Measured Air
PERFORMANCE

SmartStack™

Using Active Sensing to Safely Improve Lab Exhaust Efficiency

Rev 1.02

About This Document

This document describes many aspects of exhaust fan performance, especially as it relates to an exhaust system's ability to perform safely when handling a wide range of chemical compounds that may and sometimes will be released in lab spaces. Measured Air Performance (MAP) makes no representations or warranties of any kind with respect to the information in this publication. The information in the publication is provided "as is" and we do not guarantee the accuracy of this content. Although MAP believes the information in this publication is accurate as of its publishing date, the information is subject to change without notice. As applications of use will vary, the information provided is given without legal responsibility.

Introduction:

In most labs, there are typically only a few active fume hoods in the system emitting limited levels of contaminants. These contaminants are significantly diluted by the relatively clean air that is manifolded from other locations. Although, the laboratories operate in these relatively clean states for extended periods of time, the exhaust fan systems run at high exit velocities (e.g., 3,000 ft/min or higher). As a result, these systems frequently operate at much higher total flow rates than required using significantly more energy than necessary. Many assume that exhaust fans are required to operate at 3,000 ft/min (minimum). However, this setting is only a recommendation from ANSI Z9.5. The standard also states lower velocities can be used, provided there is sufficient dilution, as indicated below.

"*The exhaust stack velocity shall be at least 3,000 ft/min (15.2 m/s) is required unless it can be demonstrated that a specific design meets the dilution criteria necessary to reduce the concentration of hazardous materials in the exhaust to safe levels at all potential receptors.*"

SmartStack™ ensures dilution criteria are met and concentrations of hazardous materials are at safe levels, while maximizing energy savings. SmartStack™ is an active sensing system that monitors the cleanliness of lab exhaust air and indexes the exit velocity of the fans accordingly. The purpose of this system is to reduce excess bypass air at the exhaust fan when it is safe to do so; and this can reduce energy consumption, typically by a significant amount. Also, in many applications fan exit velocities may have initially been set to values much higher than 3000 ft/min. Sometimes this is the result of an undersized fan nozzle; in which case it may not be possible to reduce much below 3000 ft/min as bypass air is reduced. However, that's not viewed as a constraint to energy savings. The important thing is, by applying fan setback when the exhaust is clean, it provides a way to reduce excess bypass air.

The Inefficiency of Excess Fan Dilution:

Figure 1 helps to illustrate the common characteristics of high plume fan systems in terms of their tendency to provide dispersive dilution of contaminants with exit velocity. The actual dilution performance will vary considerably based on the vertical height of the fan and its surroundings. However, notice that the curve relating dilution levels to exit velocity is concave down. This means that, with an increase in CFM and exit velocity through the fan, you do not get a proportionally similar increase in dilution from the fan's exit plume. What this also means is that small reductions in fan exit velocity (when the exhaust is clean) will result in even smaller reductions in the overall dilution provided by the system. Further, fan affinity laws suggest a cubic relationship between flow and power. In most cases, because of system efficiency issues the power relationship is not quite cubic but is often still exponential nonetheless. Table 1 illustrates this further. In this example, a reduction in fan exit velocity by 31% (from 4400 fpm to 3000 fpm) results in an 8.4% reduction in dispersive dilution (from 483 to 442). However, the power savings in this example (assuming slightly less than cubic law performance) is approximately 62% (from 88 kW to 32.7kW).

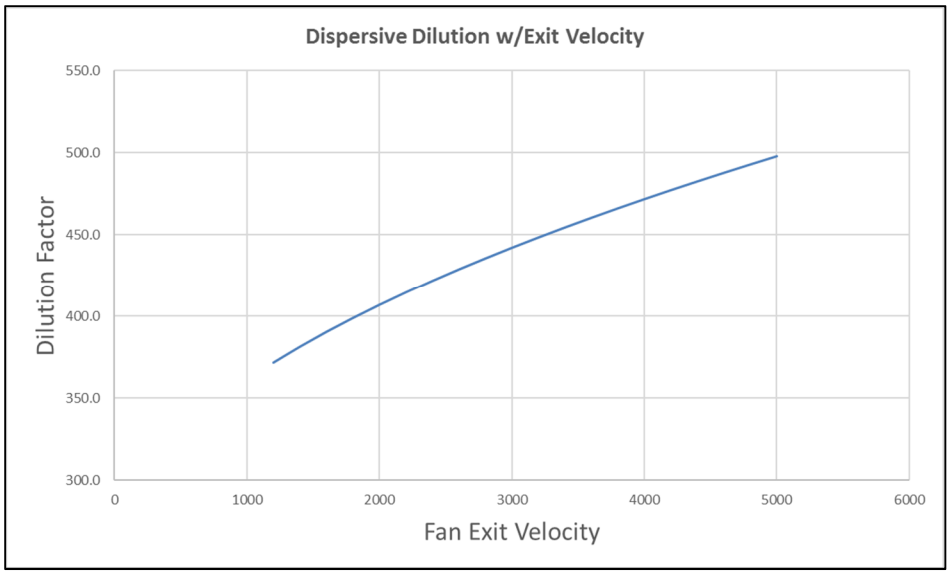

***Figure 1*: Example Relationship of Dilution with Exit Velocity**

Fan Power (KW)	Fan (CFM)	Exit Velocity (Ft/min)	Dispersive Dilution
88	55,000	4400	483
32.7	37,000	3000	442
19.4	30,000	2400	421

Table 1: Illustration of power savings with exit velocity

How it Works – SmartStack™ Applied to an Exhaust Fan System

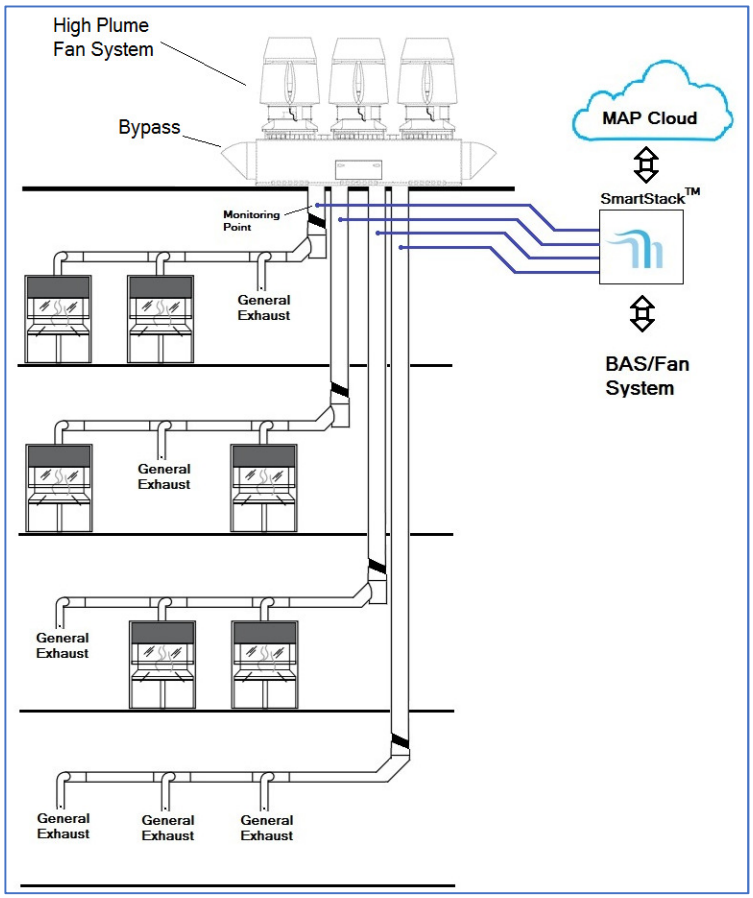

Figure 2: Multi-Riser Exhaust System

The SmartStack™ system incorporates a multi-point air sampling approach that monitors a location on each riser that is manifolded to the fan set. One SmartStack™ system is applied to each fan set and air samples are continuously drawn from each riser in a sequential fashion and analyzed by the system using a photoionization detector (PID) sensor technology that is integrated within the system. The PID is capable of detecting hundreds of compounds commonly found in laboratory facilities and is a technology that is recognized by health and safety professionals worldwide. Once all of the monitoring points have been verified to be free of contaminants, SmartStack™ then issues a "setback" command to the specific exhaust fan controls. In doing so, the fan system will reduce its exit velocity by way of a reduction in bypass air. Only the amount of bypass air is affected during this setback condition. As soon as contaminants are detected at any of the risers, the system will switch out of setback and into a mode that protects the PID ("sensor protective mode") that is intrinsic to the system. Approximately 20

minutes after the detection of contaminants, the system will resume taking air samples to see if the sampled locations still have high contaminant levels. If so, the system will go back into sensor protective mode with setback disabled. The process continues until the system is able to verify that all monitored locations are free of contaminants, before once again issuing a setback command.

