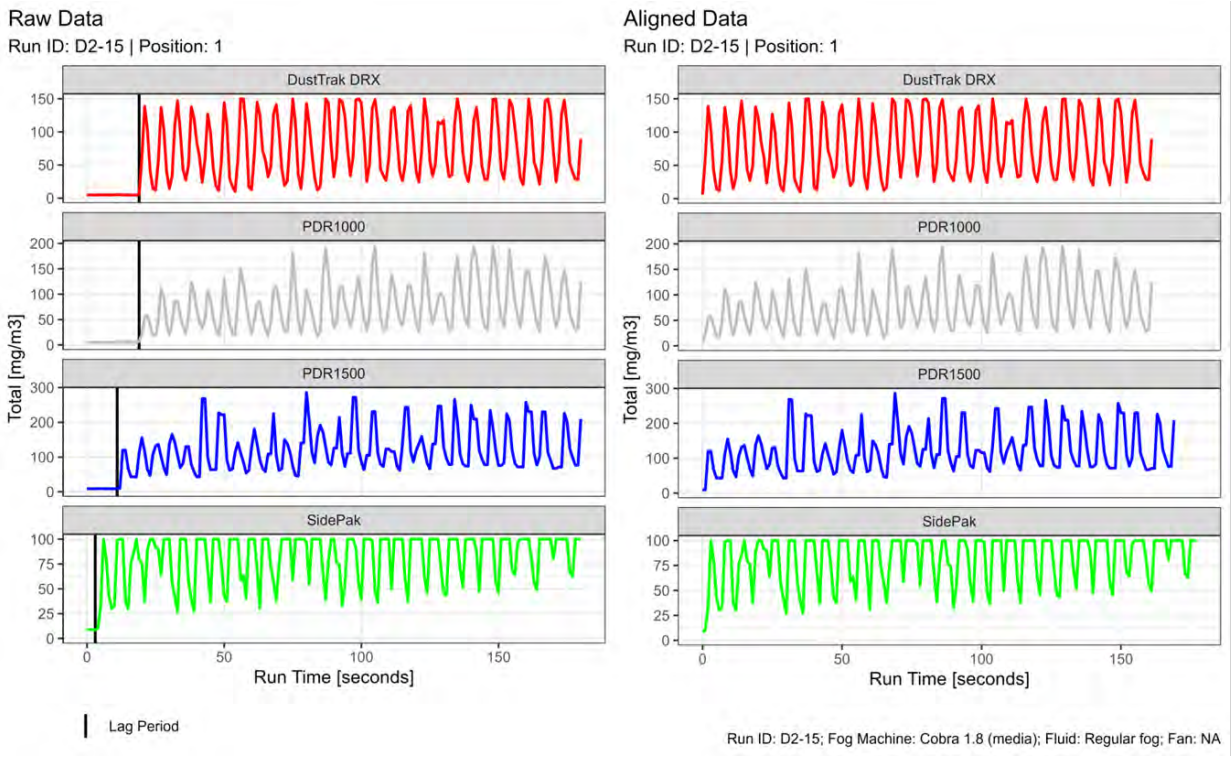

Figure 8. Example time series showing simultaneous aerosol monitor response during a fog release

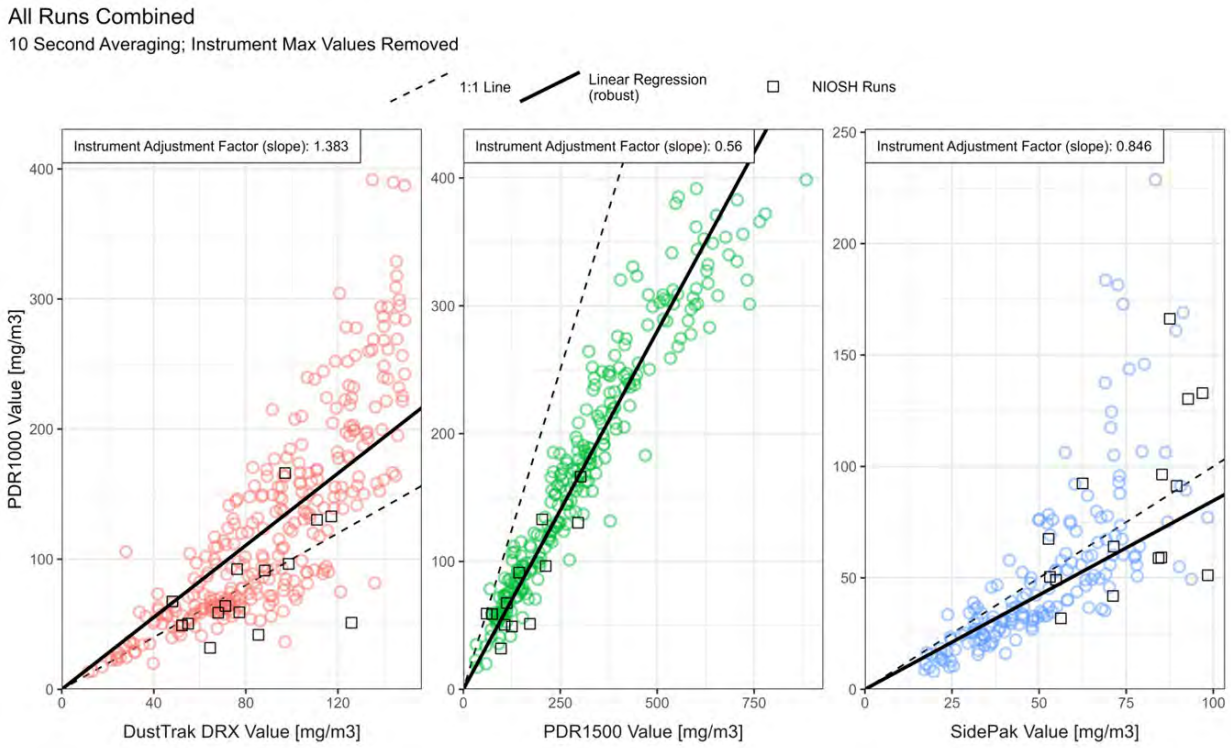

Figure 9. Scatterplot comparing aerosol monitor response to reference instrument. Each circle represents a 10-second average value from one of the 34 experimental runs. Time periods where either instrument's response was at its upper limit were removed prior to averaging, as were other specific data series as described in Section 2.7.

3. RESULTS AND DISCUSSION

3.1 Instrument Response Comparison

Across the full range of machines, fluids, and operating conditions tested, all aerosol monitors demonstrated a clear and repeatable response to theatrical fog and haze aerosols, with some degree of variability. However, the magnitude and sensitivity of response varied by instrument type.

Some instruments consistently reported higher concentrations than the reference instrument, while others exhibited a dampened response, particularly during short-duration or highly pulsed fog releases. Differences were most pronounced at higher aerosol concentrations, where certain instruments approached alarm or over-range thresholds.

3.2 Instrument Calibration Adjustment Factors

Instrument calibration adjustment factors were derived from the slope of the regression line comparing each instrument to the reference instrument. These factors represent the multiplicative adjustment required to align an instrument's readings with the reference instrument (i.e., PDR-1000) under theatrical fog and haze conditions. These are shown in **Table 5** below.

Table 5. Instrument calibration adjustment factors relative to reference instrument.

