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PERACETIC ACID
(CAS Reg. No. 79-21-0)

ACUTE EXPOSURE GUIDELINE LEVELS
(AEGLs)

June 2008

PREFACE

1
2
3 Under the authority of the Federal Advisory Committee Act (FACA) P. L. 92-463 of
4 1972, the National Advisory Committee for Acute Exposure Guideline Levels for Hazardous
5 Substances (NAC/AEGL Committee) has been established to identify, review and interpret
6 relevant toxicologic and other scientific data and develop AEGLs for high priority, acutely toxic
7 chemicals.

8
9 AEGLs represent threshold exposure limits for the general public and are applicable to
10 emergency exposure periods ranging from 10 minutes to 8 hours. Three levels — AEGL-1,
11 AEGL-2 and AEGL-3 are developed for each of five exposure periods (10 and 30 minutes,
12 1 hour, 4 hours, and 8 hours) and are distinguished by varying degrees of severity of toxic
13 effects. The three AEGLs are defined as follows:

14
15 AEGL-1 is the airborne concentration (expressed as parts per million or milligrams per
16 cubic meter [ppm or mg/m³]) of a substance above which it is predicted that the general
17 population, including susceptible individuals, could experience notable discomfort, irritation, or
18 certain asymptomatic, non-sensory effects. However, the effects are not disabling and are
19 transient and reversible upon cessation of exposure.

20
21 AEGL-2 is the airborne concentration (expressed as ppm or mg/m³) of a substance above
22 which it is predicted that the general population, including susceptible individuals, could
23 experience irreversible or other serious, long-lasting adverse health effects or an impaired ability
24 to escape.

25
26 AEGL-3 is the airborne concentration (expressed as ppm or mg/m³) of a substance above
27 which it is predicted that the general population, including susceptible individuals, could
28 experience life-threatening health effects or death.

29
30 Airborne concentrations below the AEGL-1 represent exposure levels that could produce
31 mild and progressively increasing but transient and nondisabling odor, taste, and sensory
32 irritation or certain asymptomatic, non-sensory effects. With increasing airborne concentrations
33 above each AEGL, there is a progressive increase in the likelihood of occurrence and the
34 severity of effects described for each corresponding AEGL. Although the AEGL values
35 represent threshold levels for the general public, including susceptible subpopulations, such as
36 infants, children, the elderly, persons with asthma, and those with other illnesses, it is recognized
37 that individuals, subject to unique or idiosyncratic responses, could experience the effects
38 described at concentrations below the corresponding AEGL.

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17

EXECUTIVE SUMMARY

Peracetic acid is produced by the catalytic action of sulfuric acid on acetic acid and hydrogen peroxide. Technical or commercial peracetic acid products contain different concentrations of peracetic acid, acetic acid, and hydrogen peroxide, but the concentration of peracetic acid does not exceed 40%. Peracetic acid is unstable; it decomposes to its original constituents under conditions that vary with concentration, temperature, and pH. Peracetic acid is used as a disinfectant against bacteria, fungi, and viruses in the food and medical industry, as a bleaching agent, as a polymerization catalyst or co-catalyst, in the epoxidation of fatty acid esters, as an epoxy resin precursor, and in the synthesis of other chemicals.

Peracetic acid is corrosive/irritating to the eyes, mucous membranes of the respiratory tract, and skin. It causes lacrimation, extreme discomfort, and irritation to the upper respiratory tract in humans after exposure to concentrations as low as 15.6 mg peracetic acid /m³(5 ppm) for only 3 minutes. Eye irritation, clinical signs, and pathologic lesions indicative of respiratory tract irritation have been observed in laboratory animals exposed by inhalation to various concentrations of peracetic acid aerosols. Exposure to lethal concentrations of peracetic acid causes hemorrhage, edema, and consolidation of the lungs, whereas nonlethal concentrations cause transient weight loss or reduced weight gain in addition to slight to moderate signs of respiratory tract irritation. Human data were available for deriving AEGL-1 and -2 values and animal data were available for deriving AEGL-3 values.

The proposed AEGL-1 value is 0.52 mg/m³ (0.17 ppm) for all exposure durations from 10 minutes to 8 hours. This value was derived from an exposure concentration of 1.56 mg/m³ (0.5 ppm), which, according to Fraser and Thorbinson (1986), is expected to cause no discomfort and according to McDonagh (1997) is not immediately irritating but would be unpleasant for an extended period of time. Therefore, 1.56 mg/m³ is considered to be the threshold for irritation to mucous membranes and eyes. An intraspecies uncertainty factor of 3 was applied to 1.56 peracetic acid mg/m³, because peracetic acid is a corrosive/irritant substance and the effects, which are confined to the upper respiratory tract, are expected to be similar for individuals within the population. The rationale for proposing the same value for all time points, is as follows: (1) effects of peracetic acid exposure correlate with concentration more than time, and (2) peracetic acid is freely soluble in water; therefore, it should be effectively scrubbed in the nasal passages, particularly at the very low AEGL-1 concentration.

