Appendix 3:
Select properties of commonly used electronic specialty gases

GAS	CLASS	UN #	LC_{50}/1 Hr. ISO/DIS 10298 (ppm by vol)	FLAMMABLE LIMITS (% IN AIR)	RELATIVE DENSITY GAS AT 20º C (AIR = 1)	RELAVTIVE DENSITY OF LIQUID AT 20º C (WATER = 1)	VAPOUR PRESSURE AT 20º C (bar abs)
Ammonia	2.3, 8	1005	7,338	16-25	0.6	0.7	8.6
Argon	2.2	1006	No acute toxicity	Not Flammable	1.4*	Compressed Gas	Compressed Gas
Arsine	2.3, 2.1	2188	20 or 178[1]	3.9-77.8/4.5-64[7]	2.7	1.6	15
Boron Trichloride	2.3, 8	1741	2,541	Not Flammable	4	1.3	1.6
Boron Trifluoride	2.8, 8	1008	873[2]	Not Flammable	2.4	Compressed Gas	Compressed Gas
Carbon Dioxide	2.2	1013	No acute toxicity	Not Flammable	1.5*	0.78*	57.3
Carbon Monoxide	2.3, 2.1	1016	3,614	12.5-74	1	Compressed Gas	Compressed Gas
Chlorine	2.3, 8	1017	293	Not Flammable	2.5	1.6	6.8
Chlorine Trifluoride	2.3, 5.1, 8	1749	299	Not Flammable	3.3*	1.9	1.5
Diborane	2.3, 2.1	1911	80	0.8-98	1	Compressed Gas	Compressed Gas
Dichlorosilane	2.3, 2.1, 8	2189	314	2.5-98.8[8]	3.5	1.2*	1.6
Fluorine	2.3, 5.1, 8	1045	185	Not Flammable	1.3	1.5	NA
Germane	2.3, 2.1	2192	622	2.8-98/8-30[9]	2.6[11]	1.02	34.8
Helium	2.2	1046	No acute toxicity	Not Flammable	0.14	Compressed Gas	Compressed Gas
Hexafluoroethane (R116)	2.2	3163	No acute toxicity	Not Flammable	4.8	1.6	30
Hydrogen	2.1	1049	No acute toxicity	4-75	0.07	Compressed Gas	Compressed Gas
Hydrogen Bromide	2.3, 8	1048	2,860	Not Flammable	2.8	1.9*	21.2*
Hydrogen Chloride	2.3, 8	1050	3,120	Not Flammable	1.3	0.83*	42.3*
Hydrogen Selenide	2.3, 2.1	2202	51[3]	4.5-67.5[10]	2.8	2	9.5
Hydrogen Sulphide	2.3, 2.1	1053	712	4.3-45.5	1.2	0.79*	17.7*
Methane	2.1	1971	No acute toxicity	5-15	0.6	Compressed Gas	Compressed Gas
Nitric Oxide	2.3, 5.1, 8	1660	168[4]	Not Flammable	1	Compressed Gas	Compressed Gas
Nitrogen	2.2	1066	No acute toxicity	Not Flammable	0.9	Compressed Gas	Compressed Gas
Nitrogen Trifluoride	2.2, 5.1	2451	6700	Not Flammable	2.4	Compressed Gas	Compressed Gas
Nitrous Oxide	2.2, 5.1	1070	No acute toxicity	Not Flammable	1.5	0.80*	50.8
Oxygen	2.2, 5.1	1072	No acute toxicity	Not Flammable	1.1	Compressed Gas	Compressed Gas
Phosphine	2.3, 2.1	2199	22	1.6 to 98	1.2	0.74	34.6
Silane	2.1	2203	No acute toxicity	1.37-96	1.1	Compressed Gas	Compressed Gas
Silicon Tetrafluoride	2.3, 8	1859	922[5]	Not Flammable	3.6	Compressed Gas	Compressed Gas
Sulphur Hexafluoride	2.2	1080	No acute toxicity	Not Flammable	5.1*	1.4	21
Tetrafluoromethane (R14)	2.2	1982	No acute toxicity	Not Flammable	2.8	Compressed Gas	Compressed Gas
Trifluoromethane (R23)	2.2	1984	No acute toxicity	Not Flammable	2.4*	0.81*	41.6
Tungsten Hexafluoride	2.3, 8	2196	217[6]	Not Flammable	10.3	3.4	1.1

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Select properties of commonly used electronic specialty gases

Rationale:
The data in the table were initially generated from BCGA CP-18. Data were confirmed or adjusted by primarily using references such as the Air Liquide Gaz Data Book, the Compressed Gas Association Gas Data Book, and the Matheson Gas Products Data Book.