SmartStack™ Photoionization Detector:

At the heart of SmartStack™ is our photoionization detector technology. A photoionization detector (PID) is a gas sensing technology capable of sensing hundreds of different compounds commonly found in lab environments. PID's have been in use (particularly as handheld instruments) for many decades and are especially recognized by Environmental Health and Safety (EH&S) professionals, due to their sensitivity. Such technology is also used in trace level sensing equipment, including gas chromatography-mass spectrometry due to their excellent sensing resolution. SmartStack™ incorporates a specialized PID design that provides low power performance, excellent stability, and the best sensitivity found in industry. This instrument provides detection capabilities of concentrations down to a few parts per billion (ppb). This is incorporated along with a patent pending mechanism that is used to protect the sensor from prolonged over-exposure, when high contaminant concentrations are detected and is an important enabling capability to this application. Without this capability, a PID would tend to foul and drift with prolonged exposure, thus affecting the detection reliability important to properly controlling the fan.

Figure 3 is a simplified illustration of the PID design. It incorporates an ultraviolet (UV) lamp as an ionization source and a collector electrode which serves as the detector. The air being analyzed flows through the sensor chamber and is exposed to the lamp. The sensor detects compounds based on the affinity for the gas to be ionized by the UV source. Ionization takes place when the compound's ionization potential is less than the energy level of the photons emitted from the lamp. Currently, our PID incorporates a lamp design which outputs an energy level of 10.7 electron volts (eV). This tends to be the most popular eV level used in

industry because lamps at this energy level (made from a krypton filament) tend to be highly reliable and a vast number of compounds will ionize at this level. The way that this works is that if the compound's ionization potential is lower than 10.7 eV, then it can be ionized and thus detected. For example, from the appendix below benzene has an ionization potential of 9.25 eV; therefore, it can be detected. Further, Chloroform has an ionization potential of 11.37 eV and therefore will not be detected. (See the section below explaining why some compounds such as Chloroform may not need to be detected in this application.) When a gas molecule becomes ionized, it becomes positively charged. This causes its charge to be drawn to the negative electrode causing an electrical current to flow. The level of molecular ionization and the current that is produced is proportional to the gas concentration that is present.

Another aspect of the PID's operation to be aware of is that different gases will generate different responses, even though their ionization potential may be less than 10.7 eV. This characteristic is known as a response factor or "RF". With the tables in the Appendix, a column is provided which lists the RF values for each compound. The RF value is an indication of the ratio of the sensor's sensitivity to a specific gas (isobutylene) to that of the given compound. For example, ammonia has a response factor of 9.4, which means that the sensor's response to ammonia is 9.4 times lower than its response to isobutylene. On the other hand, the sensor's RF for benzene is .5, which means that the PID is twice as sensitive to benzene as it is to isobutylene.

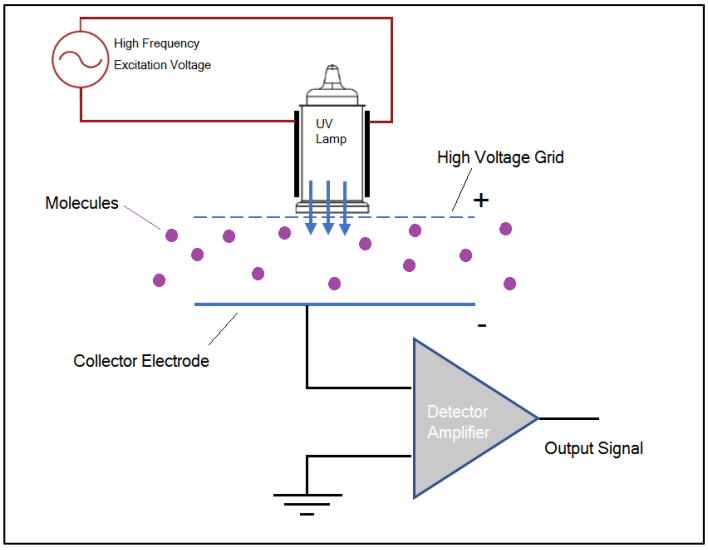

Figure 3: Simplified PID Schematic

Exhaust System Dilution with Chemical Inventory:

Usually, when a lab exhaust system is designed, much attention is given to the types of compounds that may be used in the lab spaces. Properties of the chemical inventory including not only exposure limits and odor thresholds but

also the ease with which a compound may become airborne is factored into this analysis. The performance that's needed from the system is then assessed by considering a spill condition (usually at a fume hood) for each compound in question. When evaluating exposure potentials from compounds that are liquids or solids, a fixed spill area is often applied. This usually will correlate to the area of a popular fume hood size (such as a 5-foot hood for example). Because of the fixed spill area, quantities of 1 liter are often assumed. Some compounds are too potent to be used in 1-liter quantities and will usually require a quantity limitation protocol that is independent of whether or not SmartStack™ is applied. For gas phase compounds, the analysis will usually assume a certain leakage or fugitive emissions rate from a canister.

Especially for liquids and certain solids, the vapor pressure of the compound will significantly influence the dispersion characteristics of the material in question, as well as the concentration of that material that might be seen at the exhaust fan inlet in the event of a spill. Even though SmartStack™ is capable of sensing hundreds of different compounds that may be found in a lab, it's important to realize that the dilution requirements of the exhaust fan system vary greatly due to the vapor pressure variations of the compounds. In the event of a spill, many compounds may not appear in high concentrations at the fan inlet. For example, sulfuric acid, a compound which is quite toxic to the touch, has a very low vapor pressure; so low that even a large spill in a fume hood would hardly influence airborne concentrations seen at the fan inlet.

Another factor which can significantly influence fan dilution requirements is the "internal dilution" provided by the manifolded exhaust from each lab space. The airflow from a single fume hood where a spill takes place will often be diluted by a factor of 40 or more by the clean air from other spaces.

The appendix includes a detailed list of over 350 compounds which are found in chemical inventories. This includes many compounds which are often used in labs along with a number of materials which have more specialized use, including some potent compounds which often require quantity limitation protocols. The list in the appendix not only demonstrates which compounds are detected by SmartStack™ but also models the result of a spill by each compound. For liquids and solids, the spill condition assumes a fume hood spill area of about 9ft2 and an

air flow rate of 900 CFM. It also assumes a very conservative figure for the internal dilution rate of the exhaust system by a factor of 15. For gas phase compounds, the spill condition assumes a fugitive emission at a rate of 4 liters per minute.

Although the majority of the compounds in this list are detected by the SmartStack™ system, some of these compounds need not be detected because of their relatively low impact on the dilution requirements to be provided by the fan system. This is measured in the "Fan Inlet Spill Concentration" column, which provides a measure of the dilution required of the fan. For example, a spill of Acetic Acid would result in concentrations that are only a factor of .3 of that compound's health limit and only a factor of 23.7 of that compound's odor threshold. So, in this case although the odor threshold at the fan's inlet will be exceeded by a factor of 23, the fan itself should be able to provide more than enough dilution to address those levels. It should be clear however that, in the application of SmartStack™ the fan would not be held in a setback condition as concentrations of this compound are detected.

There are also a few compounds in this list which are not detected by SmartStack™, most of which are compounds which would normally not need to be detected because of their low vapor pressures (sulfuric acid for example). However, there are also a smaller number of compounds which are not detected that would normally require a quantity limitation protocol (Boron Trifluoride, for example), due to their abnormally high toxicity, low odor threshold, and high vapor pressure.

Lastly, many EH&S personnel require that extremely toxic compounds be used only in designated fume hoods, with strict protocols. Irrespective of SmartStack™'s ability to detect these compounds, it can take an occupancy sensor signal from these fume hoods and disable the fan setback when anyone is working in or near these fume hoods. This feature could also apply to an occupancy signal detecting presence of anyone in the entire lab.

Noise Reduction

Fan noise can be an issue that requires mitigation, particularly when the fans are located near non-industrial locations such as neighborhoods, schools, or other locations where occupants may be less tolerant to noisy conditions. Noise levels are also of concern in many vivariums or animal holding facilities, for example. Mitigation may also be necessary to meet local code requirements.

