[Note -This is a reaffirmation ballot. No changes have been made to the current published document.]

NSF International Standard for Treatment Units — Ozone Generators

1 General

1.1 Purpose

The purpose of this standard is to provide a method to evaluate ozone generator production performance (i.e., ozone concentration and output rate) and to establish minimum requirements for ozone generator materials and design and construction. This standard specifies the minimum requirements for product literature and labeling information that a manufacturer shall supply to authorized representatives and owners.

1.2 Scope

The objective of this standard is to provide a method to determine ozone generator production performance for water applications. This standard covers ozone generators that produce up to 500 g/h (26.4 lbs/d) of ozone. Devices utilizing actual mixing of the gas produced with water to be treated shall be precluded from this standard.

This Standard does not cover evaluating the effectiveness of an ozone generator for the treatment for water; it also does not cover structural integrity for ozone systems.

1.3 Alternate material, design, and construction

While specific material, design, and construction may be stipulated in this standard, systems that incorporate alternate material, designs, and construction may be acceptable when it is verified that such systems meet the applicable requirements.

2 Normative references

The following documents contain provisions that by reference in this text constitute requirements of this standard. At the time of publication, the indicated editions were valid. All of the documents are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of these documents.

ASTM D4000, *Standard Classification System for Specifying Plastic Materials*[1]

EPA Requirements for Ozone, Reference: Page 27 of Ozone News, Volume 29,No. 5, October 2001[2]

[1] American Society for Testing Materials (ASTM) 100 Barr Harbor Drive, West Conshohocken, PA 19428

[2] International Ozone Association P. O. Box 28873, Scottsdale, AZ 85255 www.int-ozone-assoc.org

3 Definitions

3.1 concentration: The amount of ozone in the gas stream leaving the generator. Concentration can be reported in weight percent, g/m^3, volume percent, ppm by weight, ppm by volume, and the milligrams of ozone per liter of gas produced. Annex A gives conversion factors at one atmosphere standard pressure at 20 °C (68 °F). Under this standard, concentration will be reported by weight percent and g/m$^{3.}$

3.2 coolant flow rate: The flow rate of the coolant used to remove heat from the reaction chamber(s) of the ozone generator.

> NOTE – The critical factor for heat removal is the mass flow rate (kg/hr) of the coolant. The mass flow rate of the coolant is equal to the volumetric flow rate (m^3/hr, ft^3/hr) of the coolant times the density (Kg/m^3, lb/ft^3) of the coolant.
>
> For liquid cooled systems the density of the coolant (liquid) is virtually independent of temperature and pressure and can be specified as the volumetric flow rate of the cooling liquid (m^3/hr, ft^3/hr, gpm, Lpm.)
>
> For gas cooled systems the density (and therefore the mass flow rate) of the coolant gas is dependent on temperature and pressure. For this standard, the pressure and temperature ranges are small. The volumetric flow rate (m^3/hr, ft^3/hr, lpm, ft^3/min, CFM) of the coolant shall be specified. As a practical approximation of the mass flow rate.

3.3 dew point (dew-point temperature): The temperature to which air must be cooled to reach vapor saturation (assuming air pressure and moisture content are constant). For Corona Discharge ozone generation the minimum dew point is –60 ºC (–76 ºF).

3.4 feed gas: The gas (ambient air, dry air or oxygen) delivered to the inlet side of the ozone generator. The required quality and feed gas flow rate is determined by the manufacturer.

3.5 feed gas flow rate: The flow rate of the feed gas through the reaction chamber(s) of the ozone generator.

> NOTE – The critical factor for the reaction is the mass flow rate (kg/hr) of the feed gas. The mass flow rate is the volumetric flow rate (m^3/hr, ft^3/hr) of the feed gas times the density (kg/m^3, lb/ft^3) of the feed gas.
>
> The density of a gas is dependent on the temperature and pressure. Because of the continuous variability of the parameters affecting density and volumetric flow rate in a ozone generator, there is no practical method to determine the true mass flow rate of the feed gas. For this standard, due to the small range of pressure and temperature, the volumetric flow rate will be specified as an approximation of the mass flow rate.
>
> For pressurized systems, the manufacturer shall specify the volumetric flow rate and the gauge pressure of the feed gas at the inlet to the ozone generator.

3.6 generator cell pressure: The gauge pressure of the feed gas in the reaction chamber(s).