1. **Arsine LC_{50}** – The original 20 ppm value was derived from mouse data. Later rat data shows a value of 178 ppm. 20ppm has also been the CGA standard for many years. The reader will decide which value to use. It is recommended when there is any doubt, to use the more stringent data.

2. **Boron Trifluoride LC_{50} –** Better value from later testing (Rusch, B.M., Hoffman, G.M., McConnell, R.F., and Rinehart, W.E. "Inhalation Toxicity Studies with Boron Trifluoride" Toxicol. Appl. Pharmacol. (1986) Vol. 83, pp 69-78).

3. **Hydrogen Selenide LC_{50} –** original value of 2 ppm was from a guinea pig. (Zwart, A., Arts, J.H.E., Ten Berge, W.F., and Appleman, L.M. "Alternative Acute Inhalation Toxicity Testing by Determination of the Concentration-Time-Mortality Relationship: Experimental Comparison with Standard LC50 Testing," Reg. Tox. and Pharm., Vol. 15, 1992, pp. 278-290).

4. **Nitric Oxide LC_{50} –** assumes that the NO will oxidize to NO_2 , (Gray, E., Patton, F.M., Goldberg, S.B. and Kaplan, E., "Toxicity of the Oxides of Nitrogen II. Acute Inhalation Toxicity of Nitrogen Dioxide, Red Fuming Nitric Acid, and White Fuming Nitric Acid," Archives of Industrial Hygiene and Occupational Medicine, (1954) Vol. 10, pp 418-422).

5. **Silicon Tetrafluoride LC_{50}** – original was derived from mouse data (Scheel, L.D., Lane, W.C., Coleman, W.E., "The Toxicity of Polytetrafluoroethylene Pyrolysis Products—Including Carbonyl Fluoride and a Reaction Product, Silicon Tetrafluoride," Am. Ind. Hyg. Assoc. Journal, (1968) Jan-Feb., pp 41-48).

6. **Tungsten Hexafluoride LC_{50}** – 1/6 of Hydrogen Fluoride Value.

7. **Arsine Flammable Limits** – The CGA has published the value of 4.5-64% although another range of 3.9-77.8% has been published.

8. **Dichlorosilane Flammable Range –** Matheson data is 4%-96% and Air Liquide is 4.1%-98.8% and others is 2.5%-80%. DCS hydrolyzes in air to form H2. Selected the lowest and highest values. The range noted is the broadest range of LFL and UFL based on data submitted from three sources.

9. **Germane Flammable Range –** There is wide disparity from different data sources. The ranges of 2.8-98% and 8-30% are noted in the literatures. ISO 10156 reports a LFL of 1% and no UFL.

10. **Hydrogen Selenide Flammable Range –** Air Products third party Test Data 2000.

11. **Germane Relative Density –** Data from three different sources indicate the following specific gravities at these respective temperatures. SG = 0.907 @ 70F, SG = 1.523 @ -223.6F, and SG =2.6 @32F. These values are disparate and do not corrobate.

* **Computer Aided Physical Properties (CAPP) –** Where 2 or more values were listed, CAPP was used to estimate the value. A computer programme that provides physical and thermodynamic properties for both pure components and mixtures, it has three thermodynamic models (Ithermo 17,18 and 19) and numerous models for physical properties. Ithermo 17 is a density dependant local composition modification to the cubic Peng-Robinson equation of state. Ithermo 18 is a BWRS equation of state for pure components. Ithermo 19 is a corresponding state method (based on comparison to propane).