

THEATRICAL SMOKE, FOG, AND HAZE TESTING

CALIBRATION FACTORS

ENVIRON has developed a protocol for using a MIE PDR-1000AN aerosol monitor to measure concentrations of theatrical smoke, fog, and haze. The monitor measures the light scattering produced by particles in the air, and reports the results in terms of mass concentration (milligrams per cubic meter, or mg/m³) 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 dust readings to the correct mg/m³ readings for the fog droplets by multiplying the dust readings by a *calibration factor* for the particular fog fluid/fog machine combination being used for the fog, smoke, or haze effect.

The following calibration factors have been developed and approved by Equity and the League for use in measuring theatrical smoke, fog, and haze:

Approved Calibration Factors for Monitoring Theatrical Smoke, Fog, and Haze (updated September 2009)					
Manufacturer	Machine	Fluid	Fluid Type	Calibration Factor	Ref
CITC	Fantasy FX spray can	Fantasy FX Professional Haze	mineral oil	0.87	(20)
	Fog Max	Natural Fogging Fluid	glycol	0.66	(4)
	Haze Max	Water Vapor Haze Fluid	glycerol	0.11	(4)
	Starhazer	High Performance Fluid	mineral oil	0.87	(4)
High End Systems	F-100	Atmosphere HQ Fluid	glycol	1.21	(10)
		Atmosphere Stage Formula	glycol	0.25	(1)
		Atmosphere Cold Flow Formula	glycol	2.41	(1)
Look Solutions / Theatre Effects	Cryo-Fog	Cryo-Fog Fluid	glycol	0.91	(16,21)
	Orka	Regular-Fog Fluid	glycol	0.23	(8)
	Power Tiny	Power Tiny Fluid	glycol	0.49	(15)
	Tiny Compact/Tiny C07	Tiny Fogger Fluid	glycol	0.76	(4,21)
	Tiny Fogger/Tiny F07	Tiny Fogger Fluid	glycol	0.76	(4,21)
	Unique/Unique2 Hazer	Unique Fluid	glycol	0.30	(4,12)
	Viper II (NT)	Regular-Fog Fluid	glycol	1.46	(4,12)
Quick-Fog Fluid		glycol	2.02	(17)	
Martin Professional	Jem Glaciator	Jem B2 Heavy Fog Fluid	glycol	3.41	(4)
	Jem Glaciator X-Stream	Jem C3 Heavy Fog Fluid	glycol	3.23	(23)
	Jem ZR12-DMX	Jem Pro-Smoke Super Fluid	glycol	1.12	(4)
	Jem ZR24/7 Hazer	Jem Pro-Haze Fluid	glycol	0.76	(5)
	Jem ZR33 Hi-Mass	Jem Pro-Smoke Super Fluid	glycol	0.79	(23)
		Jem ProSteam Simulation Fluid	glycol	2.31	(23)
	Magnum 2500Hz	Jem Pro-Haze Fluid	glycol	0.28	(23)