Reducing fan exit velocity can drive not only dramatic energy savings, but can also result in reductions in noise levels that can often be significant. Figure 4 shows a typical scenario where there is approximately a 3:1 ratio of fan operating speed reduction to net sound pressure level reduction. Actual results will vary based on the fan geometry, its suroundings, and fan operating conditions, such as fan total static pressure.

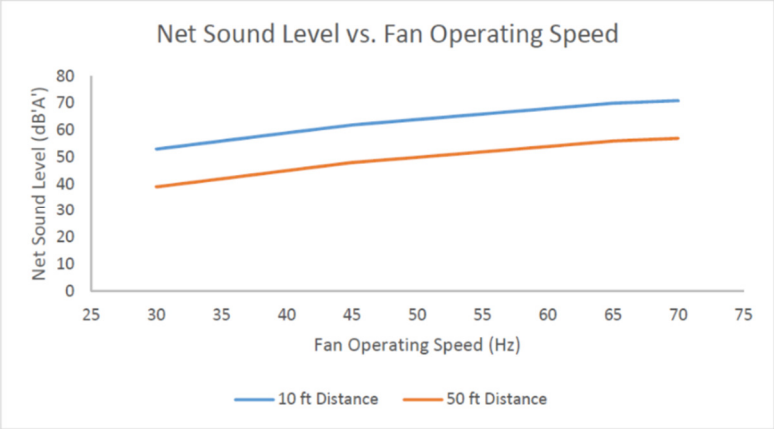

Figure 4: Net Sound Level vs. Fan Operating Speed. Chart Courtesy of Strobic Air Corporation

In certain cases, SmartStack™ may be the most effective noise abatement solution as compared to mechanical isolation, silencers, blade rebalancing, or the addition of expensive barriers or sound absorbing materials.

APPENDIX: **Exhaust System Performance and Spill Detection**

#	Compound	CAS Number	Liquid or Gas	RF	IP(eV)	Health Limits (PPM)	Odor Threshold (PPM)	OEL Type	OEL Agency	Detect?	Fan Inlet Spill Concentrations: Factor Above Health Limit	Fan Inlet Spill Concentrations: Factor Above Odor Threshold	Quantity Limitation For this Compound Recommended?
1	Acetaldehyde	75-07-0	Liquid	10.80	10.21	25.01	0.050	Ceil	ACGIH	YES	8.8	4419.5	YES
2	Acetic Acid	64-19-7	Liquid	11.00	10.69	15.05	0.160	STEL	ACGIH	YES	0.3	23.7	
3	Acetic Anhydride	108-24-7	Liquid	4.00	10	4.79		Ceil	NIOSH	YES	0.2	0.0	
4	Acetone	67-64-1	Liquid	1.20	9.69	749.91		STEL	ACGIH	YES	0.1	0.0	
5	Acetonitrile	75-05-8	Liquid	-	NA	60.68		TWA	ACGIH	NO	0.4	0.0	
6	Acetophenone	98-86-2	Liquid	0.59	9.27	29.95		TWA	ACGIH	YES	0.0	0.0	
7	Acetylene	74-86-2	Gas	-	-	None				NO	0.0	0.0	
8	Acrolein	107-02-8	Liquid	3.90	10.1	0.10	0.174	Ceil	ACGIH	YES	679.0	391.2	YES
9	Acrylic Acid	79-10-7	Liquid	2.70	10.6	6.01		TWA	ACGIH	YES	0.1	0.0	
10	Acrylonitrile	107-13-1	Liquid	-	-	2.00		TWA	ACGIH	NO	12.4	0.0	
11	Allyl Alcohol	107-18-6	Liquid	2.50	9.67	4.21		STEL	ACGIH	YES	1.2	0.0	
12	Allyl Chloride	107-05-1	Liquid	4.50	9.9	1.92	0.489	STEL	ACGIH	YES	0.1	0.4	
13	Ammonia	7664-41-7	Gas	9.40	10.2	35.00	5.000	STEL	ACGIH	YES	0.3	1.9	
14	Amyl Acetate (n-)	628-63-7	Liquid	3.50		99.90	0.100	STEL	ACGIH	YES	0.1	89.6	
15	Amyl Acetate (sec-)	626-38-0	Liquid	3.50		125.00	0.100	STEL	ACGIH	YES	0.0	20.9	
16	Amyl Alcohol	71-41-0	Liquid	3.20	10	1000.00				YES	0.0	0.0	
17	Aniline	62-53-3	Liquid	0.50	7.7	5.99		TWA	ACGIH	YES	0.0	0.0	
18	Anisole	100-66-3	Liquid	0.50	8.2	1000.000				YES	0.0	0.0	
19	Arsine	7784-42-1	Gas	2.60	9.89	0.01	0.500	Ceil	NIOSH	YES	1927.0	19.3	YES
20	Benzaldehyde	100-52-7	Liquid	0.90	9.5	1000.00				YES	0.0	0.0	
21	Benzene	71-43-2	Liquid	0.53	9.25	1.00	1.250	STEL	NIOSH	YES	28.4	22.8	
22	Benzenethiol	108-98-5	Liquid	0.70		1000.00				YES	0.0	0.0	
23	Benzonitrile	100-47-0	Liquid	0.70	9.6	1000.00				YES	0.0	0.0	
24	Benzyl Alcohol	100-51-6	Liquid	1.30		1000.00				YES	0.0	0.0	
25	Benzyl Chloride	100-44-7	Liquid	0.60	10.2	0.97		Ceil	NIOSH	YES	0.3	0.0	
26	Benzyl Formate	104-57-4	Liquid	0.80		1000.00				YES	0.0	0.0	
27	Biphenyl	92-52-4	Solid	0.40		0.60		TWA	NIOSH	YES	0.0	0.0	
28	Bis(2,3-epoxypropyl) ether	2238-07-5	Liquid	3.00		0.53		Ceil	OSHA	YES	0.1	0.0	
29	Boron Tribromide	10294-33-4	Liquid	1.30	9.7	1.00		REL	NIOSH	YES	12.0	0.0	
30	Boron Trifluoride	7637-07-2	Gas	-	15.56	0.10		TWA	ACGIH	NO	96.3	0.0	
31	Bromine	7726-95-6	Liquid	10.54	10.51	0.20	0.066	STEL	ACGIH	YES	265.9	801.4	YES
32	Bromine Pentafluoride	7789-30-2	Liquid	-		0.10		TWA	ACGIH	NO	979.4	0.0	YES
33	Bromobenzene	108-86-1	Liquid	0.70	9	1000.00		STEL	ACGIH	YES	0.0	0.0	
34	Bromoethane	74-96-4	Liquid	5.00		14.80		TWA	ACGIH	YES	7.6	0.0	
35	Bromoethyl methyl ether, 2-	6482-24-2	Liquid	2.50		1000.00		STEL	ACGIH	YES	0.0	0.0	
36	Bromoform	75-25-2	Liquid	2.30	10.48	1.45		TWA	ACGIH	YES	1.0	0.0	
37	Bromomethane	74-83-9	Gas	1.80	10.54	20.59		Ceil	ACGIH	YES	0.5	0.0	
38	Bromopropane, 1-	106-94-5	Liquid	1.30		29.82		TWA	ACGIH	YES	1.1	0.0	
39	Butadiene diepoxide, 1,3-	1464-53-5	Liquid	4.00		1000.00				YES	0.0	0.0	
40	Butadiene, 1,3-	106-99-0	Gas	0.69	9.07	4.97	0.455	STEL	OSHA	YES	1.9	21.2	
41	Butane, n-	106-97-8	Gas	46.30	10.5	2402.02		TWA	ACGIH	YES	0.0	0.0	
42	Butanol, 1-	71-36-3	Liquid	3.40	10.04	49.49		Ceil	NIOSH	YES	0.0	0.0	
43	Buten-3-ol, 1-	598-32-3	Liquid	1.20		1000.00				YES	0.0	0.0	
44	Butene,1-	106-98-9	Gas	1.30	9.5	750.50		TWA	ACGIH	YES	0.0	0.0	
45	Butoxyethanol, 2-	111-76-2	Liquid	1.30	10	14.90		TWA	NIOSH	YES	0.0	0.0	
46	Butyl Acetate	123-86-4	Liquid	2.40	10	199.89		STEL	ACGIH	YES	0.0	0.0	
47	Butyl Acrylate, n-	141-32-2	Liquid	1.50		6.94		TWA	ACGIH	YES	0.2	0.0	
48	Butyl Alcohol (n-)	71-36-3	Liquid	4.70	10.04	100.00		TWA	NIOSH	YES	0.0	0.0	
49	Butyl Alcohol (sec-)	78-92-2	Liquid	3.00	10.04	100.00		TWA	NIOSH	YES	0.0	0.0	
50	Butyl alcohol, tert-	75-65-0	Liquid	3.44	10.04	148.48		STEL	NIOSH	YES	0.1	0.0	
51	Butyl Lactate	138-22-7	Liquid	2.50		12.54		TWA	NIOSH	YES	0.0	0.0	
52	Butyl mercaptan, tert-	109-79-5	Liquid	0.55	9.15	0.49	0.010	Ceil	NIOSH	YES	189.7	9255.9	YES