3.7 ozone generator: A device that when supplied with an oxygen containing gas and power, produces an ozone-containing gas. Said ozone generator includes any controls, transformers and frequency generators required to convert a standard electrical supply (as specified) to the electrical characteristics required to operate the generator cell properly.

3.8 **packaged ozone system**: An ozone generator packaged with a gas preparation system, typically on a single skid or otherwise a single unit.

3.9 **output rate:** The mass of ozone produced by an ozone generator in weight per unit time (g/hr, lb/hr). Output rate is the mass of ozone per volume of product gas (g/m^3, lb/ft^3) multiplied by the feed gas flow rate (m^3/hr, lpm, ft^3/hr, CFM).

3.10 **relative humidity:** The ratio, in percent, of the actual amount of water vapor in a body of air in relation to the maximum amount that the body can hold at a given temperature. Relative humidity varies with temperature for a given amount of water vapor.

3.11 **Short cycle or batch system:** Systems that are not designed to operate for more than 5 min at a time.

4 Materials

Materials in direct contact with ozone shall be resistant to degradation by ozone at the ozone concentration specified by the manufacturer.

4.1 Compatible materials for operation

Tables 4.1.1 and 4.1.2 provide examples of ozone-resistant materials that are commercially available. These materials are recommended for use with dry gas with a maximum temperature of 40 ºC (104 ºF) Alternate materials may be used for ozone generators if material compatibility is demonstrated. The material supplier shall provide documentation of compatibility.

NOTE – For use of alternate materials, at a minimum the supplier shall confirm compatibility with end use. Other materials may be used for construction of ozone generators if proper material compatibility is demonstrated. Acceptable documentation shall include component material manufacturer's compatability charts or written warranty statement.

4.1.1 Components and piping

NOTE – Abbreviations for components, piping, gaskets & seals are in accordance with ASTM D4000.

	Ozone <1.5% wt.	**Ozone 1.5 to 10% wt.**
glass	X	X
ceramics	X	X
PVC	X	NR
CPVC	X	NR
UPVC (unplasticized)	X	NR
aluminum	X	X (4% wt. maximum)
304L stainless steel	X	X
316L stainless steel	X	X
Inconel	X	X
Hastelloy-C	X	X
Titanium	X	X
Perfluoroalkoxy resin (PFA) such as Teflon®[1] or equivalent	X	X
Fluorinated Ethylene Propylene (FEP) such as Teflon®[1] or equivalent	X	X
Polytetrafluoroethylene (PTFE) such as Teflon® or equivalent	X	X
Ethylene Tetrafluoroethylene (ETFE) such as Tefzel®[1] or equivalent	X	X
Ethylene Chlorotrifluoroethylene (ECTFE) such as Halar®[2] or equivalent	X	X
Neoprene ® or equivalent	X	NR
Polyvinylidene Fluoride (PVDF) such as Kynar®[3] or equivalent	X	X
P-Chlorotrifluoroethylene P-CTFE such as Kel-F®[4] 2800 and Neoflon®[5] or equivalent	X	X

[1] Dupont
[2] Ausimont USA, Inc
[3] Elf Atochem North America
[4] 3M Company
[5] Daikin Industries

4.1.2 Gaskets and seals

	Ozone <1.5% wt.	**Ozone 1.5 to 10% wt.**
P-Chlorotrifluoroethylene (P-CTFE) such as Kel-F®[4] 3700 or equivalent	X	X
Perfluoroelastomer such as Kalrez®[1] or equivalent	X	X
Perfluorinated Copolymer such as Chem-Rez®[6] or equivalent	X	X
Gortex® or equivalent	X	X
PTFE tape	X	X
Chlorosulfonated polyethylene such as Hypalon®[1] or equivalent	X	NR
Vinylidene Fluoride such as Viton®[1] or equivalent	X	X (4% wt. maximum)
Polydimethyl Siloxane (Silicone)	X	X (4% wt. maximum)
Ethylene Propylene Diene Monomer (EPDM)	X	NR

%wt. = percent by weight

NR = not recommended

5 Design and construction

5.1 Hazards

Component parts shall be free of rough or sharp edges and surfaces and of other hazards that could cause injury to persons adjusting, servicing, or using the ozone generator.

5.2 Electrical safety and operation

Electrical controls and components of the generator shall comply with the requirements of the National Electrical Code, or an equivalent where appropriate.