The proposed AEGL-2 value is 1.56 mg/m³ (0.5 ppm) for all exposure durations from 10 minutes to 8 hours based on an exposure concentration of 4.7 mg/m³, which, according to Fraser and Thorbinson (1986), is expected to be associated with slight to tolerable discomfort to nasal membranes and eyes for exposure durations up to 20 minutes. There was no increase in irritation with exposure duration. An intraspecies uncertainty factor of 3 was applied because peracetic acid is a corrosive/irritating substance and the effects, which are confined to the upper respiratory tract, are expected to be similar among individuals in the population. The rationale for proposing the same value for all exposure durations is discussed above for AEGL-1 values.

The proposed AEGL-3 values are derived from the study of Janssen (1989). This study showed that rats exposed to Proxitane[®] 1507 (15% peracetic acid, ~28% acetic acid, 14% hydrogen peroxide, ~1% "stabilizer", and ~43% water) aerosols at concentrations of 130, 300, or

1 320 mg/m³ for 30 minutes had mortality responses of 0/5, 0/5, and 3/5 rats, respectively.
 2 Exposures to aerosol concentrations of 150, 390, or 1450 mg/m³ for 60 minutes resulted in the
 3 death of 0/5, 2/5, and 5/5 rats, respectively. Clinical signs indicative of respiratory tract irritation
 4 were observed at all concentrations and increased in severity with increased exposure
 5 concentration for each exposure duration. Clinical signs suggestive of nervous system effects
 6 were also observed, but could have been due to extreme respiratory tract discomfort. The AEGL
 7 values were derived from the highest concentration at which no mortality was observed: 300
 8 mg/m³ for a 30-minute exposure and 150 mg/m³ for a 60-minute exposure. The total uncertainty
 9 factor is 10. Interspecies and intraspecies uncertainty factors of 3 were applied because mucous
 10 membranes of the respiratory tract are not expected to show significant variation in response to
 11 corrosive/irritating substances concentrations that cause physical damage and that approach the
 12 threshold for lethality regardless of species or the individuals in the population. The data,
 13 however, suggest that humans may be slightly more sensitive than animals to peracetic acid. The
 14 rationale for the intraspecies uncertainty factor of 3 was the same as described for AEGL-1. The
 15 intraspecies uncertainty factor of 3 and the interspecies uncertainty factor of 3 were applied to
 16 300 and 150 mg/m³ for the 30- and 60-minute exposures, respectively. The equation, $C^n \times t = k$,
 17 where $n = 1.6$ (estimated from 1- and 4-hour LC₅₀ data for rat), was used to scale the 60-minute
 18 exposure to 4- and 8-hour values and the 30-minute exposure to 10 minutes.

19
 20 The proposed AEGL values are summarized in Table 1:
 21

Classification	10 min	30 min	1 h	4 h	8 h	Endpoint /Reference
AEGL-1 (Nondisabling)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	Threshold for irritation (Fraser and Thorbinson, 1986; McDonagh, 1997)
AEGL-2 (Disabling)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	Mild irritation (Fraser and Thorbinson, 1986)
AEGL-3 ^a (Lethal)	60 mg/m ³	30 mg/m ³	15 mg/m ³	6.3 mg/m ³	4.1 mg/m ³	Highest concentration causing no deaths (Janssen, 1989)

^aAEGL-3 values are based on exposure to aerosol; therefore, concentrations are not converted to ppm.

22
 23
 24 **References:**
 25

- 26 Fraser, J. A. L.; Thorbinson, A. 1986. Fogging Trials with Tenneco Organics Limited (30th June, 1986)
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 28
 29 Janssen, P. J. M. 1989. Acute Inhalation Toxicity Studies of Proxitane 1507 in Male Rats (I) Duphar
 30 B.V., Report No. S. 8906, Int. Doc. No. 56645/25/89.
 31
 32 McDonagh, J. 1997. Atmospheric Monitoring of Peracetic acid on the Existing Caprolactone Plant
 33 Distillation Houses A & B – Assessment of Results. Solvay Interlox, Warrington, Reference No.
 34 EE970192.M01, Memorandum to R.A. Haffenden et al. dated 30 April 1997.