	Compound	CAS Number	Liquid or Gas	RF	IP(eV)	Health Limits (PPM)	Odor Threshold (PPM)	OEL Type	OEL Agency	Detect?	Fan Inlet Spill Concentrations: Factor Above Health Limit	Fan Inlet Spill Concentrations: Factor Above Odor Threshold	Quantity Limitation For this Compound Recommended?
53	Butylamine, n-	109-73-9	Liquid	1.00	8.71	5.01	0.053	Ceil	OSHA	YES	4.9	462.3	
54	Butylamine, tert-	75-64-9	Liquid	0.71	8.7	1000.00				YES	0.1	0.0	
55	Carbon Disulfide	75-15-0	Liquid	1.20	10.07	9.64	0.096	STEL	NIOSH	YES	9.5	952.5	YES
56	Carbon tetrabromide	558-13-4	Solid	3.00		0.30		STEL	NIOSH	YES	39.8	0.0	
57	Carbon Tetrachloride	56-23-5	Liquid	-		10.00		STEL	ACGIH	NO	2.7	0.0	
58	Carvone, R-	6485-40-1	Liquid	1.00		1000.00				YES	0.0	0.0	
59	Chlorine	7782-50-5	Gas	-	11.48	0.50		Ceil	ACGIH	NO	19.3	0.0	
60	Chlorine Dioxide	10049-04-4	Gas	1.00	10.36	0.30		STEL	ACGIH	YES	32.0	0.0	
61	Chloro-1,3-butadiene, 2-	126-99-8	Liquid	3.20	8.8	0.99		Ceil	NIOSH	YES	52.3	0.0	
62	Chlorobenzene	108-90-7	Liquid	0.40	9.07	29.97		TWA	ACGIH	YES	0.1	0.0	
63	Chloroethanol, 2-	107-07-3	Liquid	10.00	10.5	0.91		Ceil	NIOSH	YES	1.6	0.0	
64	Chloroform	67-66-3	Liquid	-	11.37	10.00		TWA	ACGIH	NO	5.8	0.0	
65	Chloromethyl Ether (bis-)	542-88-1	Liquid	-		0.001		TWA	ACGIH	NO	8964.6	0.0	YES
66	Chloropicrin	76-06-2	Liquid	400.00		0.10		TWA	ACGIH	YES	53.8	0.0	
67	Chloroprene (Beta-)	126-99-8	Liquid	1.30	8.79	10.00		TWA	ACGIH	YES	5.6	0.0	
68	Chlorotoluene, o-	95-49-8	Liquid	0.50	8.8	72.19		STEL	OSHA	YES	0.0	0.0	
69	Chlorotoluene, p-	108-41-8	Liquid	0.50	8.7	1000.00		STEL	OSHA	YES	0.0	0.0	
70	Chlorotrifluoroethylene	79-38-9	Gas	1.00	9.81	29.00		AEG	EPA	YES	0.3	0.0	
71	Citral	5392-40-5	Liquid	1.70		1000.00				YES	0.0	0.0	
72	Citronellol	26489-01-0	Liquid	1.00	8.5	1000.00				YES	0.0	0.0	
73	Cresol, m-	108-39-4	Solid	1.10	8.14	2.30		TWA	NIOSH	YES	0.0	0.0	
74	Cresol, o-	95-48-7	Solid	1.10	8.14	2.30		TWA	NIOSH	YES	0.0	0.0	
75	Cresol, p-	106-44-5	Solid	1.10	8.14	2.30		TWA	NIOSH	YES	0.0	0.0	
76	Crotonaldehyde	4170-30-3	Liquid	1.00	9.7	2.00		Ceil	ACGIH	YES	2.8	0.0	
77	Cumene (Isopropyl Benzene)	98-82-8	Liquid	0.54	8.75	149.51	0.100	TWA	OSHA	YES	0.0	23.9	
78	Cyanogen	460-19-5	Gas	-		10.00				NO	1.0	0.0	
79	Cyclohexane	110-82-7	Liquid	1.50	9.8	300.00		TWA	ACGIH	YES	0.1	0.0	
80	Cyclohexanol	108-93-0	Liquid	1.60	10	50.00		TWA	ACGIH	YES	0.0	0.0	
81	Cyclohexanone	108-94-1	Liquid	0.82	9.14	25.00		TWA	ACGIH	YES	0.1	0.0	
82	Cyclohexene	110-83-8	Liquid	0.80	8.9	300.00		TWA	ACGIH	YES	0.1	0.0	
83	Cyclohexylamine	108-91-8	Liquid	1.00	8.6	10.00		TWA	NIOSH	YES	0.3	0.0	
84	Cyclopentane	287-92-3	Liquid	4.00	10.5	600.00		TWA	ACGIH	YES	0.2	0.0	
85	Decane	124-18-5	Liquid	1.60	9.6	500.00		TWA	NIOSH	YES	0.0	0.0	
86	Dibenzoyl peroxide	94-36-0	Solid	0.80		1.50		TWA	NIOSH	YES	0.1	0.0	
87	Dibromochloromethane	124-48-1	Liquid	10.00		1000.00				YES	0.0	0.0	
88	Dibromoethane, 1,2-	106-93-4	Liquid	2.00	9.45	0.13		Ceil	NIOSH	YES	27.5	0.0	
89	Dibutyl hydrogen phosphate	107-66-4	Liquid	4.00		1.16		STEL	ACGIH	YES	0.3	0.0	
90	Dichloro-1-propene, 2,3-	78-88-6	Liquid	1.40		1000.00				YES	0.0	0.0	
91	Dichloroacetylene	7572-29-4	Liquid	5.00		0.10		Ceil	ACGIH	YES	362.8	0.0	
92	Dichlorobenzene, 1,2-	95-50-1	Liquid	0.50	9.06	49.90		Ceil	OSHA	YES	0.0	0.0	
93	Dichloroethene, cis-1,2-	156-59-2	Liquid	0.80	9.7	597.39		TWA	OSHA	YES	0.0	0.0	
94	Dichloroethylene, trans-1,2-	156-60-5	Liquid	0.45	9.7	597.39		TWA	OSHA	YES	0.0	0.0	
95	Dichloroethylene, 1,2-	540-59-0	Liquid	0.70	9.7	597.39		TWA	OSHA	YES	0.1	0.0	
96	Dicyclopentadiene	77-73-6	Solid	0.90		5.00		TWA	NIOSH	YES	0.1	0.0	
97	Diesel fuel #1	68334-30-5	Liquid	0.90	<10.6	45.00		TWA	ACGIH	YES	0.0	0.0	
98	Diesel fuel #2	68334-30-5	Liquid	0.75	<10.6	45.00		TWA	ACGIH	YES	0.0	0.0	
99	Diethyl maleate	141-05-9	Liquid	2.00		1000.00				YES	0.0	0.0	
100	Diethyl phthalate	84-66-2	Liquid	1.00		1.65		TWA	ACGIH	YES	0.0	0.0	
101	Diethyl sulphate	64-67-5	Liquid	3.00		1000.00				YES	0.0	0.0	