Instrument	Flow Rate (L/min)	Adjustment Factor (AF)	Upper Limit (mg/m³)
DustTrak DRX 8534	3.0 (total)	1.383	150
PDR-1500	2.0	0.560	1,000
SidePak AM520	1.7	0.846	100

In order to convert the calibration factor for the PDR-1000 to one of the other instruments, the PDR-1000 calibration factor should be multiplied by the appropriate adjustment factor. Appendix A contains a table with adjusted calibration factors for all four aerosol monitors.

The real-time aerosol monitor readings can be converted to glycol or mineral oil concentrations using the appropriate calibration factor for the fluid, as follows:

$$CONC = CF_{MON} \times MON$$

where:

$CONC$ = air concentration of total glycols, mineral oil, or glycerol, mg/m^3

CF_{MON} = aerosol monitor calibration factor (mg/m^3)/ (mg/m^3 aerosol) (see Appendix A)

= PDR-1000 calibration factor x adjustment factor

MON = aerosol monitor reading, mg/m^3 aerosol

3.3 Aerosol Monitor Calibration to Monitoring Instruments

Total glycol and mineral oil concentrations were calculated from the analytical data. To develop a calibration curve, the average aerosol monitor readings during the period of time in which air was drawn through the sampling media for each air sample were calculated and plotted against the total glycol and mineral oil concentration data.

The calibration curves for the equipment-fluid combination tested are shown in **Figure 10**.

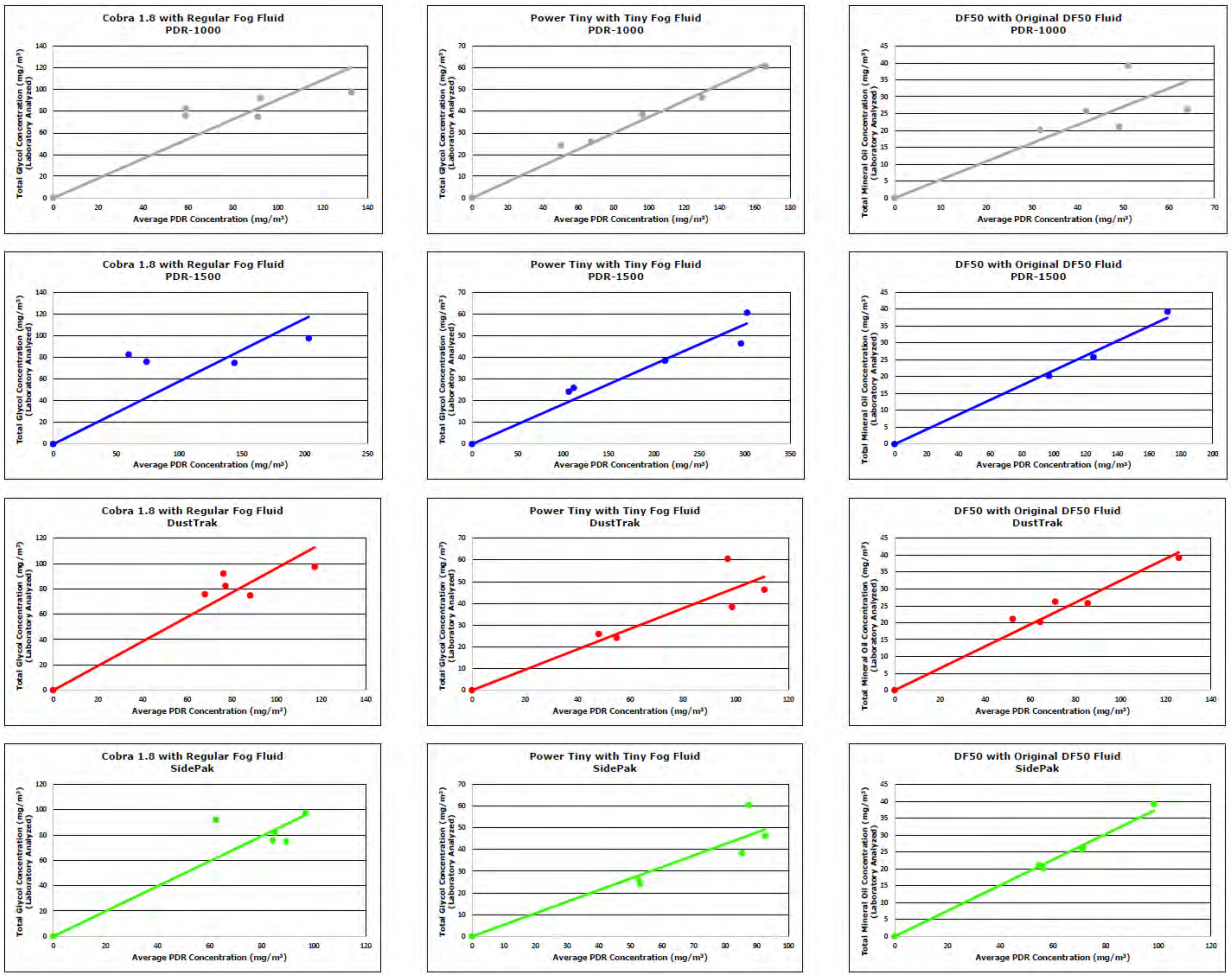

Figure 10. Summary of calibration curves for each monitoring instrument and fog machine / fluid combination.

A first order regression curves is also shown on this figure. The "measured" calibration factors, calculated from the slope of the regression, are summarized in **Table 6**. Also shown in **Table 6** in parentheses are the "calculated" calibration factors for the PDR-1500, DustTrak DRX 8534, and SidePak calculated using the PDR-1000 calibration factors multiplied by the appropriate adjustment factor. The agreement between the measured and calculated calibration factors is consistent with the variability seen in the data in **Figure 9**.

Table 6. Summary of calibration factors, measured (calculated with AF).

Machine Manufacturer	Machine	Fluid	PDR-1000	PDR-1500	Dust Trak DRX 8534	Side Pak AM520
Look Solutions	Cobra 1.8	Regular-fog fluid	0.91	0.58 (0.53)	0.96 (1.26)	0.99 (0.77)
Look Solutions	Tiny Fogger	Tiny-Fluid	0.37	0.18 (0.21)	0.47 (0.51)	0.53 (0.31)
Reel FX	DF 50	Original DF50 fluid	0.54	0.22 (0.30)	0.32 (0.75)	0.38 (0.46)

3.4 Variability and Limitations

Observed variability among instruments reflects differences in optical design, aerosol size sensitivity, and internal signal processing. While strong linear relationships were observed for most instrument pairs, occasional scatter was observed during analysis.

The results of this study are specific to theatrical fog and haze aerosols and may not be applicable to other aerosol types (e.g., dust or combustion particles). In addition, the instrument calibration factors developed herein are based on the machines and fluids evaluated and may evolve as new equipment becomes available.

4. CONCLUSIONS

4.1 Application of Results

AEA has previously published machine–fluid–specific calibration factors based on laboratory-referenced testing and controlled exposure studies. Those calibration factors were developed to directly relate aerosol monitor readings from the PDR-1000 to health-based exposure criteria and remain the authoritative basis for AEA guidance on acceptable fog and haze use during theatrical productions.

The instrument calibration adjustment factors developed in this study allow for the use of different instruments to test fog/haze levels as the PDR-1000 is phased out.

4.2 Conclusions

This study provides comparisons of three aerosol monitors, including the older PDR-1000 and three newer monitors, the PDR-1500, DustTrak DRX 8534, and SidePak AM520. Instrument adjustment factors were provided for each aerosol monitor, enabling users to select which monitor works best for them to use during fog and haze testing. While the instrument/fog machine/fluid combinations did not produce the exact same factors when compared to the adjustment values, this is expected due to the variability of these instruments and external factors such as temperature, humidity, positioning, wind/fans, etc.