1. INTRODUCTION

Peracetic acid is produced by the catalytic action of sulfuric acid on acetic acid and hydrogen peroxide (Lewis, 1993). These constituents are found in the most concentrated commercial grades of peracetic acid at the following approximate concentrations (weight %): 40% peracetic acid, 40%, acetic acid, 5% hydrogen peroxide, 1% sulfuric acid, and 13% water, along with 500 ppm of a "stabilizer" (Bock et al., 1975). The stabilizer was not identified. Peracetic acid decomposes as it is diluted with water, particularly when diluted to 10 or 20% peracetic acid. Sulfuric acid catalyzes the decomposition of peracetic acid and is present in sufficient amounts in 10 to 20% peracetic acid products to catalyze the decomposition of peracetic acid to the individual constituents: acetic acid and hydrogen peroxide. At more dilute concentrations of peracetic acid, decomposition occurs more slowly, because sulfuric acid is no longer present in sufficient quantities to catalyze its decomposition. However, very dilute solutions (0.2%) will decompose more rapidly at elevated temperatures (4 weeks at 4°C vs 1 week at 40°C). In addition, increasing the pH to 7.0 results in greater than 50% decomposition of peracetic acid after 1 day compared with almost no decomposition after 7 days at pH 2.7 (the natural pH of 0.2% peracetic acid) (Mucke, 1977). Peracetic acid is known as a powerful oxidizing agent. It is unstable upon contact with organic materials and it explodes at 110°C (Lewis, 1993).

Because of its effectiveness against bacteria, fungi, and viruses, peracetic acid is used as a disinfectant in the food and medical industries (Bock et al., 1975; Fishbein, 1979; Lewis, 1993). It is also used as a bleaching agent in the paper and textile industries, as a polymerization catalyst or co-catalyst, in the epoxidation of fatty acid esters, as an epoxy resin precursor, and in the synthesis of other chemicals (Fishbein, 1979; Bock et al., 1975).

The database for peracetic acid is limited; however, limited quantitative human and animal data are available for deriving AEGL values. The animal data for inhalation studies were performed primarily on aerosols of trade name products or diluted grades of peracetic acid referred to as Proxitane 1507 (15% peracetic acid, ~28% acetic acid, and 14% hydrogen peroxide) or Proxitane AHC (~5% peracetic acid, 19% (minimum) hydrogen peroxide, and 10% acetic acid). Measurements of atmospheric concentrations in the inhalation chambers showed that the relative concentrations of peracetic acid, acetic acid, and hydrogen peroxide varied in aerosols generated from the same product, thus demonstrating the instability of peracetic acid in the product or the aerosol. Although a contributing effect of acetic acid and hydrogen peroxide cannot be ruled out in the toxicity studies described in this report, it appears, however, that acetic acid and hydrogen peroxide are considerably less toxic than peracetic acid. Sulfuric acid concentrations were not reported for the products (Proxitane 1507 and Proxitane AHC) used in these studies, but would be expected to account for only a very small fraction since the highest concentration of sulfuric acid in most products was only 1%.

TABLE 2. Physical/Chemical Data for Peracetic Acid		
Synonyms	Peroxyacetic acid, acetic peroxide, ethaneperoxoic acid, acetyl hydroperoxide, Proxitane 4002®, Proxitane 1507®, Proxitane AHC®	RTECS, 1997, O'Neil et al., 2001
Chemical Formula	CH ₃ COOOH	O'Neil et al., 2001
Chemical Name	Peracetic Acid	
CAS Registry No.	79-21-0	RTECS, 1997
Molecular Weight	76.05	O'Neil et al., 2001
Physical State	Colorless liquid	Lewis, 1993
Solubility	Freely soluble in H ₂ O, alcohol, ether, H ₂ SO ₄	O'Neil et al., 2001
Boiling Point	105 °C	Lewis, 1993
Freezing Point	-30 °C	Lewis, 1993
Density	1.15 @ 20 °C	Lewis, 1993
Flash Point	40.5 °C	Lewis, 1993
Explosion point	110 °C	Lewis, 1993
Vapor Pressure	14.5 mm Hg @ 25 °C	HSDB, 1997
Henry's Law Constant	2.08 × 10 ⁻⁶ atm•m ³ /mol @ 25 °C	HSDB, 1997
Conversion	1 ppm= 3.110 mg/m ³ @25 °C and 760 mm Hg	

2. HUMAN TOXICITY DATA

2.1. Acute Lethality

No data on human lethality due to exposure to peracetic acid were found in the literature searched.