5.3 Structural integrity

The ozone generator system shall be structurally sound. No air, ozone, or coolant leaks shall be detected during normal operation.

6 Ozone concentration, output rate, and testing standard and conditions

6.1 Performance claims

Ozone generator performance claims shall specify the output rate and the ozone concentration at the

[6] Green, Tweed and Company

temperature specified in 6.3.1 and the generator cell pressure specified by the manufacturer.

6.2 Analytical equipment / test setup

6.2.1 Test apparatus

All material in direct contact with the feed gas and ozone gas shall be impervious to moisture permeation and resistant to ozone degradation.

6.2.2 Analytical devices

All analytical devices shall be calibrated using accepted calibration procedures, such as those published by the International Ozone Association (IOA) for high-concentration ozone analyzers.

An ultraviolet (UV) absorption ozone concentration analyzer, as described in "Guideline for Measurement of Ozone Concentration in the Process Gas From an Ozone Generator," Ozone Science and Engineering 18(3): 209-229 (1996), shall be utilized.

6.2.3 Feed gas flow meters

Test apparatus flow meters shall be accurate within ± 5% at the measured flow rate. The measured feed gas flow rate shall be corrected to standard pressure and temperature (one Atm [14.7 psi] and 20 °C [68 °F]).

Gas flow correction factor is:

$Q_2 = Q_1 \times (P_2/P_1)^{1/2} \times T_2/T_1$

Where Q_1 = Observed flow meter reading (temperature and pressure calibrated at 1 Atm and 20 °C)
Q_2 = Actual feed gas flow corrected for temperature and pressure;
P_1 = Standard atmospheric pressure, 14.7 psi;
P_2 = Actual pressure, 14.7 + pressure in psi inside the flowmeter;
T_1 = Standard temperature, 293 °K (20 °C + 273 in degrees Kelvin); and
T_2 = Observed temperature in degree Kelvin (measured temperature in degrees Celsius + 273 °K)

Example – Measured feed gas flow test conditions are 10 scfh at 10 psig and 25 °C. Calculated actual gas flow is 10 cfh x $(24.7/14.7)^{1/2}$ x (298/293) = 13.18 scfh

6.2.4 Coolant flow meters

For liquid cooled ozone generators, the coolant flow rate shall be measured during the test. The flow meter(s) shall be accurate within ± 5% at the measured flow rate.

For gas-cooled ozone generators, the coolant flow rate shall be the volumetric flow rate of the system fans as provided by the manufacturer.

6.3 General test conditions and methods

6.3.1 Temperature conditions

ambient air temperature	22 ± 2 °C (72 ± 5 °F)
cooling water temperature	22 ± 2 °C (72 ± 5 °F)
cooling air temperature	22 ± 2 °C (72 ± 5 °F)

6.3.2 Gas preparation equipment

The feed gas for a packaged ozone generator shall be the output of the packaged gas preparation equipment. The feed gas dew point and oxygen concentration shall be measured and reported. The input gas to the gas preparation equipment shall be the ambient air at the laboratory.

6.3.2.1 Corona discharge ozone generators

The feed gas shall be 93 ± 2% oxygen by weight with a maximum dew point of -80 °C (-112 °F), or air with a dew point of -62 °C (-80 °F) or less.

> NOTE – Ambient oxygen concentration decreases as the elevation above sea level increases. The performance of an ozone generator that uses air as the feed gas will decrease with decreasing oxygen concentration in the feed gas. The manufacturer shall provide information about the performance of the ozone generator with feed gas oxygen concentrations different from test conditions in this Standard.

6.3.2.2 UV ozone generators

UV ozone generators shall be tested under ambient air conditions at the laboratory. All test conditions (including ambient temperature, relative humidity, and ambient oxygen concentration) shall be documented.

> NOTE **–** Ozone production from a UV ozone generators will change as operating conditions vary from test conditions. Ozone production will decrease with higher ambient temperature, higher relative humidity, and lower oxygen concentration.

6.4 Ozone production test

6.4.1 Purpose

This test is to verify the the ozone concentration and output rate of an ozone generator.

6.4.2 Apparatus

The test apparatus shall be set up according to figure A1. All components of the apparatus shall comply with 4.