The instrument adjustment factors presented herein provide a practical and transparent approach for normalizing real-time aerosol monitoring data when laboratory-based calibration is not feasible.

The findings support the continued use of portable aerosol monitors as a tool for managing performer exposure, provided that users understand instrument limitations and apply appropriate calibration adjustment factors in data interpretation.

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APPENDIX A
REVISED CALIBRATION FACTOR TABLE

Theatrical Fog and Haze Testing: Calibration Factors

Actor's Equity productions that use haze and/or fog effects are required to meet the following peak exposure guidelines:

Glycols: 40 mg/m^3	Mineral oil: 25 mg/m^3	Glycerol/glycerin: 50 mg/m^3

To ensure that peak exposure concentrations are below these guidelines, theatres may either (1) use the fog and haze machines in accordance with the Time and Distance (T&D) Guidelines developed by Ramboll or (2) conduct production-specific testing using calibrated aerosol monitors. A production that is able to block its scenes in accordance with the T&D guidelines would not be required to conduct production-specific testing.

Ramboll has developed a protocol for using several different aerosol monitors to measure concentrations of theatrical fog and haze during production-specific testing. The monitors report the results in terms of mass concentration (milligrams per cubic meter, or mg/m^3) with the assumption that the particles in the air are a fine dust. Because different types of particles have different light scattering properties, the readings from the monitor need to be adjusted (or calibrated) when measuring something other than dust (such as fog droplets). The user converts the aerosol readings to the correct mg/m^3 readings for the fog droplets by multiplying the aerosol readings by a calibration factor for the particular fog fluid/fog machine combination being used for the fog or haze effect, as follows:

$$CONC = CF_{MON} \times MON$$

where:

CONC = air concentration of total glycols, mineral oil, or glycerol, mg/m^3
CF_{MON} = aerosol monitor calibration factor (mg/m^3)/ (mg/m^3 aerosol)
MON = aerosol monitor reading, mg/m^3 aerosol

The following table lists calibration factors that have been developed and approved by Actors' Equity Association and the Broadway League for use in measuring theatrical fog and haze:

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Advanced Entertainment Systems (AES) / MT-Electronic	Vario 6	Cryo Fog Fluid	Glycol	0.86	0.48	1.19	0.73	(49)
Advanced Entertainment Systems (AES) / MT-Electronic	Vario 6	Cryo Fog Fluid	Glycol	1.40	0.78	1.94	1.18	(49)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Advanced Entertainment Systems (AES) / MT-Electronic	Vario 8	Cryo Fog Fluid	Glycol	0.66	0.37	0.91	0.56	(49)
Advanced Entertainment Systems (AES) / MT-Electronic	Vario 8	Cryo Fog Fluid	Glycol	0.70	0.39	0.97	0.59	(49)
American DJ (ADJ)	Fog Fury 3000	Froggy's Fog Backwood Bay	Glycol	0.39	0.22	0.54	0.33	(35)
American DJ (ADJ)	Fog Fury 3000	Froggy's Fog Bog Fog	Glycol	1.62	0.91	2.24	1.37	(35)
American DJ (ADJ)	Fog Fury 3000	Froggy's Fog Cryo Freeze	Glycol	0.64	0.36	0.89	0.54	(35)
American DJ (ADJ)	Fog Fury 3000	Froggy's Fog Quick Blast	Glycol	0.64	0.36	0.89	0.54	(35)
American DJ (ADJ)	Fog Fury 3000	Froggy's Fog Velocity	Glycol	0.64	0.36	0.89	0.54	(35)
American DJ (ADJ)	Fog Storm 1700 HD	Froggy's Fog Cryo Freeze	Glycol	2.67	1.50	3.69	2.26	(35)
American DJ (ADJ)	Fog Storm 1700 HD	Froggy's Fog Quick Blast	Glycol	2.67	1.50	3.69	2.26	(35)
American DJ (ADJ)	Fog Storm 1700 HD	Froggy's Fog Velocity	Glycol	2.67	1.50	3.69	2.26	(35)
Antari	1520 RGB Upshot	Froggy's Fog Quick Blast	Glycol	1.28	0.72	1.77	1.08	(35)
Antari	CH-1 Cinema Hazer	Antari CHL-2 Fluid	Mineral Oil	0.30	0.17	0.41	0.25	(66)
Antari	DNG-200 Low Fog	Antari FLC Fog Fluid	Glycol	3.40	1.90	4.70	2.88	(45)
Antari	DNG-200 Low Fog	Froggy's Fog Cryo Freeze	Glycol	4.99	2.79	6.90	4.22	(35)
Antari	DNG-250 Low Fogger	Antari FLL Low Fog Fluid	Glycol	3.89	2.18	5.38	3.29	(66)
Antari	F-1 Fazer	Antari FLG Fog Fluid	Glycol	0.68	0.38	0.94	0.58	(45)
Antari	F-4 Fazer	Antari FLG Fog Fluid	Glycol	1.06	0.59	1.47	0.90	(45)
Antari	F-5/F-5D Fazer	Froggy's Fog Faze Haze	Glycol	0.69	0.39	0.95	0.58	(35)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Antari	F-7 Smaze	Antari FLG Fog Fluid	Glycol	0.97	0.54	1.34	0.82	(45)
Antari	ICE	Froggy's Fog Cryo Freeze	Glycol	2.54	1.42	3.51	2.15	(35)
Antari	M-5	Froggy's Fog Amusement Park Fluid	Glycol	1.41	0.79	1.95	1.19	(35)
Antari	M-5	Froggy's Fog Backwood Bay	Glycol	1.41	0.79	1.95	1.19	(35)
Antari	M-5	Froggy's Fog Bog Fog	Glycol	1.03	0.58	1.42	0.87	(35)
Antari	M-5	Froggy's Fog Cryo Freeze	Glycol	1.74	0.97	2.41	1.47	(35)
Antari	M-5	Froggy's Fog Quick Blast	Glycol	1.74	0.97	2.41	1.47	(35)
Antari	M-5	Froggy's Fog Velocity	Glycol	1.74	0.97	2.41	1.47	(35)
Antari	M-8	Antari FLG Fog Fluid	Glycol	2.17	1.22	3.00	1.84	(45)
Antari	M-8	Froggy's Fog Amusement Park Fluid	Glycol	1.35	0.76	1.87	1.14	(35)
Antari	M-8	Froggy's Fog Backwood Bay	Glycol	1.35	0.76	1.87	1.14	(35)
Antari	M-8	Froggy's Fog Bog Fog	Glycol	1.29	0.72	1.78	1.09	(35)
Antari	M-8	Froggy's Fog Cryo Freeze	Glycol	2.65	1.48	3.66	2.24	(35)
Antari	M-8	Froggy's Fog Quick Blast	Glycol	2.65	1.48	3.66	2.24	(35)
Antari	M-8	Froggy's Fog Velocity	Glycol	2.65	1.48	3.66	2.24	(35)
Antari	M-10	Froggy's Fog Bog Fog	Glycol	2.62	1.47	3.62	2.22	(35)
Antari	M-10	Froggy's Fog Cryo Freeze	Glycol	2.46	1.38	3.40	2.08	(35)
Antari	M-10	Froggy's Fog Quick Blast	Glycol	2.46	1.38	3.40	2.08	(35)
Antari	M-10	Froggy's Fog Velocity	Glycol	2.46	1.38	3.40	2.08	(35)
Antari	W-515D	Antari FLG Fog Fluid	Glycol	1.12	0.63	1.55	0.95	(45)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Antari	W-715x Fog Jet	Antari FLC Fog Fluid	Glycol	1.58	0.88	2.19	1.34	(44,45)
Antari	X-515	Froggy's Fog Amusement Park Fluid	Glycol	1.07	0.60	1.48	0.91	(35)
Antari	X-515	Froggy's Fog Backwood Bay	Glycol	1.07	0.60	1.48	0.91	(35)
Antari	X-515	Froggy's Fog Bog Fog	Glycol	1.43	0.80	1.98	1.21	(35)
Antari	X-515	Froggy's Fog Cryo Freeze	Glycol	1.74	0.97	2.41	1.47	(35)
Antari	X-515	Froggy's Fog Quick Blast	Glycol	1.74	0.97	2.41	1.47	(35)
Antari	X-515	Froggy's Fog Velocity	Glycol	1.74	0.97	2.41	1.47	(35)
Antari	Z-350	Froggy's Fog Beam Splitter	Glycol	1.90	1.06	2.63	1.61	(35)
Antari	Z-380 Fazer	Antari FLG Fog Fluid	Glycol	0.49	0.27	0.68	0.41	(45)
Aspire	K4 Vape Pen**	Damokee E-Liquid Daily Dose Fluid	Glycol	0.10	0.06	0.14	0.08	(48,72)
Aspire	K4 Vape Pen**	American Patriot by Naked 100 E-Liquid	Glycol	0.02	0.01	0.03	0.02	(69,72)
Blue Haze Entertainment (BHE)	1550	Froggy's Fog Amusement Park Fluid	Glycol	1.07	0.60	1.48	0.91	(35)
Blue Haze Entertainment (BHE)	1550	Froggy's Fog Backwood Bay	Glycol	1.07	0.60	1.48	0.91	(35)
Blue Haze Entertainment (BHE)	1550	Froggy's Fog Bog Fog	Glycol	1.43	0.80	1.98	1.21	(35)
Blue Haze Entertainment (BHE)	1550	Froggy's Fog Cryo Freeze	Glycol	1.74	0.97	2.41	1.47	(35)
Blue Haze Entertainment (BHE)	1550	Froggy's Fog Quick Blast	Glycol	1.74	0.97	2.41	1.47	(35)
Blue Haze Entertainment (BHE)	1550	Froggy's Fog Velocity	Glycol	1.74	0.97	2.41	1.47	(35)
Chauvet	Amhaze ECO	Premium Haze Fluid	Glycol	0.17	0.10	0.24	0.14	(53)
Chauvet	Amhaze II	Froggy's Fog Faze Haze	Glycol	0.83	0.46	1.15	0.70	(35)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Chauvet	Amhaze Stadium	Grignard Pure	Glycol	0.16	0.09	0.22	0.14	(60)
Chauvet	Amhaze Stadium	Premium Haze Fluid	Glycol	0.33	0.18	0.46	0.28	(57)
Chauvet	Cloud 9	LLG Fog Fluid	Glycol & Glycerol	0.47	0.26	0.65	0.40	(57)
Chauvet	Geyser	Froggy's Fog Quick Blast	Glycol	1.62	0.91	2.24	1.37	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Amusement Park Fluid	Glycol	1.00	0.56	1.38	0.85	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Backwood Bay	Glycol	1.00	0.56	1.38	0.85	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Beam Splitter	Glycol	2.94	1.65	4.07	2.49	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Bog Fog	Glycol	1.07	0.60	1.48	0.91	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Cryo Freeze	Glycol	0.76	0.43	1.05	0.64	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Quick Blast	Glycol	0.76	0.43	1.05	0.64	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Techno	Glycol	2.94	1.65	4.07	2.49	(35)
Chauvet	Hurricane 1800 Flex	Froggy's Fog Velocity	Glycol	0.76	0.43	1.05	0.64	(35)
Chauvet	Hurricane 1800 Flex	Grignard Pure	Glycol	0.31	0.17	0.43	0.26	(60)
Chauvet	Hurricane Haze 1XD	Grignard Pure	Glycol	0.21	0.12	0.29	0.18	(60)
Chauvet	Vesuvio II	Ultratec Quick Dissipating Fluid	Glycol	1.20	0.67	1.66	1.02	(65)
CITC	AquaMax	Organic Haze Fluid	Glycerol	1.36	0.76	1.88	1.15	(33)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
CITC	Fantasy FX spray can	Fantasy FX Professional Haze	Mineral Oil	0.87	0.49	1.20	0.74	(20)
CITC	Fog Max	Natural Fogging Fluid	Glycol	0.66	0.37	0.91	0.56	(4)
CITC	HazeMax	Water Vapor Haze Fluid	Glycerol	1.87	1.05	2.59	1.58	(33)
CITC	Starhazer	High Performance Fluid	Mineral Oil	0.87	0.49	1.20	0.74	(4)
Concept Smoke Systems	ViCount	Smoke Oil 135	Mineral Oil	0.34	0.19	0.47	0.29	(75)
Concept Smoke Systems	ViCount	Smoke Fluid A	Glycerol	0.46	0.26	0.64	0.39	(75)
Elation	Magma Prime	AEF Fog Fluid	Glycol	0.43	0.24	0.59	0.36	(58)
ePuffer	D-1500/Robusto Electronic Cigar**	e-Liquid	Glycol	1.04	0.58	1.44	0.88	(30,42,72)
ePuffer	Snaps Rev4 E-Cigarette**	e-Liquid	Glycol	0.05	0.03	0.07	0.05	(63,72)
FireBase	SG-1300	Froggy's Fog Training Smoke FR-Fire Rescue Formula	Glycol	0.58	0.32	0.80	0.49	(35)
FireBase	SG-1300	Froggy's Fog Training Smoke Q-Quick Dissipating	Glycol	1.69	0.95	2.34	1.43	(35)
FireBase	SG-1300	Froggy's Fog Training Smoke XD-Extreme Density	Glycol	0.86	0.48	1.19	0.73	(35)
FireBase	SG-2600	Froggy's Fog Training Smoke FR-Fire Rescue Formula	Glycol	0.99	0.55	1.37	0.84	(35)
FireBase	SG-2600	Froggy's Fog Training Smoke XD-Extreme Density	Glycol	3.11	1.74	4.30	2.63	(35)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
FireBase	SG-M1500	Froggy's Fog Training Smoke FR-Fire Rescue Formula	Glycol	1.41	0.79	1.95	1.19	(35)
FireBase	SG-M1500	Froggy's Fog Training Smoke Q-Quick Dissipating	Glycol	1.74	0.97	2.41	1.47	(35)
FireBase	SG-M1500	Froggy's Fog Training Smoke XD-Extreme Density	Glycol	1.03	0.58	1.42	0.87	(35)