2.2. Nonlethal Toxicity

Bock et al. (1975) reported that peracetic acid was intensely irritating to the human nasal passages. There was no additional information documenting the source of this information. McDonagh (1997) and an associate conducted measurements of airborne peracetic acid concentrations in two caprolactone distillation plants. Peracetic acid, which is used in caprolactone monomer production, was distilled in the distillation houses of the plant. The monitoring took place over a 3-hour period. Peracetic acid vapor was measured at total peroxygen content; hydrogen peroxide was not expected to comprise a large proportion of the measured substance in the vapor. In one area, peracetic acid concentrations ranged from 0.5–0.6 ppm (1.56–1.87 mg/m³); these concentrations were not considered to be immediately irritating, but would have been considered “unpleasant for an extended period” of time. Peracetic acid concentrations of 0.13–0.17 ppm (0.40–0.53 mg/m³) in another area were considered tolerable and not unpleasant. McDonagh and his associate spent most of their time in an area where the average peracetic acid concentration measured for a 10-minute sampling time was 0.17 ppm (0.53 mg/m³). They noted no lacrimation at any time during their 3-hour exposure. McDonagh (1997) recommended 0.15 ppm (0.47 mg/m³) as an acceptable 8-hour occupational exposure limit for peracetic acid. This concentration would be perceptible, but not irritating or unpleasant.

1 Fraser and Thorbinson (1986) conducted fogging studies in a chicken house using
2 Tenneco Organics' "Peratol" diluted to 1:20 (5% peracetic acid = 1904 mg/L in the liquid
3 formulation) to determine atmospheric levels of peroxygen and establish safe working practices.
4 Measurements of aerosol concentrations were taken at various distances from the fogging unit to
5 establish the spread and distribution of peracetic acid concentrations. The analytical procedure
6 measured total peroxygen concentration, which was calculated as hydrogen peroxide (H₂O₂).
7 The details of the analytical method were not presented in the report. The fogging unit was
8 placed about 1 m off the ground, and measurements were taken at various locations (the shed
9 apex, the floor, and sides of the shed). The first half of Table 3 presents the concentrations, time
10 of measurements starting at 3:30 (p.m. assumed), and physiological responses to peracetic acid.
11 The authors did not report the number of subjects exposed to the aerosol. Lacrimation was noted
12 at 5 ppm (15.6 mg/m³), extreme discomfort was noted at concentrations ≥2.5 ppm (7.79 mg/m³),
13 and 2.0 ppm (6.23 mg/m³) was considered unbearable in one instance and tolerable for 2 minutes
14 in another. After 23 minutes, the fogging unit was turned off and refilled; during this time, the
15 concentration of peracetic acid dropped to <0.5, 0.5- 1.0, and 1.0-1.5 ppm (1.56, 1.56-3.12, and
16 3.12-4.7 mg/m³) at 0.3, 2, and 4 meters, respectively, above ground; a slight discomfort of nasal
17 and eye membranes was noted during this phase. For the next 1 hour and 15 minutes, the
18 concentrations ranged from 2.0 to 3.0 ppm (6.23 to 9.35 mg/m³); these concentrations were
19 associated with unbearable or extreme discomfort.
20

21 At 5:20 p.m., the fogger was turned off and the concentrations of peracetic acid began to
22 decrease. The second half of Table 3 describes the concentrations and observed physiological
23 responses after shutoff. After the fogger was turned off, the concentrations on peracetic acid
24 decreased from 2.0 ppm (6.23 mg/m³) to ≤0.5 ppm within 45 minutes. During this time the
25 physiological responses decreased from extreme discomfort of mucous membranes to mild
26 discomfort at 0.5-1.0 ppm (1.56-3.12 mg/m³) to no discomfort at ≤0.5 ppm (1.56 mg/m³). No
27 irritation to the chest occurred at any time during this test.
28

29 2.3. Summary

30
31 No data on human lethality caused by exposure to peracetic acid were found in the
32 literature, and the data on nonlethal effects are limited. Peracetic acid is extremely irritating to
33 mucous membranes of the eyes and nasal passages at low concentrations. Exposure to aerosols
34 generated from diluted Peratol was associated with lacrimation at 5 ppm (15.6 mg/m³), extreme
35 discomfort and irritation to mucous membranes at ≥2.0 ppm (6.23 mg/m³); slight or mild
36 discomfort at 0.5-1.5 ppm (1.56-4.67 mg/m³), and no discomfort at <0.5 ppm (1.56 mg/m³)
37 (Fraser and Thorbinson, 1986). Exposure to peracetic acid vapor at concentrations of 0.13-0.17
38 ppm (0.40-0.53 mg/m³) for up to 3 hours were detectable, tolerable, and not unpleasant
39 (McDonagh, 1997). Irritation to the chest did not occur at concentrations ≥5 ppm (15.6 mg/m³),
40 and no data were available for exposure of humans to concentrations >5 ppm (15.6 mg/m³). In
41 the study by McDonagh (1997), humans were exposed to peracetic acid vapor, and in the study
42 by Fraser and Thorbinson (1986) humans were exposed to the aerosols. There was agreement
43 between exposure to aerosol and vapors at 0.5 ppm (1.56 mg/m³), the highest vapor
44 concentrations reported; both studies reported either no discomfort or only mild or slight
45 discomfort at this concentration. There were no comparable levels between the two studies at
46 the higher exposure concentrations.
47

