

TABLE 3.—SUMMARY OF PROPOSED AEGL VALUES FOR AMMONIA [PPM (MG/M<sup>3</sup>)]—Continued

Classification	Exposure duration						Endpoint (Reference)
	5-minutes	10-minutes	30-minutes	1-hour	4-hours	8-hours	
AEGL-3 (Lethal)	3,800 (2,657)	2,700 (1,890)	1,600 (1,119)	1,100 (769)	550 (385)	390 (273)	Lethality (Kapeghian et al., 1982; MacEwen and Vernot, 1972)

ii. *References.* a. Kapeghian, J.C.; Mincer, H.H.; and Hones, A.B., et al. 1982. Acute inhalation toxicity of ammonia in mice. *Bulletin of Environmental Contamination and Toxicology*. 29:371–378.

b. MacEwen, J.D.; Theodore, J.; and Vernot, E.H. 1970. Human exposure to EEL concentrations of monomethylhydrazine, AMRL-TR-70-102, Paper No 23. *Proceedings of the 1st Annual Conference on Environmental Toxicology*. September 9–11, 1970. Wright-Patterson AFB, OH. pp. 355–363.

c. MacEwen, J.D. and Vernot, E.H. 1972. Toxic Hazards Research Unit Annual Technical Report: 1972. *SysteMed Report No. W-72003*, AMRL-TR-72-62. Sponsor: Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH. AD-755-358.

d. Verberk, M.M. 1977. Effects of ammonia on volunteers. *International Archives of Occupational and Environmental Health*. 39:73–81.

3. *Bromine*—i. *Description.* The halogen bromine (Br<sub>2</sub>) is a dark reddish-brown volatile liquid at room temperature. Its oxidizing potential lies between that of chlorine and iodine. Bromine is used as a water disinfectant, for bleaching fibers and silk, and in the manufacture of medicinal bromine compounds, dyestuffs, flame retardants, agricultural chemicals, inorganic bromide drilling fluids, and gasoline additives.

Bromine is a skin, eye, and respiratory tract irritant. Inhalation causes respiratory tract irritation and pulmonary edema. Although accidental human exposures have occurred, concentrations were either not reported or were judged unreliable. Aside from old and anecdotal information, the data

base is limited to one study with human subjects and two lethality studies with the mouse as the test species. One of the lethality studies (Bitron and Aharonson 1978) provided data sufficient for derivation of the relationship between concentrations that result in lethality (LC<sub>50</sub> values) and exposure duration: C<sup>2.2</sup> × t = k.

The AEGL-1 was based on exposures of 20 healthy human volunteers to concentrations of 0.1 to 1.0 ppm for at least 30 minutes (Rupp and Henschler 1967). Eye irritation, but not nose or throat irritation, occurred during a 30-minute exposure to 0.1 ppm. At concentrations 0.5 ppm, there was a stinging and burning sensation of the conjunctiva. The 30-minute 0.1 ppm was chosen as the basis for the AEGL-1. The 0.1 ppm concentration was divided by an intraspecies uncertainty factor of 3 to protect susceptible individuals. An intraspecies uncertainty factor of 3 was considered sufficient because workers have been occupationally exposed to 1 ppm with no symptoms other than “excess irritation” (Elkins 1959). Furthermore, effects at this low concentration appear to be limited to the eyes and upper respiratory tract; there was no penetration to the lower respiratory tract. The resulting 30-minute AEGL-1 value of 0.03 ppm was time-scaled to the other AEGL exposure durations using the C<sup>2.2</sup> × t = k relationship derived from the mouse lethality study.

The AEGL-2 was based on the concentration of 1 ppm for 30 minutes which the volunteers in the above study (Rupp and Henschler 1967) found irritating (stinging and burning sensation of the conjunctiva; nose and throat irritation). The 30-minute 1 ppm value was divided by an intraspecies

uncertainty factor of 3 to protect susceptible individuals and time scaled to the other AEGL-2 exposure durations using the concentration-exposure duration relationship from the mouse lethality study of C<sup>2.2</sup> × t = k. An intraspecies uncertainty factor of 3 was considered sufficient as the symptoms may be below those defining an AEGL-2. However, no reliable studies with exposures to higher concentrations were located.

Both lethality studies with the mouse described the inhalation toxicity of chlorine and bromine. However, both studies reported lower LC<sub>50</sub> values for chlorine than those reported in more recent well-conducted studies. Nevertheless, the study that reported the lower lethal concentrations for chlorine was used for derivation of the AEGL-3 values for bromine (Schlagbauer and Henschler 1967). The data in this study showed a clear concentration-response relationship; the exposure duration was 30 minutes. Using probit analysis, a 30-minute LC<sub>50</sub> value of 204 ppm and a 30-minute LC<sub>01</sub> of 116 ppm were calculated. The 30-minute LC<sub>01</sub> of 116 ppm was used as the basis for calculation of AEGL-3 values. The 116 ppm LC<sub>01</sub> was divided by a combined uncertainty factor of 10 (3 for interspecies differences [the mouse was the most sensitive species for lethal effects in tests with other halogens] and 3 for intraspecies differences [at high concentrations bromine is corrosive to the mucous membranes of the respiratory system; effects are not expected to differ greatly among individuals]) and scaled across time using the relationship C<sup>2.2</sup> × t = k, derived from the same study.

The proposed AEGL values are listed in Table 4 of this unit.

TABLE 4.—SUMMARY OF PROPOSED AEGL VALUES FOR BROMINE [PPM (MG/M<sup>3</sup>)]

Classification	10-minutes	30-minutes	1-hour	4-hours	8-hours	Endpoint (Reference)
AEGL-1 (Nondisabling)	0.055 (0.36)	0.033 (0.22)	0.024 (0.16)	0.013 (0.09)	0.0095 (0.06)	Rupp and Henschler 1967
AEGL-2 (Disabling)	0.55 (3.6)	0.33 (2.1)	0.24 (1.6)	0.13 (0.85)	0.095 (0.62)	Rupp and Henschler 1967