FireBase	SG-M1800	Froggy's Fog Training Smoke FR-Fire Rescue Formula	Glycol	1.35	0.76	1.87	1.14	(35)
FireBase	SG-M1800	Froggy's Fog Training Smoke Q-Quick Dissipating	Glycol	2.65	1.48	3.66	2.24	(35)
FireBase	SG-M1800	Froggy's Fog Training Smoke XD-Extreme Density	Glycol	1.29	0.72	1.78	1.09	(35)
FireBase	SG-M3000	Froggy's Fog Training Smoke Q-Quick Dissipating	Glycol	2.46	1.38	3.40	2.08	(35)
FireBase	SG-M3000	Froggy's Fog Training Smoke XD-Extreme Density	Glycol	2.62	1.47	3.62	2.22	(35)
Froggy's Fog	Poseidon	Froggy's Fog Aqua Fog Fluid/Long Distance Formula	Glycol	0.43	0.24	0.59	0.36	(54)
Froggy's Fog	Poseidon	Froggy's Fog Aqua Fog Fluid/Long Distance Formula	Glycol	0.55	0.31	0.76	0.47	(54)
Froggy's Fog	Poseidon	Froggy's Fog Aqua Fog Fluid/Short Distance Formula	Glycol	0.67	0.38	0.93	0.57	(54)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
hazebase	Base Classic	Froggy's Fog Amusement Park Fluid	Glycol	0.58	0.32	0.80	0.49	(35)
hazebase	Base Classic	Froggy's Fog Backwood Bay	Glycol	0.58	0.32	0.80	0.49	(35)
hazebase	Base Classic	Froggy's Fog Bog Fog	Glycol	0.86	0.48	1.19	0.73	(35)
hazebase	Base Classic	Froggy's Fog Cryo Freeze	Glycol	1.69	0.95	2.34	1.43	(35)
hazebase	Base Classic	Froggy's Fog Quick Blast	Glycol	1.69	0.95	2.34	1.43	(35)
hazebase	Base Classic	Froggy's Fog Velocity	Glycol	1.69	0.95	2.34	1.43	(35)
hazebase	Base Classic	Ultratec Molecular Fog Fluid	Glycol	2.15	1.20	2.97	1.82	(43)
hazebase	Base Hazer Pro	Base Hazer Liquid	Glycol	0.43	0.24	0.59	0.36	(35)
hazebase	Base Hazer Pro	Froggy's Fog Faze Haze	Glycol	0.76	0.43	1.05	0.64	(35)
hazebase	Base Highpower 220V	Froggy's Fog Backwood Bay	Glycol	0.99	0.55	1.37	0.84	(35)
hazebase	Base Highpower 220V	Froggy's Fog Bog Fog	Glycol	3.11	1.74	4.30	2.63	(35)
hazebase	Cube Hazer2	Base V Fluid	Glycerol	0.00	0.00	0.00	0.00	(67)
hazebase	FAB	Base V Fluid	Glycerol	0.00	0.00	0.00	0.00	(67)
High End Systems (ETC)	F-100	Atmosphere HQ Fluid	Glycol	1.21	0.68	1.67	1.02	(10)
High End Systems (ETC)	F-100	Atmosphere Cold Flow Formula	Glycol	2.41	1.35	3.33	2.04	(1)
High End Systems (ETC)	F-100	Atmosphere Stage Formula	Glycol	0.25	0.14	0.35	0.21	(1)
High End Systems (ETC)	FQ-100	Atmosphere HQ Fluid	Glycol	1.30	0.73	1.80	1.10	(26)
High End Systems (ETC)	FQ-100	Atmosphere Stage Formula	Glycol	0.96	0.54	1.33	0.81	(26)
High End Systems (ETC)	HQ100 Hazer	HQ100 Haze Fluid	Glycol	0.41	0.23	0.57	0.35	(56)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Kandypens	Rube Vape Pen**	Lava Flow by Naked 100 E-Liquid	Glycol	0.02	0.01	0.03	0.02	(61,72)
Le Maitre Ltd.	G300	Molecular Fog Fluid	Glycol	0.53	0.30	0.73	0.45	(4,24,25)
Le Maitre Ltd.	G300	Quick Dissipating	Glycol	2.65	1.48	3.66	2.24	(4,24,25)
Le Maitre Ltd.	G300	Regular Haze (C-Beam) Fluid	Glycerol	0.09	0.05	0.12	0.08	(10,24,25)
Le Maitre Ltd.	G300	Standard Smoke Fluid	Glycol	0.30	0.17	0.41	0.25	(4,9,24,25)
Le Maitre Ltd.	G300/LSG/ Freezefog Pro or equivalent chiller*	Molecular Fog Fluid	Glycol	4.95	2.77	6.85	4.19	(7,25,28)
Le Maitre Ltd.	G-Force, Gforce3	Molecular Fog Fluid	Glycol	0.53	0.30	0.73	0.45	(4,24,28,47)
Le Maitre Ltd.	G-Force, Gforce3	Quick Dissipating	Glycol	2.65	1.48	3.66	2.24	(4,24,28,47)
Le Maitre Ltd.	G-Force, Gforce3	Standard Smoke Fluid	Glycol	0.30	0.17	0.41	0.25	(4,9,24,25, 47)
Le Maitre Ltd.	G-Force/Gforce3/ LSG/Freezefog Pro or equivalent chiller*	Molecular Fog Fluid	Glycol	4.95	2.77	6.85	4.19	(7,25,28,47)
Le Maitre Ltd.	Mini Mist	Standard Smoke Fluid	Glycol	2.24	1.25	3.10	1.90	(10,25)
Le Maitre Ltd.	MVS	Froggy's Fog Neutronic Haze Fluid	Glycerol	0.35	0.20	0.48	0.30	(35)
Le Maitre Ltd.	Neutron XS	Froggy's Fog Neutronic Haze Fluid	Glycerol	0.09	0.05	0.12	0.08	(35)
Le Maitre Ltd.	Neutron XS	Neutron Haze Fluid	Glycerol	0.12	0.07	0.17	0.10	(2,25)
Le Maitre Ltd.	Opti Mist Ranger	Mini Mist Canister	Glycol	3.01	1.69	4.16	2.55	(1,25)
Look Solutions	Cobra (1.8, 3.1)	Quick-Fog Fluid	Glycol	1.51	0.85	2.09	1.28	(52,74)
Look Solutions	Cobra (1.8, 3.1)	Regular-Fog Fluid	Glycol	0.76	0.43	1.05	0.64	(52,74)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Look Solutions	Cobra (1.8, 3.1)	Slow-Fog Fluid	Glycol	1.10	0.62	1.52	0.93	(52,74)
Look Solutions	Cobra (1.8, 3.1) / CryoGate	Cryo-Fog Fluid	Glycol	3.93	2.20	5.44	3.32	(52,74)
Look Solutions	Cobra (1.8, 3.1) / LSG	Cryo-Fog Fluid	Glycol	1.72	0.96	2.38	1.46	(51,74)
Look Solutions	Cryo-Fog	Cryo-Fog Fluid	Glycol	0.91	0.51	1.26	0.77	(16,21)
Look Solutions	Orka	Regular-Fog Fluid	Glycol	0.23	0.13	0.32	0.19	(8)
Look Solutions	Power Tiny	Tiny Fluid	Glycol	0.49	0.27	0.68	0.41	(15)
Look Solutions	Tiny Compact/Tiny C07	Tiny Fluid	Glycol	0.76	0.43	1.05	0.64	(4,21)
Look Solutions	Tiny Fogger/Tiny F07	Tiny Fluid	Glycol	0.76	0.43	1.05	0.64	(4,21)
Look Solutions	Tiny FX/Tiny CX	Tiny Fluid	Glycol	0.71	0.40	0.98	0.60	(31,37)
Look Solutions	Tiny S	Tiny Fluid	Glycol	0.69	0.39	0.95	0.58	(31)
Look Solutions	Unique/Unique2 Hazer	Unique Fluid	Glycol	0.30	0.17	0.41	0.25	(4,12)
Look Solutions	Unique Hazer fitted with an accumulator box	Unique Fluid	Glycol	0.26	0.15	0.36	0.22	(46)
Look Solutions	Viper (NT, S, 2.6)	Quick-Fog Fluid	Glycol	2.02	1.13	2.79	1.71	(17,50)
Look Solutions	Viper (NT, S, 2.6)	Regular-Fog Fluid	Glycol	1.46	0.82	2.02	1.24	(4,12,50)
Look Solutions	Viper (NT, S, 2.6)	Slow-Fog Fluid	Glycol	0.90	0.50	1.24	0.76	(31,50)
Look Solutions	Viper / LSG MKII or equivalent chiller	Quick-Fog Fluid	Glycol	0.89	0.50	1.23	0.75	(32,50)
Martin Professional	Jem Compact Hazer Pro	JEM C-Plus Haze Fluid	Glycol	0.70	0.39	0.97	0.59	(38,55)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Martin Professional	Jem Glaciator	JEM Low-Fog Fluid	Glycol	3.41	1.91	4.72	2.88	(4,55)
Martin Professional	Jem Glaciator Dynamic	JEM Low-Fog Fluid, High Density	Glycol	1.80	1.01	2.49	1.52	(71)
Martin Professional	Jem Glaciator X-Stream	JEM Low-Fog Fluid, High Density	Glycol	3.23	1.81	4.47	2.73	(23,55)
Martin Professional	Jem Hazer Pro	JEM C-Plus Fluid	Glycol	0.88	0.49	1.22	0.74	(38,55)
Martin Professional	Jem Ready 365	JEM R365 Haze Fluid	Glycol & Glycerol	0.24	0.13	0.33	0.20	(38)
Martin Professional	Jem Roadie	JEM Pro-Fog Fluid	Glycol	0.62	0.35	0.86	0.52	(27,55)
Martin Professional	Jem ZR12-DMX	JEM Pro-Fog Fluid	Glycol	1.12	0.63	1.55	0.95	(4,55)
Martin Professional	Jem ZR24/7 Hazer	RUSH & THRILL Haze Fluid	Glycol	0.76	0.43	1.05	0.64	(5,41,55)
Martin Professional	Jem ZR33 Hi-Mass	Froggy's Fog Cryo Freeze	Glycol	2.20	1.23	3.04	1.86	(35)
Martin Professional	Jem ZR33 Hi-Mass	Froggy's Fog Quick Blast	Glycol	2.20	1.23	3.04	1.86	(35)
Martin Professional	Jem ZR33 Hi-Mass	Froggy's Fog Velocity	Glycol	2.20	1.23	3.04	1.86	(35)
Martin Professional	Jem ZR33 Hi-Mass	JEM Pro-Fog Fluid	Glycol	0.79	0.44	1.09	0.67	(23,55)
Martin Professional	Jem ZR33 Hi-Mass	JEM Pro-Fog Fluid, Extra Quick Dissipating	Glycol	2.31	1.29	3.19	1.95	(23,55)
Martin Professional	Jem ZR44	Froggy's Fog Backwood Bay	Glycol	0.77	0.43	1.06	0.65	(35)
Martin Professional	Jem ZR44	Froggy's Fog Bog Fog	Glycol	1.40	0.78	1.94	1.18	(35)
Martin Professional	Jem ZR44	Froggy's Fog Cryo Freeze	Glycol	0.95	0.53	1.31	0.80	(35)
Martin Professional	Jem ZR44	Froggy's Fog Quick Blast	Glycol	0.95	0.53	1.31	0.80	(35)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Martin Professional	Jem ZR44	Froggy's Fog Velocity	Glycol	0.95	0.53	1.31	0.80	(35)
Martin Professional	K-1	Froggy's Fog K-razy Haze	Glycol	0.49	0.27	0.68	0.41	(35)
Martin Professional	Magnum 2000	Froggy's Fog Backwood Bay	Glycol	0.93	0.52	1.29	0.79	(35)
Martin Professional	Magnum 2000	Froggy's Fog Bog Fog	Glycol	1.21	0.68	1.67	1.02	(35)
Martin Professional	Magnum 2000	Froggy's Fog Cryo Freeze	Glycol	1.01	0.57	1.40	0.85	(35)
Martin Professional	Magnum 2000	Froggy's Fog Quick Blast	Glycol	1.01	0.57	1.40	0.85	(35)
Martin Professional	Magnum 2000	Froggy's Fog Velocity	Glycol	1.01	0.57	1.40	0.85	(35)