6.4.3 Ozone production procedure

6.4.3.1 An ozone generator shall be set up and conditioned according to the manufacturers' specifications and in accordance with 6.3. Prior to testing in 6.4.3.1, the ozone generator shall be purged using the feed gas at the design flow rate for a minimum of 2 h, or as specified by the manufacturer, or until the specified dew point and oxygen concentration are achieved. The generator cell pressure range shall be measured and reported.

1) The generator cell pressure operation range shall be specified by the manufacturer. The generator cell pressure shall be reported.

2) The type and quality of feed gas source shall be in accordance with the manufacturers' specifications.

3) A minimum of two up to a maximum of ten feed gas flow rates shall be tested. Feed gas flow rate shall be set according to the manufacturers' instructions. The feed gas flow rate shall be recorded in volume per unit time.

NOTE – If the gas flow rate of the generator is not adjustable, the ozone generator may be tested at its specified gas flow rate.

4) For an ozone generator with a liquid coolant, the coolant specified by the manufacturer shall be used. The coolant flow rate shall be set in accordance with the manufacturers' instructions. The coolant flow rate shall be recorded.

The coolant flow rate for an air-cooled ozone generator shall not be measured, but proper operation of the fan shall be verified.

5) Generator power supply (voltage, frequency and maximum amperage) shall be set according to the manufacturers' instructions.

6) The ozone generator shall be operated for the time specified by the manufacturer or 2 h, whichever is greater, prior to measurements taken. The ozone concentration in the product gas shall be measured at one-minute intervals using an ozone gas analyzer meeting the requirements of 6.2.2 until the average percent difference in ozone concentration among three consecutive measurements is 3% or less (equilibrium). If equilibrium is not achieved within 10 min (11 measurements), the test shall be terminated.

7) The ozone concentration shall be recorded as the weight percent of ozone in the product gas.

8) The output rate shall be recorded.

9) Steps 1 through 9 shall be repeated for each feed gas flow rate. Data shall be collected for a minimum of 2 gas flow rates up to a maximum of 10. The time to reach equilibrium at each feed gas flow rate shall be reported.

Percent Equilibrium Attainment for each measurement = absolute value of $\{(a_i – b) / b\} \times 100 = E_i$,

Where:

i = number of measurements (3);

a_i = each of the final 3 measured concentrations, a_1, a_2 and a_3;

b = average of the final 3 measured concentrations = $(a_1 + a_2 + a_3)/ 3$; and

$\%E_{ave} = (E_1 + E_2 + E_3)/3$.

$\%E_{ave} \leq 3\%$ = Pass; and

$\%E_{ave} > 3\%$ = Fail.

NOTE – Repeat calculations for ozone production.

6.4.3.2 6.4.3.1 1-6 shall be repeated three times to determine reproducibility. The generators shall be turned off for 10 min between the three consecutive operation measurements. All test parameters of 6.4.3.1 shall be confirmed upon restart of the generator after the 10 min off period. The feed gas shall remain flowing during the 10 min off period. The ozone concentration and output rate for each test shall be within 5% of the average ozone concentration and output rate of the three tests. The test result shall be the average of the three runs.

6.4.4 Ozone production, concentration, and feed gas flow rate report

Performance data shall be expressed in graphic and/or table format relating stabilized ozone output and concentration to feed gas flow rate. All test conditions specified in 6.3 shall be reported. The maximum time from start up to ozone output equilibrium shall be reported. The first of the three samples that pass the requirement of 6.4.3.2 shall define the equilibrium time.

7 Instructions and information

All manufacturer specified test conditions shall be included in 7.1.

Ozone generator performance claims shall specify the ozone concentration and the output rate. Claims for ozone generator performance shall be based on the conditions as specified in 6.3. Manufacturers' published conditions shall be consistent with the test conditions.

7.1 Installation, operation, and maintenance instructions

The manufacturer shall provide complete instructions for startup and operation of each ozone generator tested under this Standard. The manufacturer shall provide written maintenance instructions to the user, or the manufacturer shall inform the user in writing where maintenance and repair services may be obtained when user maintenance is not recommended by the manufacturer.