Approved Calibration Factors for Monitoring Theatrical Smoke, Fog, and Haze (updated September 2009)						
Manufacturer	Machine	Fluid	Fluid Type	Calibration Factor	Ref	
MDG Fog Generators	Mini-Max	MDG Dense Fluid	glycol	3.21	(1)	
	Atmosphere APS	MDG Neutral Fluid	mineral oil	0.78	(1)	
	MAX 3000 APS	MDG Neutral Fluid	mineral oil	0.78	(1)	
	MDG MAX 3000 APS through accumulator box	MDG Neutral Fluid	mineral oil	0.27	(6)	
Reel EFX, Inc.	DF-50	Diffusion Fluid	mineral oil	0.78	(1)	
Rosco Laboratories	1500 / 1600	Rosco Clear Fog Fluid	glycol	1.82	(1)	
		Rosco Fog Fluid	glycol	1.27	(1)	
		Rosco Light Fog Fluid	glycol	1.38	(1)	
		Rosco Stage & Studio Fluid	glycol	1.56	(1)	
	1750	Rosco Fog Fluid	glycol	0.58	(19)	
		Rosco Stage & Studio Fluid	glycol	0.67	(19)	
	Alpha 900	Rosco Clear Fog Fluid	glycol	1.82	(1)	
		Rosco Fog Fluid	glycol	1.27	(1)	
Rosco Laboratories (cont.)	Alpha 900 (cont.)	Rosco Light Fog Fluid	glycol	1.38	(1)	
		Rosco Stage & Studio Fluid	glycol	1.56	(1)	
	Delta 3000	Rosco Clear Fog Fluid	glycol	1.43	(4)	
		Rosco Fog Fluid	glycol	1.00	(4)	
		Rosco Light Fog Fluid	glycol	1.35	(4)	
		Rosco Stage & Studio Fluid	glycol	1.97	(4)	
	Delta Hazer	Rosco Delta Hazer Fluid	glycol	0.71	(18)	
	PF-1000	Rosco Clear Fog Fluid	glycol	1.82	(1)	
		Rosco Fog Fluid	glycol	1.27	(1)	
		Rosco Light Fog Fluid	glycol	1.38	(1)	
		Rosco Stage & Studio Fluid	glycol	1.56	(1)	
	SFX	Fog Master FM-1	Aqua fog Fluid	glycol	0.19	(3)
Smoke Factory	Tour Hazer	Tour Hazer Fog Fluid	glycol	0.30	(4)	
Ultratec Special Effects (formerly Le Maitre Special Effects)	G100	Directors Choice	glycol	4.17	(1,9,25)	
		Extra Quick Dissipating	glycol	3.17	(1,25)	
		Quick Dissipating	glycol	3.45	(1,25)	
		Regular Fog Fluid	glycol	4.17	(1,25)	
	G150	Directors Choice	glycol	4.17	(1,9,25)	
		Extra Quick Dissipating	glycol	3.17	(1,25)	
		Molecular Fog Fluid	glycol	2.58	(1,25)	
		Pro Beam (Long Lasting)	glycol	1.42	(4,25)	
		Quick Dissipating	glycol	3.45	(1,25)	
		Regular Fog Fluid	glycol	4.17	(1,25)	
	G300/G3000	Directors Choice	glycol	0.30	(4,9,24,25)	
		Molecular Fog Fluid	glycol	0.53	(4,24,25)	
		Pro Beam (Long Lasting)	glycol	0.67	(4,24,25)	
		Quick Dissipating	glycol	2.65	(4,24,25)	
		Regular Fog Fluid	glycol	0.30	(4,24,25)	
	G300/LSG or equivalent chiller	Regular Haze Fluid	glycerol	0.09	(10,24,25)	
		Molecular Fog Fluid	glycol	4.95*	(7,25)	
		Mini Mist	Regular Fog Fluid	glycol	2.24	(10,25)

Approved Calibration Factors for Monitoring Theatrical Smoke, Fog, and Haze (updated September 2009)						
Manufacturer	Machine	Fluid	Fluid Type	Calibration Factor	Ref	
Ultratec Special Effects (cont.)	Neutron XS	Luminous 7 Haze Fluid	glycerol	0.12	(2,25)	
	Opti Mist Ranger	Mini Mist Canister	glycol	3.01	(1,25)	
	Power Fog Industrial (PFI) or PFI 9D	Directors Choice		glycol	0.99	(4,9,11,25)
		Molecular Fog Fluid		glycol	2.77	(4,11,25)
		Pro Beam (Long Lasting)		glycol	1.36	(4,11,25)
		Quick Dissipating		glycol	1.37	(4,11,25)
		Regular Fog Fluid		glycol	0.99	(4,11,25)
	Power Fog Industrial 9D (PFI 9D) with LSG-MKII or equivalent chiller	Extra Quick Dissipating		glycol	1.23	(22,25)
		Molecular Fog Fluid		glycol	0.75	(13,25)
		Quick Dissipating		glycol	0.21	(22,25)
	Radiance Hazer	Luminous 7 Haze Fluid		glycerol	0.26	(14,25)
	Show Fogger Pro	Directors Choice		glycol	0.44	(4,9,25)
		Pro Beam (Long Lasting)		glycol	0.44	(4,25)
		Quick Dissipating		glycol	2.56	(4,25)
		Regular Fog Fluid		glycol	0.44	(4,25)
	Stage Fogger DMX	Directors Choice		glycol	0.99	(4,9,25)
		Molecular Fog Fluid		glycol	2.77	(4,25)
		Pro Beam (Long Lasting)		glycol	1.36	(4,25)
Quick Dissipating			glycol	1.37	(4,25)	
Regular Fog Fluid			glycol	0.99	(4,25)	

Notes:

* Due to monitor overloading during the calibration testing for the Ultratec (Le Maitre) G300/LSG-Molecular Fog Fluid combination, the resulting calibration factor of 4.95 is known to be overestimated. This value can be used as a conservative (i.e., health protective) screening value. If monitoring results using this calibration factor result in exposures exceeding the guidance levels, it is recommended that additional testing to refine this calibration factor be conducted.