Martin Professional	Magnum 2500Hz	RUSH & THRILL Haze Fluid	Glycol	0.28	0.16	0.39	0.24	(23,41,55)
MDG Fog Generators	Mini-Max	MDG Dense Fluid	Glycol	3.21	1.80	4.44	2.72	(1)
MDG Fog Generators	ATMe	MDG Neutral Fluid	Mineral Oil	0.78	0.44	1.08	0.66	(70)
MDG Fog Generators	Atmosphere APS	MDG Neutral Fluid	Mineral Oil	0.78	0.44	1.08	0.66	(1)
MDG Fog Generators	MAX 3000 APS	MDG Neutral Fluid	Mineral Oil	0.78	0.44	1.08	0.66	(1)
MDG Fog Generators	MDG MAX 3000 APS through accumulator box	MDG Neutral Fluid	Mineral Oil	0.27	0.15	0.37	0.23	(6)
New Rule FX	Electronic Actor Cigarette Prop**	Cartridge Fluid	Glycol	0.44	0.25	0.61	0.37	(36,72)
Practical Magic & Innovation Co., Ltd.	SmokeGENIE	Cloud Liquid	Glycol & Glycerol	0.09	0.05	0.12	0.08	(62)
Practical Magic & Innovation Co., Ltd.	SmokeNINJA	Cloud Liquid	Glycol & Glycerol	0.07	0.04	0.10	0.06	(73)
Pure Smoke	Electronic Cigarette**	Electronic Cigarette Flavors	Glycol	0.33	0.18	0.46	0.28	(29,72)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Reel EFX, Inc.	DF-50	Diffusion Fluid	Mineral Oil	0.78	0.44	1.08	0.66	(1)
Reel EFX, Inc.	DF-50	Froggy's Fog DaFiddy Oil-Based Haze	Mineral Oil	0.40	0.22	0.55	0.34	(35)
Reel EFX, Inc.	DF-50	Master Fog DEE-EFF-50	Mineral Oil	0.37	0.21	0.51	0.31	(40)
Robe	Fog 1550 FT	Froggy's Fog Amusement Park Fluid	Glycol	1.07	0.60	1.48	0.91	(35)
Robe	Fog 1550 FT	Froggy's Fog Backwood Bay	Glycol	1.07	0.60	1.48	0.91	(35)
Robe	Fog 1550 FT	Froggy's Fog Bog Fog	Glycol	1.43	0.80	1.98	1.21	(35)
Robe	Fog 1550 FT	Froggy's Fog Cryo Freeze	Glycol	1.74	0.97	2.41	1.47	(35)
Robe	Fog 1550 FT	Froggy's Fog Quick Blast	Glycol	1.74	0.97	2.41	1.47	(35)
Robe	Fog 1550 FT	Froggy's Fog Velocity	Glycol	1.74	0.97	2.41	1.47	(35)
Rosco Laboratories	1500 / 1600	Rosco Clear Fog Fluid	Glycol	1.82	1.02	2.52	1.54	(1)
Rosco Laboratories	1500 / 1600	Rosco Fog Fluid	Glycol	1.27	0.71	1.76	1.07	(1)
Rosco Laboratories	1500 / 1600	Rosco Light Fog Fluid	Glycol	1.38	0.77	1.91	1.17	(1)
Rosco Laboratories	1500 / 1600	Rosco Stage & Studio Fluid	Glycol	1.56	0.87	2.16	1.32	(1)
Rosco Laboratories	1750	Rosco Fog Fluid	Glycol	0.58	0.32	0.80	0.49	(19)
Rosco Laboratories	1750	Rosco Stage & Studio Fluid	Glycol	0.67	0.38	0.93	0.57	(19)
Rosco Laboratories	Alpha 900	Rosco Clear Fog Fluid	Glycol	1.82	1.02	2.52	1.54	(1)
Rosco Laboratories	Alpha 900	Rosco Fog Fluid	Glycol	1.27	0.71	1.76	1.07	(1)
Rosco Laboratories	Alpha 900	Rosco Light Fog Fluid	Glycol	1.38	0.77	1.91	1.17	(1)
Rosco Laboratories	Alpha 900	Rosco Stage & Studio Fluid	Glycol	1.56	0.87	2.16	1.32	(1)
Rosco Laboratories	Delta 3000	Rosco Clear Fog Fluid	Glycol	1.43	0.80	1.98	1.21	(4)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Rosco Laboratories	Delta 3000	Rosco Fog Fluid	Glycol	1.00	0.56	1.38	0.85	(4)
Rosco Laboratories	Delta 3000	Rosco Light Fog Fluid	Glycol	1.35	0.76	1.87	1.14	(4)
Rosco Laboratories	Delta 3000	Rosco Stage & Studio Fluid	Glycol	1.97	1.10	2.72	1.67	(4)
Rosco Laboratories	Delta Hazer	Rosco Delta Hazer Fluid	Glycol	0.71	0.40	0.98	0.60	(18)
Rosco Laboratories	Mini-V	Rosco Fog Fluid	Glycol	0.55	0.31	0.76	0.47	(34)
Rosco Laboratories	Mini-V	Rosco Stage & Studio Fluid	Glycol	0.85	0.48	1.18	0.72	(34)
Rosco Laboratories	PF-1000	Rosco Clear Fog Fluid	Glycol	1.82	1.02	2.52	1.54	(1)
Rosco Laboratories	PF-1000	Rosco Fog Fluid	Glycol	1.27	0.71	1.76	1.07	(1)
Rosco Laboratories	PF-1000	Rosco Light Fog Fluid	Glycol	1.38	0.77	1.91	1.17	(1)
Rosco Laboratories	PF-1000	Rosco Stage & Studio Fluid	Glycol	1.56	0.87	2.16	1.32	(1)
Rosco Laboratories	V-Hazer	Rosco V-Hazer Fluid	Glycol	0.68	0.38	0.94	0.58	(34)
Rosco Laboratories	Vapour	Rosco Fog Fluid	Glycol	0.44	0.25	0.61	0.37	(34)
Rosco Laboratories	Vapour	Rosco Stage & Studio Fluid	Glycol	0.85	0.48	1.18	0.72	(34)
Rosco Laboratories	Vapour Plus	Rosco Fog Fluid	Glycol	0.82	0.46	1.13	0.69	(34)
Rosco Laboratories	Vapour Plus	Rosco Stage & Studio Fluid	Glycol	0.78	0.44	1.08	0.66	(34)
SFX Design	Fog Master FM-1	Aquafog Fluid	Glycol	0.19	0.11	0.26	0.16	(3)
Smoke Factory	Captain D	Gotham Fog Fluid	Glycol	0.57	0.32	0.79	0.48	(64)
Smoke Factory	Tour Hazer	Gotham Haze Fluid	Glycol	0.30	0.17	0.41	0.25	(4)
Smoke Factory	Tour Hazer II	Gotham Haze Fluid	Glycol	0.43	0.24	0.59	0.36	(64)
Smoke In Style	Electronic Pipe Prop**	FeelLife E-Liquid	Glycol & Glycerol	0.42	0.24	0.58	0.36	(39,72)
Ultratec Special Effects	G100	Director's Choice	Glycol	4.17	2.34	5.77	3.53	(1,9,25)
Ultratec Special Effects	G100	Extra Quick Dissipating	Glycol	3.17	1.78	4.38	2.68	(1,25)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Ultratec Special Effects	G100	Quick Dissipating	Glycol	3.45	1.93	4.77	2.92	(1,25)
Ultratec Special Effects	G150	Director's Choice	Glycol	4.17	2.34	5.77	3.53	(1,9,25)
Ultratec Special Effects	G150	Extra Quick Dissipating	Glycol	3.17	1.78	4.38	2.68	(1,25)
Ultratec Special Effects	G150	Molecular Fog Fluid	Glycol	2.58	1.44	3.57	2.18	(1,25)
Ultratec Special Effects	G150	Pro Beam (Long Lasting)	Glycol	1.42	0.80	1.96	1.20	(4,25)
Ultratec Special Effects	G150	Quick Dissipating	Glycol	3.45	1.93	4.77	2.92	(1,25)
Ultratec Special Effects	G3000	Director's Choice	Glycol	0.30	0.17	0.41	0.25	(4,9,24,25)
Ultratec Special Effects	G3000	Molecular Fog Fluid	Glycol	0.53	0.30	0.73	0.45	(4,24,25)
Ultratec Special Effects	G3000	Pro Beam (Long Lasting)	Glycol	0.67	0.38	0.93	0.57	(4,24,25)
Ultratec Special Effects	G3000	Quick Dissipating	Glycol	2.65	1.48	3.66	2.24	(4,24,25)
Ultratec Special Effects	G3000	Regular Haze Fluid	Glycerol	0.09	0.05	0.12	0.08	(10,24,25)
Ultratec Special Effects	G3000	Froggy's Fog Amusement Park Fluid	Glycol	1.07	0.60	1.48	0.91	(25,35)
Ultratec Special Effects	G3000	Froggy's Fog Backwood Bay	Glycol	1.07	0.60	1.48	0.91	(25,35)
Ultratec Special Effects	G3000	Froggy's Fog Bog Fog	Glycol	0.88	0.49	1.22	0.74	(25,35)
Ultratec Special Effects	G3000	Froggy's Fog Cryo Freeze	Glycol	2.96	1.66	4.09	2.50	(25,35)
Ultratec Special Effects	G3000	Froggy's Fog Quick Blast	Glycol	2.96	1.66	4.09	2.50	(25,35)
Ultratec Special Effects	G3000	Froggy's Fog Velocity	Glycol	2.96	1.66	4.09	2.50	(25,35)
Ultratec Special Effects	G3000/LSG or equivalent chiller*	Molecular Fog Fluid	Glycol	4.95	2.77	6.85	4.19	(7,25)
Ultratec Special Effects	Handy Fogger	Director's Choice	Glycol	0.49	0.27	0.68	0.41	(59)
Ultratec Special Effects	Handy Fogger	Quick Dissipating	Glycol	1.60	0.90	2.21	1.35	(59)
Ultratec Special Effects	Handy Fogger	Pro Beam	Glycol	1.18	0.66	1.63	1.00	(59)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Ultratec Special Effects	Power Fog Industrial (PFI) or PFI 9D	Director's Choice	Glycol	0.99	0.55	1.37	0.84	(4,9,11,25)
Ultratec Special Effects	Power Fog Industrial (PFI) or PFI 9D	Molecular Fog Fluid	Glycol	2.77	1.55	3.83	2.34	(4,11,25)
Ultratec Special Effects	Power Fog Industrial (PFI) or PFI 9D	Pro Beam (Long Lasting)	Glycol	1.36	0.76	1.88	1.15	(4,11,25)
Ultratec Special Effects	Power Fog Industrial (PFI) or PFI 9D	Quick Dissipating	Glycol	1.37	0.77	1.89	1.16	(4,11,25)
Ultratec Special Effects	Power Fog Industrial 9D (PFI 9D) with LSG-MKII or equivalent chiller	Extra Quick Dissipating	Glycol	1.23	0.69	1.70	1.04	(22,25)
Ultratec Special Effects	Power Fog Industrial 9D (PFI 9D) with LSG-MKII or equivalent chiller	Molecular Fog Fluid	Glycol	0.75	0.42	1.04	0.63	(13,25)
Ultratec Special Effects	Power Fog Industrial 9D (PFI 9D) with LSG-MKII or equivalent chiller	Quick Dissipating	Glycol	0.21	0.12	0.29	0.18	(22,25)
Ultratec Special Effects	Radiance Hazer	Froggy's Fog Neutronic Haze Fluid	Glycerol	1.06	0.59	1.47	0.90	(25,35)
Ultratec Special Effects	Radiance Hazer	Neutron/Luminous 7 Haze Fluid	Glycerol	0.26	0.15	0.36	0.22	(14,25)
Ultratec Special Effects	Show Fogger Pro	Director's Choice	Glycol	0.44	0.25	0.61	0.37	(4,9,25)
Ultratec Special Effects	Show Fogger Pro	Pro Beam (Long Lasting)	Glycol	0.44	0.25	0.61	0.37	(4,25)