The information provided by the manufacturer shall include:

- name and mailing address of the manufacturer. If no network of authorized representatives is available, the telephone number and facsimile number of the manufacturer shall be provided;

- statement noting the need for the system and installation to comply with federal, state and local laws and regulations;

- an exploded drawing and parts list for each ozone generator system;

- model number and/or trade designation;

- statement noting that the system conforms to NSF/ANSI 222 Ozone generators for the specific ozone production claims as verified and substantiated by test data;

- performance data expressed in graphic and/or table format relating ozone output and concentration to feed gas flow rate;

– statement for systems using a UV generator: "Ozone production from UV generators will decrease with higher ambient temperature, higher relative humidity and at higher elevations.";

– statement noting that the effectiveness of the ozone generator on the treatment of water has not been evaluated;

– test conditions including, but not limited to:

  – air temperature;
  – coolant temperature;
  – coolant flow rate;
  – feed gas temperature;
  – feed gas (ambient air, dry air, or oxygen);
  – feed gas dew point;
  – generator cell pressure;
  – power supply characteristics (frequency, voltage, and current); and
  – minimum time for system output stabilization (equilbrium).

– detailed installation instructions including an explanation or schematic diagram of recommended connections to plumbing system;

– electrical requirements, including frequency, voltage, and current;

– a description of any restriction or limitation to the use of the product; and

– "Ambient oxygen concentration decreases as the elevation above sea level increases. The performance of an ozone generator that uses air as the feed gas will decrease with decreasing oxygen concentration in the feed gas. Information about the performance of the ozone generator at higher elevations is available from the manufacturer."

7.2 Data plate

A permanent plate(s) or label(s) shall be affixed to the ozone generator in a conspicuous location and include the following:

– equipment name and primary functional description;

– model number and/or trade designation;

– serial number or manufacturing date code;

– name and mailing address of the manufacturer;

– power supply requirement (volts, amps, frequency, phase if not single phase);

– statement noting that the effectiveness of the ozone generator for the treatment of water has not been evaluated; and

– statement noting that the system conforms to NSF/ANSI 222 Ozone Generators for the specific ozone production claims as verified and substantiated by test data.

7.3 Performance data sheet

A performance data sheet shall be available to potential buyers for each ozone generator and shall include the following information:

– statement noting that the system conforms to NSF/ANSI 222 Ozone Generator Performance for the specific ozone production claims as verified and substantiated by test data;

– performance data in graphic or table format that relates ozone output and concentration to feed gas flow rate (see tables A3-A6 and figures A2-A3 for examples);

– statement noting that the effectiveness of the ozone generator for the treatment of water has not been evaluated;

– "The performance of an ozone generator will change as operating conditions vary from test conditions.";

– for UV ozone generators: "Ozone production from this generator will decrease at higher temperature, higher relative humidity, and higher elevations above sea level";

– test conditions including, but not limited to:

  – ambient air temperature during the test;
  – coolant temperature;
  – feed gas temperature;
  – feed gas (ambient air, dry air, or oxygen);
  – feed gas dew point;
  – generator cell pressure;
  – coolant flow rate;
  – line power supply voltage, current, and frequency; and
  – minimum time for system output stabilization (equilbrium).

– electrical requirements, including voltage, current, and frequency;

– general operation and maintenance requirements including, but not limited to:

  – user responsibility; and
  – parts and service availability.

– complete name, address, and telephone number of manufacturer; and

– "Ambient oxygen concentration decreases as the elevation above sea level increases. The performance of an ozone generator that uses air as the feed gas will decrease with decreasing oxygen concentration in the feed gas. Information about the performance of the ozone generator at higher elevations is available from the manufacturer."

Annex A

Conversion Factors for Ozone Concentrations 20 °C (68 °F)

And One Atmosphere (760 mm Hg) Pressure

Density of dry air at 20°C and 1 atmosphere = 1.205 g/L

Density of gaseous oxygen (O_2) at 20°C (68 °F) and 1 atmosphere = 1.330 g/L

Density of gaseous ozone (O_3) at 20°C (68 °F) = 2.078 g/L

One cubic foot = 28.32 L

Table A1 – Ozone in dry air

MG O_3/L of dry air and O_3 mixture	Weight % (mg O_3/100 mg of dry air and O_3 mixture)	Volume % (L O_3/100 L of dry air and O_3 mixture)	PPM by weight (mg O_3/1 million mg of dry air and O_3 mixture)	PPM by volume (L O_3/1 million L of dry air and O_3 mixture)
1.000	0.08296	0.04812	829.6	481.2
12.10	1.000	0.5823	10,000	5823
20.78	1.712	1.000	17,121	10,000
0.001210	0.0001000	0.00005823	1.000	0.5823
0.002078	0.0001712	0.0001000	1.7121	1.000