	Compound	CAS Number	Liquid or Gas	RF	IP(eV)	Health Limits (PPM)	Odor Threshold (PPM)	OEL Type	OEL Agency	Detect?	Fan Inlet Spill Concentrations: Factor Above Health Limit	Fan Inlet Spill Concentrations: Factor Above Odor Threshold	Quantity Limitation For this Compound Recommended?
102	Diethyl sulphide	352-93-2	Liquid	0.60		1000.00				YES	0.0	0.0	
103	Diethylamine	109-89-7	Liquid	1.00	8.01	10.00	0.140	STEL	ACGIH	YES	5.7	409.8	
104	Diethylaminoethanol, 2-	100-37-8	Liquid	2.70		10.00		TWA	NIOSH	YES	0.0	0.0	
105	Diethylaminopropylamine, 3-	104-78-9	Liquid	1.00		1000.00				YES	0.0	0.0	
106	Dihydrogen Selenide	7783-07-5	Gas	1.00		0.14	0.300	TWA	ACGIH	YES	66.5	32.1	
107	Dihydroxybenzene, 1,2-	120-80-9	Solid	1.00		5.00		TWA	NIOSH	YES	0.6	0.0	
108	Dihydroxybenzene, 1,3-	108-46-3	Solid	1.00		10.00		STEL	NIOSH	YES	0.0	0.0	
109	Diisobutylene	107-39-1	Liquid	0.60		1000.00				YES	0.0	0.0	
110	Diisopropylamine	108-18-9	Liquid	0.70		5.00	0.398	TWA	OSHA	YES	4.2	52.5	
111	Diketene	674-82-8	Liquid	2.20		1000.00				YES	0.0	0.0	
112	Dimethoxymethane	109-87-5	Liquid	11.30	10	1000.00		TWA	OSHA	YES	0.1	0.0	
113	Dimethyl cyclohexane, 1,2-	583-57-3	Liquid	1.10		1000.00				YES	0.0	0.0	
114	Dimethyl ether	115-10-6	Gas	1.30		1000.00				YES	0.0	0.0	
115	Dimethyl phthalate	131-11-3	Liquid	1.00	9.64	1.89		TWA	OSHA	YES	0.0	0.0	
116	Dimethylacetamide, N,N-	127-19-5	Liquid	0.73	8.81	10.00		TWA	OSHA	YES	0.1	0.0	
117	Dimethylamine	124-40-3	Gas	1.40	8.23	10.00	0.081	STEL	ACGIH	YES	1.0	118.9	
118	Dimethylaminoethanol	108-01-0	Liquid	1.50		1000.00				YES	0.0	0.0	
119	Dimethylaniline, N,N-	121-69-7	Liquid	0.60	7.13	10.09		STEL	ACGIH	YES	0.0	0.0	
120	Dimethylbutyl acetate	108-84-9	Liquid	1.60		50.00		TWA	ACGIH	YES	0.0	0.0	
121	Dimethyldisulfide	624-92-0	Liquid	0.30	8.69	1.56		TWA	ACGIH	YES	5.5	0.0	
122	Dimethylethylamine, N,N-	598-56-1	Liquid	0.80		1000.00				YES	0.1	0.0	
123	Dimethylformamide, N,N-	68-12-2	Liquid	0.80	9.12	10.00		TWA	OSHA	YES	0.1	0.0	
124	Dimethylheptan-4-one, 2,6-	108-83-8	Liquid	0.80		25.00		TWA	ACGIH	YES	0.0	0.0	
125	Dimethylhydrazine, 1,1-	57-14-7	Liquid	1.00	7.3	0.06	8.800	Ceil	NIOSH	YES	503.1	3.5	YES
126	Dinitrobenzene, m-	99-65-0	Solid	3.00	10.43	0.45		TWA	NIOSH	YES	0.5	0.0	
127	Dinitrobenzene, o-	100-25-4	Solid	5.00		0.45		TWA	NIOSH	YES	0.5	0.0	
128	Dinonyl phthalate	84-76-4	Liquid	1.00		1000.00				YES	0.0	0.0	
129	Dioxane, 1,4-	123-91-1	Liquid	1.40	9.19	1.00		Ceil	ACGIH	YES	8.7	0.0	
130	Dipentene	138-86-3	Liquid	0.90		1000.00				YES	0.0	0.0	
131	Diphenyl ether	101-84-8	Liquid	0.80	8.09	1.00		STEL	ACGIH	YES	0.0	0.0	
132	Disulphur dichloride	10025-67-9	Liquid	3.00		1.00		Ceil	ACGIH	YES	2.1	0.0	
133	Di-tert-butyl-p-cresol	2409-55-4	Solid	1.00		1.00				YES	0.0	0.0	
134	Divinylbenzene	1321-74-0	Liquid	0.40		10.00		TWA	NIOSH	YES	0.0	0.0	
135	Dodecanol	112-53-8	Solid	0.90		1000.00				YES	0.0	0.0	
136	Enflurane	13838-16-9	Liquid	-		2.00				NO	26.1	0.0	
137	Epichlorohydrin	106-89-8	Liquid	7.60	10.2	1.51		TWA	ACGIH	YES	2.6	0.0	
138	Epoxypropyl isopropyl ether, 2,3-	4016-14-2	Liquid	1.10		50.50		Ceil	NIOSH	YES	0.1	0.0	
139	Ethanol	64-17-5	Liquid	10.02	10.5	997.09		STEL	ACGIH	YES	0.0	0.0	
140	Ethanolamine	141-43-5	Liquid	3.00	8.9	3.00		STEL	ACGIH	YES	0.0	0.0	
141	Ethoxy-2-propanol, 1-	1569-02-4	Liquid	2.00		1000.00				YES	0.0	0.0	
142	Ethoxyethanol, 2-	110-80-5	Liquid	29.80	9.6	1.47		TWA	NIOSH	YES	0.8	0.0	
143	Ethoxyethyl acetate, 2-	111-15-9	Liquid	3.00		1.50		TWA	NIOSH	YES	0.4	0.0	
144	Ethyl (S)-(-)-lactate	97-64-3	Liquid	3.00	10	1000.00				YES	0.0	0.0	
145	Ethyl Acetate	141-78-6	Liquid	4.20	10.11	1165.61		TWA	OSHA	YES	0.0	0.0	
146	Ethyl Acetoacetate	141-97-9	Liquid	0.90		1000.00				YES	0.0	0.0	
147	Ethyl Acrylate	140-88-5	Liquid	2.30	10.3	25.00		TWA	OSHA	YES	0.3	0.0	
148	Ethyl amine	75-04-7	Gas	1.00	8.9	10.00	0.324	STEL	NIOSH	YES	1.0	29.7	
149	Ethyl butyrate	105-54-4	Liquid	1.00		1000.00				YES	0.0	0.0	
150	Ethyl chloroformate	541-41-3	Liquid	80.00		1000.00				YES	0.0	0.0	
151	Ethyl cyanoacrylate	7085-85-0	Liquid	1.50		0.59		TWA	ACGIH	YES	0.2	0.0	
152	Ethyl decanoate	110-38-3	Liquid	1.80		1000.00				YES	0.0	0.0	
153	Ethyl Ether	60-29-7	Liquid	1.20	9.51	501.54	2.290	STEL	ACGIH	YES	0.3	57.4	
154	Ethyl formate	109-94-4	Liquid	30.00	10.6	296.96		TWA	OSHA	YES	0.2	0.0	