References:

- (1) Equipment-Based Guidelines for the Use of Theatrical Smoke and Haze, prepared by ENVIRON International Corporation for the Equity-League Pension and Health Trust Funds, June 8, 2001.
- (2) Theatrical Haze and Fog Testing for Mamma Mia! Winter Garden Theatre, prepared by ENVIRON International Corporation for Mamma Mia! Broadway and Nina Lannan Associates, November 12, 2001.
- (3) Theatrical Smoke and Haze Testing for The Phantom of the Opera, Majestic Theatre, prepared by ENVIRON International Corporation for Alan Wasser Associates, July 2002.
- (4) Calibration Factors for Monitoring Theatrical Smoke and Haze, prepared by ENVIRON International Corporation for Entertainment Services and Technology Association, November 11, 2002.
- (5) Development of Calibration Factors for Monitoring Theatrical Smoke and Haze: Jem 24/7 Hazer with Pro-Haze Fluid, prepared by ENVIRON International Corporation for Martin Professional, August 2003.
- (6) Theatrical Smoke and Haze Testing, Wicked the Musical, Gershwin Theatre, prepared by ENVIRON International Corporation for Stone Productions, July 2004.
- (7) Theatrical Smoke Testing at Bombay Dreams, prepared by ENVIRON International Corporation for Bombay Dreams NY L.L.C., July 30, 2004.

Approved Calibration Factors for Monitoring Theatrical Smoke, Fog, and Haze (updated September 2009)					
Manufacturer	Machine	Fluid	Fluid Type	Calibration Factor	Ref
(8)				<u>Development of Calibration Factors for Monitoring Theatrical Smoke and Haze: Look Solutions Orka with Regular-Fog Fluid</u> , prepared by ENVIRON International Corporation for Look Solutions, April 1, 2005.	
(9)				Letter from Le Maitre Special Effects to ENVIRON International Corporation regarding name change of Regular Fog Fluid to Directors Choice, December 5, 2005.	
(10)				<u>Theatrical Smoke and Haze Testing for The Phantom of the Opera, Forrest Theatre</u> , prepared by ENVIRON International Corporation for Alan Wasser Associates, January 2003.	
(11)				Letter from Le Maitre Special Effects to ENVIRON International Corporation regarding Stage Fogger DMX, Power Fog Industrial, and Power Fog Industrial 9D, April 12, 2006.	
(12)				Letter from Look Solutions to ENVIRON International Corporation regarding Viper Fluid, Unique2 Hazer, and Viper II/NT, May 5, 2006.	
(13)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Le Maitre LSG-MKII with Power Fog Industrial 9D (PFi9D) Low Smoke Generator</u> , prepared by ENVIRON International Corporation for Le Maitre Special Effects, August 2006.	
(14)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Le Maitre Radiance Hazer</u> , prepared by ENVIRON International Corporation for Le Maitre Special Effects, August 2006.	
(15)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Look Solutions Power Tiny</u> , prepared by ENVIRON International Corporation for Look Solutions, August 2006.	
(16)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Look Solutions Low-Fogger</u> , prepared by ENVIRON International Corporation for Look Solutions, August 2006.	
(17)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Look Solutions Viper NT</u> , prepared by ENVIRON International Corporation for Look Solutions, August 2006.	
(18)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Rosco Delta Hazer</u> , prepared by ENVIRON International Corporation for Rosco Laboratories, August 2006.	
(19)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Rosco Model 1750</u> , prepared by ENVIRON International Corporation for Rosco Laboratories, August 2006.	
(20)				<u>Development of Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Fantasy FX Professional Haze</u> , prepared by ENVIRON International Corporation for Richard Frankel Productions Inc., December 14, 2006.	
(21)				Letter from Look Solutions to ENVIRON International Corporation regarding Tiny-Compact, Tiny F07, Tiny C07, and Cryo-Fog, January 24, 2007.	
(22)				<u>Development of Calibration Factors and Time-And-Distance Guidelines for Use of Theatrical Smoke Equipment: Le Maitre LSG-MKII with Power Fog Industrial 9D (PFi9D) Low Smoke Generator with Extra Quick Dissipating and Quick Dissipating Fluid</u> , prepared by ENVIRON International Corporation for 321 Management, February 2007.	

Approved Calibration Factors for Monitoring Theatrical Smoke, Fog, and Haze (updated September 2009)					
Manufacturer	Machine	Fluid	Fluid Type	Calibration Factor	Ref
(23) <u>Development of Calibration Factors for Monitoring Theatrical Fog: Jem ZR33 Hi-Mass with ProSmoke Super (ZR-mix) Fluid, Jem ZR33 Hi-Mass with ProSteam Simulation Fluid, Magnum 2500Hz with Pro Haze Fluid, Jem Glaciator X-Stream with C3 Fluid</u> , prepared by ENVIRON International Corporation for Martin Professional A./S, August 2008.					
(24) Letter from Le Maitre Special Effects to ENVIRON International Corporation regarding renaming of G300 to G3000, June 2, 2008.					
(25) Letter from Ultratec Special Effects Inc. to ENVIRON International Corporation regarding renaming of Le Maitre Special Effects Inc., to Ultratec Special Effects Inc, June 10, 2009.					

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