

resulting in an overall 60% mortality for four species (Eriksen 1945; Stokinger 1949) is higher than the extrapolated 7-

hour values for the mouse and rat based on the Keplinger and Suissa study.

The proposed AEGL values are listed in Table 6 of this unit.

TABLE 6.—SUMMARY OF PROPOSED AEGL VALUES FOR FLUORINE [PPM (MG/M³)]

Classification	10-minutes	30-minutes	1-hour	4-hours	8-hours	Endpoint (Reference)
AEGL-1 ^{a, b} (Nondisabling)	1.7 (2.6)	1.7 (2.6)	1.7 (2.6)	1.7 (2.6)	1.7 (2.6)	No irritant effects—humans (Keplinger and Suissa 1968)
AEGL-2 (Disabling)	20 (31)	11 (17)	5.0 (7.8)	2.3 (3.6)	2.3 (3.6)	Mild lung congestion—mice (Keplinger and Suissa 1968)
AEGL-3 ^c (Lethal)	36 (56)	19 (29)	13 (20)	5.7 (8.8)	5.7 (8.8)	Severe lung congestion—mice (Keplinger and Suissa 1968)

^aThe characteristic, pungent odor of fluorine will be noticeable at this concentration.

^bThe same value was used across all time periods because at low concentrations there is accommodation to irritant gases.

^c30-Minute and 1-hour values are based on separate data points.

ii. *References.* a. Eriksen, N. 1945. A Study of the Lethal Effect of the Inhalation of Gaseous Fluorine (F₂) at Concentrations from 100 ppm to 10,000 ppm. DOE/EV/03490-T3, United States Atomic Energy Commission. Pharmacology Report 435. University of Rochester, Rochester, NY.

b. Keplinger, M.L. and L.W. Suissa. 1968. Toxicity of fluorine short-term inhalation. *American Industrial Hygiene Association Journal*. 29:10–18.

c. Lyon, J.S. 1962. Observations on personnel working with fluorine at a gaseous diffusion plant. *Journal of Occupational Medicine*. 4:199–201.

d. Rickey, R.P. 1959. *Decontamination of Large Liquid Fluorine Spills*. AFFTC-TR-59-31, U.S. Air Force, Air Research and Development Command, Air Force Flight Test Center, Edwards Air Force Base, CA; AD-228-033, Defense Technical Information Center, Ft. Belvoir, VA.

e. Stokinger, H.E. 1949. Toxicity following inhalation of fluorine and hydrogen fluoride, Chapter 17. *Pharmacology and Toxicology of Uranium Compounds*. C. Voegtlin and H.C. Hodge, eds. McGraw-Hill Book Company, New York.

6. *Jet Fuel 8*—i. *Description.* Jet propellant (JP) fuels, used in military and civilian aircraft, are complex mixtures of aliphatic and aromatic hydrocarbons made by blending various distillate stocks of petroleum. The primary military fuel for land-based military aircraft is JP-8; JP-5 was developed by the U.S. Navy for shipboard service. The composition of these two fuels is basically that of kerosene (with additives) and they have similar chemical and physical characteristics. Worldwide, approximately 60 billion gallons of military JP-8 and the equivalent commercial Jet A and Jet A-1 are consumed on an annual basis. The

military jet fuels contain additives that are not contained in commercial jet fuels. Civilian and military personnel may be exposed to jet fuels during fuel production, aircraft fueling operations, aircraft maintenance operations, and accidental spills or pipeline leaks.

Although several jet fuels are discussed in this document (JP-4, JP-5, JP-7, and JP-8), the discussion focuses on the toxicity of JP-8 with some attention to the chemically similar JP-5. These two fuels have a similar composition and appear to have similar toxicities. Monitoring data indicate that exposures to JP-4 which has a higher vapor pressure than JP-8 and JP-5 were higher than to the presently used JP-8 and JP-5. Data were located on acute sensory and systemic effects of JP-8 and JP-5 to mice and rats; subchronic studies addressed systemic effects, particularly effects on the lungs. For all fuels, tests of eye irritation were generally negative, whereas mild skin irritation occurred for some fuels. Several short-term and repeated exposure studies addressed the particular issue of the toxicity of aerosols. Exposure to aerosols of jet fuels induces more toxic effects than exposure to vapors, with the lungs and immune system identified as the target organs. Animal studies also addressed neurotoxicity, developmental/reproductive effects, and carcinogenicity. These fuels are generally not considered genotoxic or carcinogenic and, in a preliminary study, JP-8 failed to cause spermatotoxic effects in humans. A nephropathy and resulting carcinogenic effect, unique to male rats exposed to hydrocarbons, is not relevant to humans. No information relevant to time scaling was available.

The AEGL-1 is based on the sensory irritation study of Whitman et al. (2001), specifically the RD₅₀ (the concentration that reduces the respiratory rate by 50%) for JP-8 of 2,876 mg/m³ vapor plus

aerosol. The RD₅₀ test is a standard test for estimating sensory irritancy of airborne chemicals (ASTM E981–84). In the key study, male Swiss-Webster mice were exposed for 30 minutes to 681; 1,090; 1,837; or 3,565 mg/m³. JP-8 is not a primary irritant and reductions in the respiratory rate did not occur within 10 minutes at the lower concentrations. However, reductions in the respiratory rate within the 30-minute exposure durations were concentration-dependent and allowed calculation of an RD₅₀. Based on the correlation between RD₅₀ data and sensory irritancy levels for numerous chemicals, a 0.1-fold reduction of the RD₅₀ results in a concentration that elicits some sensory irritation in humans but that can be tolerated for hours to days (Alarie 1981). Using this reasoning, the resulting concentration of 290 mg/m³ can be tolerated over all AEGL-1 exposure durations. The 290 mg/m³ value is supported by the lack of adverse health effects in animal studies with repeated exposures to 1,000 mg/m³ of JP-8 vapor (continuous exposures up to 90 days) (Mattie et al. 1991; Briggs 2001; Rossi et al. 2001). Dividing the 1,000 mg/m³ value by an interspecies uncertainty factor of 1 (no species differences were observed in multiple studies with rats and mice and the exposures were repeated) and an intraspecies uncertainty factor of 3 (to account for potential differences in human susceptibilities to sensory irritation) results in 330 mg/m³, a value similar to that derived from the RD₅₀ study. The repeated nature of the support studies also supports the use of a single value for all exposure durations.

The AEGL-2 is based on several studies with rodents (rats and mice) that indicate that exposure to 1,100 mg/m³ of JP-8 would not elicit adverse health effects but may be the threshold for such effects. The shorter-term studies (30