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155	Ethyl hexanoate	123-66-0	Liquid	2.60		1000.00				YES	0.0	0.0	
156	Ethyl hexanol, 2-	105-76-7	Liquid	1.50		1000.00				YES	0.0	0.0	
157	Ethyl hexyl acrylate, 2-	103-11-7	Liquid	1.00		1000.00				YES	0.0	0.0	
158	Ethyl Mercaptan	75-08-1	Liquid	0.60	9.29	0.51	0.001	Ceil	NIOSH	YES	258.0	132066.1	YES
159	Ethyl octanoate	106-32-1	Liquid	2.30		1000.00				YES	0.0	0.0	
160	Ethylbenzene	100-41-4	Liquid	0.51	8.76	100.00		STEL	ACGIH	YES	0.0	0.0	
161	Ethylene	74-85-1	Gas	10.10	10.52	200.00		TWA	ACGIH	YES	0.0	0.0	
162	Ethylene Glycol	107-21-1	Liquid	15.70	10.2	40.00		Ceil	ACGIH	YES	0.0	0.0	
163	Ethylene Oxide	75-21-8	Gas	19.50	10.57	4.99	851.000	STEL	NIOSH	YES	1.9	0.0	
164	Ferrocene	102-54-5	Solid	0.80	6.88	3.93		TWA	NIOSH	YES	0.0	0.0	
165	Formamide	75-12-7	Liquid	2.00	10.2	10.00		TWA	NIOSH	YES	0.0	0.0	
166	Formic Acid	64-18-6	Liquid	-	11.05	5.00				NO	0.5	0.0	
167	Furfural	98-01-1	Liquid	1.40	9.2	6.03		TWA	ACGIH	YES	0.1	0.0	
168	Furfuryl alcohol	98-00-0	Liquid	2.00		14.95		STEL	ACGIH	YES	0.0	0.0	
169	Gasoline	8006-61-9	Liquid	1.10	<10.6	1000.00				YES	0.0	0.0	
170	Germane Tetrahydride	7782-65-2	Gas	-	11.34	0.20		TWA	NIOSH	NO	48.2	0.0	
171	Glutaraldehyde	111-30-8	Liquid	0.90		0.20		Ceil	ACGIH	YES	25.3	0.0	
172	Glycolonitrile	107-16-4	Liquid	-		2.00		Ceil	ACGIH	NO	0.1	0.0	
173	Halothane	151-67-7	Liquid	-	11	2.00		Ceil	ACGIH	NO	36.3	0.0	
174	Heptan-2-one	110-43-0	Liquid	0.70	9.3	149.65	0.141	TWA	ACGIH	YES	0.0	6.4	
175	Heptan-3-one	106-35-4	Liquid	0.80	9.02	74.93		STEL	ACGIH	YES	0.0	0.0	
176	Heptane	142-82-5	Liquid	2.50	10.08	439.22		Ceil	NIOSH	YES	0.0	0.0	
177	Hexamethyldisilazane, 1,1,1,3,3,3-	999-97-3	Liquid	1.00	<10.6	1000.00				YES	0.0	0.0	
178	Hexamethyldisiloxane	107-46-0	Liquid	0.30		1000.00				YES	0.0	0.0	
179	Hexan-2-one	591-78-6	Liquid	0.80	9.34	9.76		STEL	ACGIH	YES	0.3	0.0	
180	Hexane, n-	110-54-3	Liquid	4.50	10.18	149.76		TWA	ACGIH	YES	0.2	0.0	
181	Hexene, 1-	592-41-6	Liquid	0.90	9.4	149.91		TWA	ACGIH	YES	0.4	0.0	
182	Hexyl Acetate (sec-)	108-84-9	Liquid	-		50.00		TWA	NIOSH	NO	0.0	0.0	
183	Hydrazine	302-01-2	Liquid	2.60	8.1	0.03	3.600	Ceil	NIOSH	YES	97.7	0.8	
184	Hydrogen Bromide	10035-10-6	Gas	-	11.62	3.00		TWA	OSHA	NO	3.2	0.0	
185	Hydrogen Chloride	7647-01-0	Gas	-	12.74	5.00		REL	NIOSH	NO	1.9	0.0	
186	Hydrogen Cyanide	74-90-8	Liquid	-	13.6	4.70		REL	NIOSH	NO	40.1	0.0	
187	Hydrogen Fluoride	7664-39-3	Liquid	-	15.98	3.00		TWA	NIOSH	NO	78.0	0.0	
188	Hydrogen Peroxide	7722-84-1	Liquid	4.00	10.5	1.00		TWA	NIOSH	YES	1.5	0.0	
189	Hydrogen Selenide	7783-07-5	Gas	2.00	9.8	0.05		TWA	NIOSH	YES	192.7	0.0	
190	Hydrogen Sulfide	7783-06-4	Gas	3.20	10.46	10.76	0.130	Ceil	NIOSH	YES	0.9	74.1	
191	Hydroquinone	123-31-9	Solid	0.80	7.95	0.44		Ceil	NIOSH	YES	0.0	0.0	
192	Hydroxy-4-methyl-2-pentanone, 4-	123-42-2	Liquid	0.55		150.23		TWA	ACGIH	YES	0.0	0.0	
193	Hydroxypropyl acrylate, 2-	999-61-1	Liquid	1.50		1.58		TWA	ACGIH	YES	0.0	0.0	
194	Iminodi(ethylamine), 2,2-	111-40-0	Liquid	0.90		1.00		TWA	NIOSH	YES	0.1	0.0	
195	Iminodiethanol, 2,2'-	111-42-2	Solid	1.60		3.00		TWA	ACGIH	YES	0.0	0.0	
196	Indene	95-13-6	Liquid	0.50		10.00		TWA	OSHA	YES	0.0	0.0	
197	Iodine	7553-56-2	Solid	0.20	9.4	0.10		Ceil	NIOSH	YES	0.9	0.0	
198	Iodoform	75-47-8	Solid	1.50		1.80		TWA	NIOSH	YES	0.0	0.0	
199	Iodomethane	74-88-4	Liquid	0.40		5.00		PEL	OSHA	YES	23.9	0.0	
200	Iron Carbonyl	13463-40-6	Liquid	-		0.10		TWA	NIOSH	NO	119.5	0.0	
201	Isoamyl Acetate	123-92-2	Liquid	1.80		99.90		STEL	ACGIH	YES	0.0	0.0	
202	Isobutane	75-28-5	Gas	8.00	10.6	800.00		TWA	NIOSH	YES	0.0	0.0	
203	Isobutanol	78-83-1	Liquid	4.70	10.12	100.00		PEL	OSHA	YES	0.0	0.0	
204	Isobutyl Acetate	110-19-0	Liquid	2.60	9.97	150.00		TWA	OSHA	YES	0.0	0.0	
205	Isobutyl Acrylate	106-63-8	Liquid	1.30		1000.00				YES	0.0	0.0	
206	Isobutylene	115-11-7	Gas	1.00	9.4	750.50		TWA	ACGIH	YES	0.0	0.0	
207	Isobutyraldehyde	78-84-2	Liquid	1.20		1000.00				YES	0.1	0.0	
208	Isodecanol	25339-17-7	Liquid	0.90		1000.00				YES	0.000	0.000	