Approved Calibration Factors for Monitoring Theatrical Fog and Haze (Updated August 2026)								
Machine Manufacturer	**Machine**	**Fluid**	**Fluid Type**	**Calibration Factor**				**Reference**
				PDR-1000	**PDR-1500**	**Dust Trak DRX 8534**	**SidePak AM520**	
Ultratec Special Effects	Show Fogger Pro	Quick Dissipating	Glycol	2.56	1.43	3.54	2.17	(4,25)
Ultratec Special Effects	Stage Fogger DMX	Director's Choice	Glycol	0.99	0.55	1.37	0.84	(4,9,25)
Ultratec Special Effects	Stage Fogger DMX	Molecular Fog Fluid	Glycol	2.77	1.55	3.83	2.34	(4,25)
Ultratec Special Effects	Stage Fogger DMX	Pro Beam (Long Lasting)	Glycol	1.36	0.76	1.88	1.15	(4,25)
Ultratec Special Effects	Stage Fogger DMX	Quick Dissipating	Glycol	1.37	0.77	1.89	1.16	(4,25)
Vosentech	Microfogger 3 & 4 Pro	Fog Fluid	Glycol	0.10	0.06	0.14	0.08	(68)

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45. Environmental Testing of Theatrical Fog Equipment: Antari F-1 Fazer, F-4 Fazer, F-7 Smaze, X-380 Fazer, M-8, W-515D, W-715x Fog Jet, and DNG-200 Low Fog, prepared by Ramboll Environ, December 2017.
46. Development of Calibration Factor for Monitoring Theatrical Haze: Ghost The Musical, prepared by ENVIRON International Corporation for Aurora Productions, June 2012.
47. Letter from Le Maitre regarding Gforce3, August 2, 2017.
48. Environmental Testing of Theatrical Fog Equipment: Aspire K4 Vape Pen with Damokee E-Liquid Daily Dose Fluid, prepared by Ramboll, February 2019.
49. Environmental Testing of Theatrical Fog Equipment: Vario 8 and Vario 6 Fog machines with Cryo Fog Fluid, prepared by Ramboll, March 2019.
50. Letter from Look Solutions to Ramboll regarding Viper S and Viper 2.6, October 9, 2019.
51. Environmental Testing of Theatrical Fog Equipment: Cobra 1.8 with LSG Chiller, prepared by Ramboll, October 2019.
52. Environmental Testing of Theatrical Fog Equipment: Cobra 1.8, prepared by Ramboll, October 2019.
53. Environmental Testing of Theatrical Fog Equipment: Chauvet Amhaze ECO, prepared by Ramboll, October 2019.
54. Environmental Testing of Theatrical Fog Equipment: Poseidon, prepared by Ramboll, November 2019.
55. Effect Fluids Cross References. August 29, 2018. Available at https://adn.harmanpro.com/site_elements/resources/15128_1535576658/Martin%20Atmospheric%20Effects%20Fluids%20-%20Cross%20References%20-%20B_08-2018_original.pdf