Table A2 – Ozone in oxygen

MG O_3/L of oxygen (O_2) and O_3 mixture	Weight % (mg O_3/100 mg of O_2 and O_3 mixture)	Volume % (L O_3/100 L of O_2 and O_3 mixture)	PPM by weight (mg O_3/1 million mg of O_2 and O_3 mixture)	PPM by volume (liters O_3/1 million L of O_2 and O_3 mixture)
1.000	0.07517	0.04812	751.7	481.2
13.35	1.000	0.6424	10,000	6424
20.78	1.554	1.000	15537	10,000
0.001335	0.0001000	0.00006424	1.000	0.6424
0.002078	0.0001554	0.0001000	1.554	1.000

Figure A 1

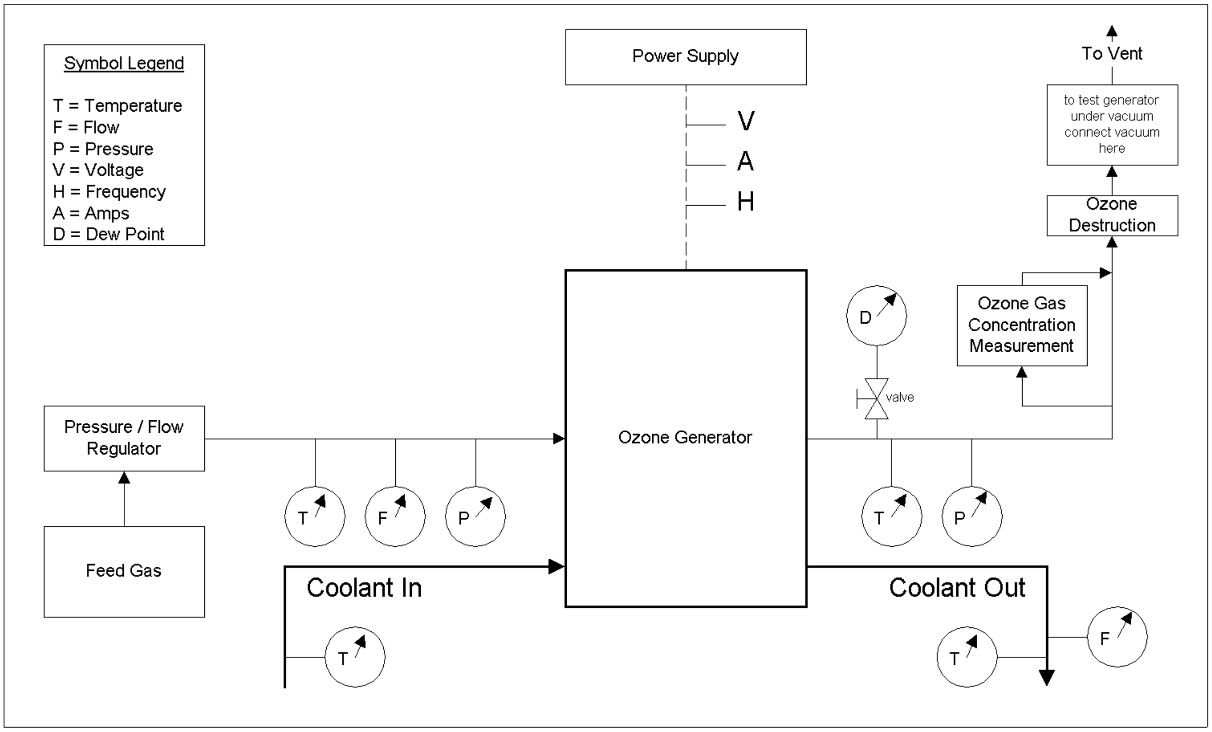
Symbol Legend
T = Temperature
F = Flow
P = Pressure
V = Voltage
H = Frequency
A = Amps
D = Dew Point
Power Supply
V
A
H
To Vent
to test generator under vacuum connect vacuum here
Ozone Destruction
Ozone Gas Concentration Measurement
D
valve
Pressure / Flow Regulator
Ozone Generator
Feed Gas
T
F
P
T
P
Coolant In
Coolant Out
T
T
F