											Fan Inlet Spill Concentrations		
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209	Isooctane	540-84-1	Liquid	1.30		385.38		Ceil	NIOSH	YES	0.0	0.0	
210	Isooctanol	26952-21-6	Liquid	1.70		50.00		TWA	ACGIH	YES	0.0	0.0	
211	Isopentane	78-78-4	Liquid	8.00	10.32	609.98		Ceil	NIOSH	YES	0.3	0.0	
212	Isophorone	78-59-1	Liquid	0.74	9.07	4.95		Ceil	ACGIH	YES	0.0	0.0	
213	Isoprene	78-79-5	Liquid	0.60	8.85	1000.00				YES	0.2	0.0	
214	Isopropanol	67-63-0	Liquid	5.55	10.12	400.31		STEL	ACGIH	YES	0.0	0.0	
215	Isopropyl Acetate	108-21-4	Liquid	2.60	9.99	250.00		PEL	OSHA	YES	0.1	0.0	
216	Isopropyl chloroformate	108-23-6	Liquid	1.60		1000.00				YES	0.0	0.0	
217	Isopropyl Ether	108-20-3	Liquid	0.80	9.2	311.01	0.017	STEL	ACGIH	YES	0.1	2091.5	YES
218	Isopropylamine	75-31-0	Liquid	0.90	8.72	5.00	0.210	TWA	OSHA	YES	27.5	654.5	YES
219	Jet A fuel	8008-20-6	Liquid	0.40	<10.6	36.68		TWA	NIOSH	YES	0.0	0.0	
220	JP-5 fuel	8008-20-6	Liquid	0.48	<10.6	36.68		TWA	NIOSH	YES	0.0	0.0	
221	JP-8 fuel	8008-20-6	Liquid	0.48	<10.6	36.68		TWA	NIOSH	YES	0.0	0.0	
222	Ketene	463-51-4	Gas	3.00	9.61	0.50		REL	ACGIH	YES	19.3	0.0	
223	Maleic anhydride	108-31-6	Solid	2.00	10.8	0.25		TWA	NIOSH	YES	0.2	0.0	
224	Mercaptoacetic acid	68-11-1	Liquid	1.00		1.00		TWA	ACGIH	YES	3.0	0.0	
225	Mesityl Oxide	141-79-7	Liquid	0.47	9.08	24.90	0.056	STEL	ACGIH	YES	0.1	48.0	
226	Methacrylic acid	79-41-4	Liquid	2.30		59.70		TWA	ACGIH	YES	0.0	0.0	
227	Methacrylonitrile	126-98-7	Liquid	5.00		1.00		REL	NIOSH	YES	21.2	0.0	
228	Methane	74-82-8	Gas	-	NA	1000.00		TWA	ACGIH	NO	0.0	0.0	
229	Methanol	67-56-1	Liquid	-	NA	200.00		TWA	NIOSH	NO	0.1	0.0	
230	Methoxy-2-Propanol, 1-	107-98-2	Liquid	1.40	9.54	100.00		TWA	NIOSH	YES	0.0	0.0	
231	Methoxyethoxyethanol, 2-	111-77-3	Liquid	1.40		1000.00				YES	0.0	0.0	
232	Methoxymethylethoxy-2-propanol	34590-94-8	Liquid	1.30		100.00		TWA	NIOSH	YES	0.0	0.0	
233	Methoxypropyl acetate	108-65-6	Liquid	1.20		1000.00				YES	0.0	0.0	
234	Methyl Acetate	79-20-9	Liquid	7.00	10.27	200.00		TWA	NIOSH	YES	0.3	0.0	
235	Methyl Acetoacetate	105-45-3	Liquid	1.09		1000.00				YES	0.0	0.0	
236	Methyl Acrylate	96-33-3	Liquid	3.40	9.9	10.00		TWA	NIOSH	YES	1.9	0.0	
237	Methyl Benzoate	93-58-3	Liquid	0.93		1000.00				YES	0.0	0.0	
238	Methyl cyanoacrylate	137-05-3	Liquid	5.00		3.52		STEL	NIOSH	YES	0.0	0.0	
239	Methyl Ethyl Ketone	78-93-3	Liquid	0.90	9.54	200.00		TWA	NIOSH	YES	0.1	0.0	
240	Methyl Ethyl Ketone peroxides	1338-23-4	Liquid	0.80		0.21		Ceil	ACGIH	YES	0.0	0.0	
241	Methyl Isobutyl Ketone	108-10-1	Liquid	1.10	9.3	73.20		STEL	NIOSH	YES	0.1	0.0	
242	Methyl isothiocyanate	556-61-6	Liquid	0.60		1000.00				YES	0.0	0.0	
243	Methyl Mercaptan	74-93-1	Gas	0.60	9.44	0.51	0.001	Ceil	NIOSH	YES	19.0	9634.8	YES
244	Methyl Methacrylate	80-62-6	Liquid	1.50	9.7	100.14	0.085	STEL	NIOSH	YES	0.1	101.9	
245	Methyl salicylate	119-36-8	Liquid	1.20		1000.00				YES	0.0	0.0	
246	Methyl sulphide	75-18-3	Liquid	0.50		29.53		TWA	ACGIH	YES	4.0	0.0	
247	Methyl tert-Butyl Ether	1634-04-4	Liquid	0.86		150.03		TWA	ACGIH	YES	0.5	0.0	
248	Methyl-2-propen-1-ol, 2-	51-42-8	Liquid	1.10		1000.00				YES	0.0	0.0	
249	Methyl-2-pyrrolidinone, N-	872-50-4	Liquid	0.90		1000.00				YES	0.0	0.0	
250	Methyl-4,6-dinitrophenol, 2-	534-52-1	Solid	3.00		0.20		TWA	NIOSH	YES	0.0	0.0	
251	Methyl-5-hepten-2-one, 6-	110-93-0	Liquid	0.80		1000.00				YES	0.0	0.0	
252	Methylamine	74-89-5	Gas	1.15	8.97	14.94	0.019	STEL	ACGIH	YES	0.6	507.1	YES
253	Methylbenzyl alcohol	89-95-2	Solid	0.80		1000.00				YES	0.0	0.0	
254	Methylbutan-1-ol, 3-	123-51-3	Liquid	3.40		124.74		STEL	NIOSH	YES	0.1	0.0	
255	Methylcyclohexane	108-87-2	Liquid	1.10		400.00		TWA	NIOSH	YES	0.0	0.0	
256	Methylcyclohexanol, 4-	589-91-3	Liquid	2.40		1000.00				YES	0.0	0.0	
257	Methylcyclohexanone, 2-	583-60-8	Liquid	1.00		74.96		STEL	ACGIH	YES	0.0	0.0	
258	Methylene Chloride	75-09-2	Liquid	-	NA	125.00		STEL	OSHA	NO	0.8	0.0	
259	Methylheptan-3-one, 5-	541-85-5	Liquid	0.80		74.50		TWA	NIOSH	YES	0.0	0.0	
260	Methylhexan-2-one, 5-	110-12-3	Liquid	0.80		100.00		PEL	OSHA	YES	0.0	0.0	

	Compound	CAS Number	Liquid or Gas	RF	IP(eV)	Health Limits (PPM)	Odor Threshold (PPM)	OEL Type	OEL Agency	Detect?	Fan Inlet Spill Concentrations: Factor Above Health Limit	Fan Inlet Spill Concentrations: Factor Above Odor Threshold	Quantity Limitation For this Compound Recommended?
261	Methyl-N-2,4 6-tetranitroaniline, N-	479-45-8	Solid	3.00		0.38		TWA	NIOSH	YES	0.8	0.0	
262	Methylpentan-2-ol, 4-	108-11-2	Liquid	2.80		39.47		STEL	NIOSH	YES	0.0	0.0	
263	Methylpentane-2,4-diol, 2-	107-41-5	Liquid	4.00		25.07		Ceil	ACGIH	YES	0.0	0.0	
264	Methylstyrene	25013-15-4	Liquid	0.50	8.2	99.91		STEL	ACGIH	YES	0.0	0.0	
265	Methyoxyethanol, 2-	109-86-4	Liquid	2.50	9.6	0.29		TWA	ACGIH	YES	6.2	0.0	
266	Mineral Oil	8042-47-5	Liquid	0.80	<10.6	1000.00				YES	0.0	0.0	
267	Mineral spirits	64475-85-0	Liquid	0.80	<10.6	1000.00				YES	0.0	0.0	
268	Naphthalene	91-20-3	Solid	0.37	8.12	10.00		TWA	NIOSH	YES	0.0	0.0	
269	Nitric Acid	7697-37-2	Liquid	-	11.95	2.00		TWA	NIOSH	NO	7.2	0.0	
270	Nitric Oxide	10102-43-9	Gas	7.20	9.25	25.00	1.000	TWA	NIOSH	YES	0.4	9.6	
271	Nitroaniline, 4-	100-01-6	Solid	0.80		1.59		TWA	NIOSH	YES	0.0	0.0	
272	Nitrobenzene	98-95-3	Liquid	1.70	9.8	1.00		TWA	OSHA	YES	0.1	0.0	
273	Nitrogen dioxide	10102-44-0	Liquid	10.00	9.8	0.96	0.190	STEL	NIOSH	YES	224.9	1132.3	YES
274	Nitrogen trichloride	10025-85-1	Liquid	1.00		1000.00				YES	0.0	0.0	
275	Nitromethane	75-52-5	Liquid	-	11.08	100.00		TWA	OSHA	NO	0.1	0.0	
276	Nonane, n-	111-84-2	Liquid	1.60	10.6	200.00		TWA	NIOSH	YES	0.0	0.0	
277	Norbornadiene, 2,5-	121-46-0	Liquid	0.60		1000.00				YES	0.0	0.0	
278	Octachloronaphthalene	2234-13-1	Solid	1.00		0.02		STEL	NIOSH	YES	14.9	0.0	
279	Octane	111-65-9	Liquid	2.20	9.82	385.38		Ceil	NIOSH	YES	0.0	0.0	
280	Octene, 1-	111-66-0	Liquid	0.70		1000.00				YES	0.0	0.0	
281	Oxydiethanol, 2,2-	111-46-6	Liquid	4.00		1000.00				YES	0.0	0.0	
282	Parraffin wax, fume	8002-74-2	Solid	1.00	<10.6	1000.00				YES	0.0	0.0	
283	Parraffin wax, normal	64771-72-8	Solid	1.00	<10.6	1000.00				YES	0.0	0.0	
284	Pentacarbonyl iron	13463-40-6	Liquid	1.00		0.06		STEL	ACGIH	YES	212.9	0.0	
285	Pentadione, 2,4-	123-54-6	Liquid	0.80		1000.00				YES	0.0	0.0	
286	Pentan-3-one	96-22-0	Liquid	0.80		300.16		STEL	ACGIH	YES	0.0	0.0	
287	Pentane, n-	109-66-0	Gas	9.73	10.3	10.00		Ceil	ACGIH	YES	1.0	0.0	
288	Pentanone, 2-	107-87-9	Liquid	0.78	9.38	150.22		STEL	ACGIH	YES	0.1	0.0	
289	Peracetic acid	79-21-0	Liquid	2.00		1000.00				YES	0.0	0.0	
290	Phenol	108-95-2	Solid	1.00	8.5	15.59		Ceil	NIOSH	YES	0.0	0.0	
291	Phenyenediamine, p-	106-50-3	Solid	0.60	6.89	0.07		TWA	NIOSH	YES	4.4	0.0	
292	Phenyl propene, 2-	98-83-9	Liquid	0.40		99.29		Ceil	OSHA	YES	0.0	0.0	
293	Phenyl-2,3-epoxypropyl ether	122-60-1	Liquid	0.80		0.98		Ceil	NIOSH	YES	0.0	0.0	
294	Phosphine	7803-51-2	Gas	2.80	9.87	0.72	0.140	STEL	NIOSH	YES	13.4	68.8	
295	Phosgene	75-44-5	Gas	-	11.55	0.10		REL	NIOSH	NO	96.3	0.0	
296	Picoline, 2-	109-06-8	Liquid	0.57		1000.00				YES	0.0	0.0	
297	Picoline, 3-	108-99-6	Liquid	0.90	9	1000.00				YES	0.0	0.0	
298	Pinene, alpha-	80-56-8	Liquid	0.40	8.1	60.30		TWA	ACGIH	YES	0.0	0.0	
299	Pinene, beta-	127-91-3	Liquid	0.40	8.1	60.36		TWA	ACGIH	YES	0.0	0.0	
300	Piperidine	110-89-4	Liquid	0.90		1000.00				YES	0.0	0.0	
301	Piperylene	504-60-9	Liquid	0.70		1000.00				YES	0.1	0.0	