56. Environmental Testing of Theatrical Fog Equipment: HQ100 Hazer, prepared by Ramboll, August 2020.
57. Environmental Testing of Theatrical Fog Equipment: Chauvet Amhaze Stadium Hazer and Cloud 9 Fogger, prepared by Ramboll, August 2020.
58. Environmental Testing of Theatrical Fog Equipment: Magma Prime Fogger, prepared by Ramboll, August 2020.
59. Environmental Testing of Theatrical Fog Equipment: Handy Fogger, prepared by Ramboll, October 2020.
60. Environmental Testing of Theatrical Fog Equipment: Amhaze Stadium Hazer, Hurricane 1800 Flex Fogger, and Hurricane Haze 1XD Hazer with Grignard Pure, prepared by Ramboll, October 2020.
61. Environmental Testing of Theatrical Fog Equipment: Kandypens Rubi Vape Pen with Lava Flow by Naked 100 E-Liquid, prepared by Ramboll, August 2022.
62. Environmental Testing of Theatrical Fog Equipment: SmokeGENIE with Cloud Fluid, prepared by Ramboll, October 2022 (revised April 2024).
63. Environmental Testing of Theatrical Fog Equipment: Puffer Snaps Rev4 E-Cigarette with E-Liquid, prepared by Ramboll, October 2022.
64. Environmental Testing of Theatrical Fog Equipment: Tour Hazer II with Gotham Haze Fluid and Captain D with Gotham Fog Fluid, prepared by Ramboll, March 2023.
65. Environmental Testing of Theatrical Fog Equipment: Chauvet Vesuvio II with Ultratec Quick Dissipating Fluid, prepared by Ramboll, April 2023.
66. Environmental Testing of Theatrical Fog Equipment: DNG-250 Low Fogger with FLL Low Fog Fluid and CH-1 Cinema Hazer with CHL-2 Fluid, prepared by Ramboll, April 2023.
67. Environmental Testing of Theatrical Fog Equipment: FAB and Cube Hazer2 with Base V Fluid, prepared by Ramboll, May 2023.
68. Environmental Testing of Theatrical Fog Equipment: Vosentech Microfogger 3 Pro, prepared by Ramboll, October 2021.
69. Environmental Testing of Theatrical Fog Equipment: Aspire K4 Vape Pen with American Patriots by Naked 100 E-Liquid, prepared by Ramboll, November 2021.
70. Letter from Ramboll to Actors' Equity Association regarding MDG ATMe, June 26, 2023.
71. Environmental Testing of Theatrical Fog Equipment: JEM Glaciator Dynamic with JEM Low Fog High Density Fluid, prepared by Ramboll, December 2023.
72. Memo from Ramboll to Actors' Equity Association regarding Time & Distance Guidelines for E-Cigarettes and Vape Pens, March 28, 2024.
73. Environmental Testing of Theatrical Fog Equipment: SmokeNINJA with Cloud Fluid, prepared by Ramboll, April 2024.
74. Letter from Look Solutions to Ramboll regarding Cobra foggers, April 15, 2024.
75. Environmental Testing of Theatrical Fog Equipment: ViCount Smoke Generator with Smoke Oil 135 and Smoke Fluid A Formula, prepared by Ramboll, August 2026.