Table A3 – Example format 1 for Performance Data Sheet

AK70 - Data Collection Sheet

TEST INFORMATION	
Company Name	Acme Ozone Company
Model Number:	AK70
Serial Number:	XYZ-123
Line Power Supply:	240 VAC 60HZ
Test Date	6/15/2000
Tested By	John Smith
Test date air temp	20 °C (68 °F)
Feed gas temp	20 °C (68 °F)
Test date air pressure	76.35 cm of mercury (30.06 in of mercury)
Feed Gas	PSA Oxygen Concentrator
Feed gas dew point	-73 °C (-100 °F)
Feed Gas Density (g/m^3)	1095.47
Cell Pressure	7.0 kPa (1.0 psi)
Mininum system stabillization time	20 min
Generator power supply set point	100%
Laboratory	Ozone Testing Inc
Analyzer:	In USA HC (factory calibrated on 2/18/99)
Notes	

Table A4 – Example format 2 for Performance Data Sheet

Data Points

Test Point	desired SCFH	meter SCFH (note 1)	G/NM$_3$	G/H	% by Weight	Feed Gas Temp	Cell Pressure PSIA	Ambient Temp	O_3 output level 1-100%
1	8	8.0	93.5	21.2	7.9%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
2	16	16.0	86.1	39.0	7.3%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
3	24	24.0	77.2	52.4	6.6%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
4	32	32.0	70.0	63.4	6.0%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
5	40	40.0	63.5	71.9	5.5%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
6	48	48.0	58.2	79.1	5.0%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
7	56	56.0	51.9	82.3	4.5%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
8	64	64.0	45.3	82.0	4.0%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
9	72	72.0	38.3	78.0	3.4%	20 °C (68 °F)	14.7	20 °C (68 °F)	100
10	80	80.0	32.7	74.0	2.9%	20 °C (68 °F)	14.7	20 °C (68 °F)	100

NOTES

1 SCFH corrected to meter outlet pressure
2 Meter outlet pressure is equal to cell pressure for this test
3 Enter in data for items highlighted in red

Table A5 – Example format 3 for Performance Data Sheet

Acme Ozone Company

Model Number: AK70, Serial Number: XYZ-123

Air Flow (SCFH)	Analyzer Reading (g/m^3)	Ozone Produced (g/h)	Percent O3 by Weight	Percent O2 in Feed Gas		Test Information
8	93.5	21.2	7.9%	95.0%	**Laboratory:**	Ozone Testing Inc
16	86.1	39.0	7.3%	95.0%	**Test performed by:**	J. Doe
24	77.2	52.4	6.6%	93.0%	**Analyzer:**	In USA HC (factory calibrated on 2/18/99)
32	70	63.4	6.0%	93.0%	**Test date:**	6/15/2000
40	63.5	71.9	5.5%	93.0%	**Test date air temp:**	20 °C (68 °F)
48	58.2	79.1	5.0%	93.0%	**Test date air pressure:**	76.35 cm of mercury (30.06" of mercury)
56	51.9	82.3	4.5%	93.0%	**Feed gas supplied by:**	PSA Oxygen Concentrator
64	45.3	82.0	4.0%	90.0%	**Feed gas temp:**	20 °C (68 °F)
72	38.3	78.0	3.4%	88.0%	**Feed gas dewpoint:**	-73 °C (-100 °F)
80	32.7	74.0	2.9%	85.0%	**Cell Pressure:**	7.0 kPa (1.0 psi)
					Line power supply:	240 VAC 60HZ
					Generator power supply set point:	100%
					Minimum system stabillization time:	20 min.