											Fan Inlet Spill Concentrations		
	Compound	CAS Number	Liquid or Gas	RF	IP(eV)	Health Limits (PPM)	Odor Threshold (PPM)	OEL Type	OEL Agency	Detect?	Factor Above Health Limit	Factor Above Odor Threshold	Quantity Limitation For this Compound Recommended?
302	Prop-2-yn-1-ol	107-19-7	Liquid	1.30		2.62		TWA	NIOSH	YES	1.4	0.0	
303	Propane-1,2-diol, total	57-55-6	Liquid	10.00		1000.00				YES	0.0	0.0	
304	Propanol, 1-	71-23-8	Liquid	5.70	10.2	200.00		TWA	NIOSH	YES	0.0	0.0	
305	Propionaldehyde (propanal)	123-38-6	Liquid	14.80	9.98	60.60		TWA	ACGIH	YES	0.0	0.0	
306	Propionic acid	79-09-4	Liquid	8.00		15.72		STEL	NIOSH	YES	0.1	0.0	
307	Propyl acetate, n-	109-60-4	Liquid	3.10	10.04	248.81	0.575	STEL	ACGIH	YES	0.0	13.0	
308	Propylene	115-07-1	Gas	1.30	9.73	1498.36		TWA	ACGIH	YES	0.0	0.0	
309	Propylene Oxide	75-56-9	Liquid	6.50	10.22	100.00		TWA	OSHA	YES	1.3	0.0	
310	Propyleneimine	75-55-8	Liquid	1.30	9	2.00		TWA	NIOSH	YES	16.7	0.0	
311	Pyridine	110-86-1	Liquid	0.79	9.32	5.00		TWA	NIOSH	YES	1.0	0.0	
312	Pyridylamine, 2-	504-29-0	Solid	0.80		0.50		TWA	NIOSH	YES	0.5	0.0	
313	Quinoline	91-22-5	Liquid	0.72		1000.00				YES	0.0	0.0	
314	Styrene	100-42-5	Liquid	0.40	8.47	40.00		STEL	ACGIH	YES	0.0	0.0	
315	Sulfuric Acid	7664-93-9	Liquid	-		0.25		TWA	NIOSH	NO	0.0	0.0	
316	Terpinolene	586-62-9	Liquid	0.50		1000.000				YES	0.0	0.0	
317	Tetrabromoethane, 1,1,2,2-	79-27-6	Liquid	2.00		0.30		TWA	ACGIH	YES	0.0	0.0	
318	Tetracarbonylnickel	13463-39-3	Liquid	1.00	8.28	0.001	1.000	TWA	OSHA	YES	94119.1	94.1	YES
319	Tetrachloroethylene	127-18-4	Liquid	0.56	9.32	101.01		STEL	ACGIH	YES	0.0	0.0	
320	Tetrachloronaphthalenes, all isomers	20020-02-4	Solid	1.00		1000.00				YES	0.0	0.0	
321	Tetraethyl orthosilicate	78-10-4	Liquid	2.00	9.8	10.00		TWA	ACGIH	YES	0.0	0.0	
322	Tetrafluoroethylene	116-14-3	Gas	1.00		6.01		TWA	ACGIH	YES	1.6	0.0	
323	Tetrahydrofuran	109-99-9	Liquid	1.60	9.54	200.00		TWA	NIOSH	YES	0.2	0.0	
324	Tetramethyl succinonitrile	3333-52-6	Solid	1.00		1.50		TWA	NIOSH	YES	0.0	0.0	
325	Thiophene	110-02-1	Liquid	0.47	8.86	1000.00				YES	0.0	0.0	
326	Toluene	108-88-3	Liquid	0.53	8.82	148.66		STEL	NIOSH	YES	0.0	0.0	
327	Toluene-2,4-diisocyanate	584-84-9	Solid	1.60		0.02		STEL	ACGIH	YES	0.1	0.0	
328	Toluenesulphonylchloride, p-	98-59-9	Solid	3.00		1000.00				YES	0.0	0.0	
329	Toluidine, o-	95-53-4	Liquid	0.50	7.44	6.02		TWA	ACGIH	YES	0.0	0.0	
330	Tributyl phosphate	126-73-8	Liquid	5.00		0.61		TWA	ACGIH	YES	0.0	0.0	
331	Tributylamine	102-82-9	Liquid	1.00		1000.00				YES	0.0	0.0	
332	Trichlorobenzene, 1,2,4-	120-82-1	Liquid	0.60		5.00		Ceil	ACGIH	YES	0.1	0.0	
333	Trichloroethylene	79-01-06	Liquid	0.50	9.47	2.00		Ceil	NIOSH	YES	8.7	0.0	
334	Trichlorophenoxyacetic acid, 2,4,5-	93-76-5	Solid	1.00		2.87		TWA	NIOSH	YES	0.0	0.0	
335	Triethylamine	121-44-8	Liquid	0.90	7.5	3.00	0.001	STEL	ACGIH	YES	5.4	16134.0	YES
336	Trimethylamine	75-50-3	Gas	0.83	7.82	14.89		STEL	NIOSH	YES	0.6	0.0	
337	Trimethylbenzene, 1,2,3-	526-73-8	Liquid	0.49	8.48	75.06		TWA	ACGIH	YES	0.0	0.0	
338	Trimethylbenzene, 1,2,4-	95-63-6	Liquid	0.43	8.27	75.06		TWA	ACGIH	YES	0.0	0.0	
339	Trimethylbenzene, 1,3,5-	108-67-8	Liquid	0.34	8.39	75.06		TWA	ACGIH	YES	0.0	0.0	
340	Turpentine -crude sulfite	8006-64-2	Liquid	1.00	<10.6	60.36		TWA	ACGIH	YES	0.0	0.0	
341	Turpentine -pure gum	8006-64-2	Liquid	0.45	<10.6	302.03		TWA	OSHA	YES	0.0	0.0	
342	Undecane, n-	1120-21-4	Liquid	0.90	9.6	1000.00				YES	0.0	0.0	
343	Vinyl Acetate	108-05-04	Liquid	1.30	9.19	4.26		Ceil	NIOSH	YES	5.8	0.0	
344	Vinyl Bromide	593-60-2	Gas	0.40	9.8	1.51		TWA	ACGIH	YES	6.4	0.0	
345	Vinyl Chloride	75-01-4	Gas	1.80	10	5.00		STEL	OSHA	YES	1.9	0.0	
346	Vinyl-2-pyrrolidinone, 1-	88-12-0	Solid	0.90		0.15		TWA	ACGIH	YES	0.2	0.0	
347	Vinylidene Chloride (1,1-DCE)	75-35-4	Liquid	0.80	10	15.12		TWA	ACGIH	YES	9.9	0.0	
348	Xylene, m-	108-38-3	Liquid	0.53	8.56	149.88		STEL	ACGIH	YES	0.0	0.0	
349	Xylene, o-	95-47-6	Liquid	0.54	8.56	149.88		STEL	ACGIH	YES	0.0	0.0	
350	Xylene, p-	106-42-3	Liquid	0.50	8.44	149.88		STEL	ACGIH	YES	0.0	0.0	
351	Xylenes, mixed isomers	1330-20-7	Liquid	0.40	8.6	149.88		STEL	ACGIH	YES	0.0	0.0	
352	Xylidine, all	1300-73-8	Liquid	0.70	7.65	1.51	0.010	TWA	ACGIH	YES	0.2	29.8	