Figure A2 – Example graph 1 for Performance Data Sheet

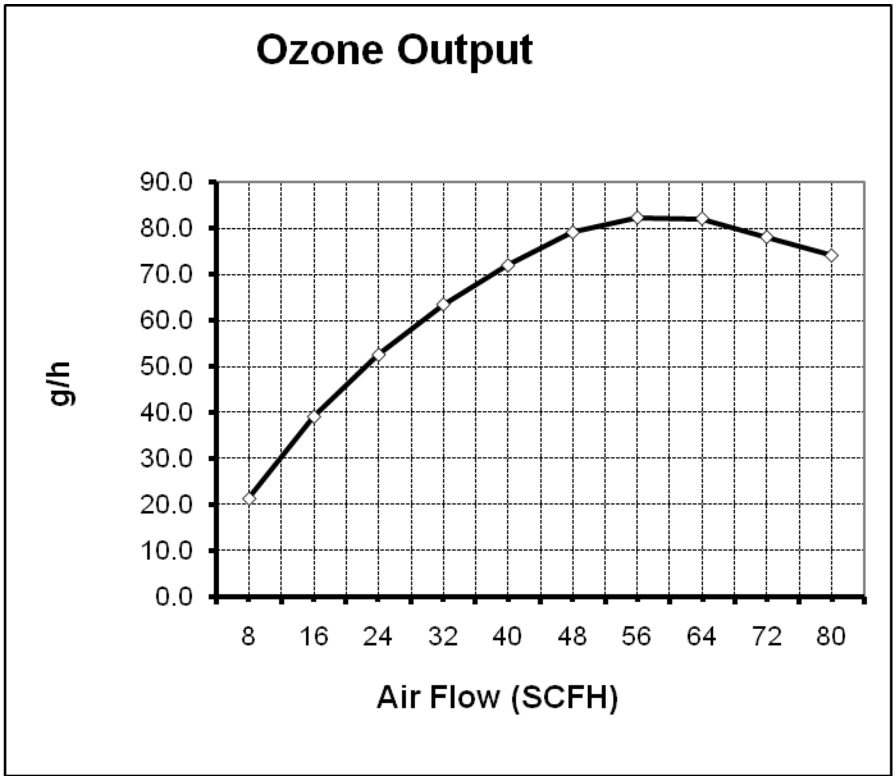

Figure A3 – Example graph 2 for Performance Data Sheet

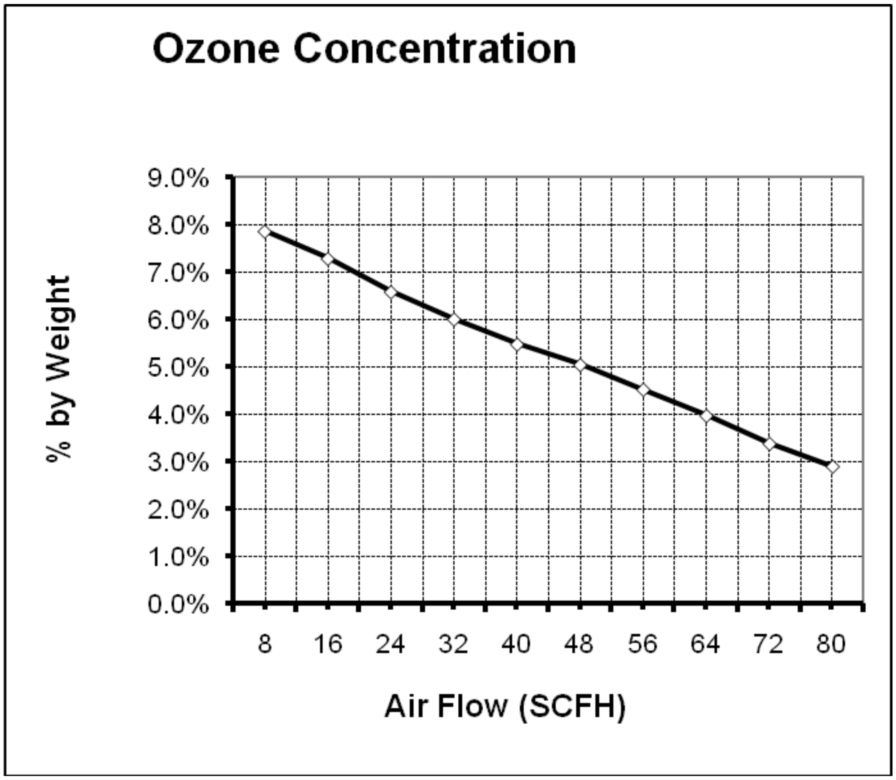

Table A6 – Example format 4 for Performance Data Sheet

This table contains constants that are used in formulas.	
Density of Air (g/m^3)	992.5
Density of O_2 (g/m^3)	1095.47
Density of O_3 (g/m^3)	1711.54
m^3 per ft^3	0.02831685
Atmospheric pressure PSIA	1489 kPa (14.7 PSIA)
Standard temperature °C (°F)	20 °C (68 °F)

NOTE – Density constants are referenced to 20 °C (68 °F) and 1489 kPa **(**14.7 PSIA)