TABLE 3. Physiological Response to Low Level Exposure to Peracetic Acid Aerosols Generated by a Fogger		
Time	ppm (as total H ₂ O ₂) ^a	Observed Effects
3.30	5 (15.6)	Lacrimation, extreme discomfort, irritation of nasal membranes
3.37	5 (15.6)	Lacrimation, extreme discomfort, irritation of nasal membranes
3.53	1-1.5 (3.12-4.67)	Slight discomfort of nasal and eye membranes, decreasing with concentration
	0.5-1.0 (1.56-3.12)	
	<0.5 (1.56)	
4.05	2.0 (6.23)	Irritation considered unbearable
5.00	2.5 (7.79)	Extreme discomfort of nasal membranes
5.10	2.5 (7.79)	Extreme discomfort
	3.0 (9.35)	Extreme discomfort
5.15	3.0 (9.35)	Extreme discomfort
5.20	2.0 (6.23)	Irritation tolerable for 2 minutes
Concentrations and response after the fogger was turned off (minutes)		
5-10	2.0 (6.23)	Extreme discomfort of mucous membranes
15-20	1-1.5 (3.12-4.67)	Discomfort of mucous membranes
25	1.0 (3.12)	Discomfort tolerable
30	0.5-1.0 (1.56-3.12)	Discomfort mild
35-45	≤0.5 (1.56)	No discomfort

Source: Fraser and Thorbinson, 1986

^aMeasurements taken at different locations relative to fogging unit; numbers in parentheses are concentrations in mg/m³.

3. ANIMAL TOXICITY DATA

3.1 Acute Lethality

3.1.1. Rats

Janssen (1989a) conducted a study in which groups of five male CPB-WU Wistar derived rats were exposed to Proxitane 1507[®] (15% peracetic acid, ~28% acetic acid, 14% hydrogen peroxide, ~1% stabilizer, and ~43% water) aerosol by nose-only inhalation in a 40 L dynamic flow chamber. The chamber was constructed of aluminum, and the inside walls were coated with silver and a thin layer of polytetrafluoroethylene. The test atmospheres were generated with a stainless-steel nebulizer, and test concentrations were analyzed as total peroxygen concentration corrected for the amount of hydrogen peroxide. Chamber concentrations (converted from mg/L to mg/m³) of the constituents in the test material and exposure durations are listed in Table 4. The study author did not comment on the greater than zero concentration of constituents in the control atmosphere, but it may be related to the detection limit of the analytical procedure or natural occurrence of hydrogen peroxide in the atmosphere (ATSDR, 1997). Respiratory rates were determined during exposure, clinical signs of toxicity were recorded for 14 days after exposure, and body weight was measured on post-exposure days 2, 7, and 14. Postmortem studies included gross examination, measurement of lung weight, and histopathological examination of the lungs. The results are summarized in Table 4.

Deaths occurred only in groups exposed to peracetic concentrations ≥ 320 mg/m³ regardless of exposure duration (320 mg/m³ for 15 or 30 minutes, 390 mg/m³ for 60 minutes, and 1450 mg/m³ for 60 minutes). The LC₅₀ for the 60-minute exposure to peracetic acid was 476

1 mg/m³. Clinical signs of toxicity included effects primarily indicative of extreme respiratory
2 irritation (reduced respiratory rate, respiratory difficulties, blood around the nose and mouth,
3 sneezing, and rubbing the nose) and those that may be indicative of nervous system effects
4 (passivity, decreased alertness and startle response, piloerection, salivation, decreased coordi-
5 nation and muscle tone), but were probably related to extreme discomfort of the animals. The
6 only effect on the eyes was drooping eye lids. The severity of the clinical signs (slight,
7 moderate, severe) as well as the number of signs observed in each group and time of
8 disappearance of clinical signs increased with concentration of test material and exposure
9 duration. Clinical signs disappeared 1.5 hours to 5 days after exposure. Respiratory rates
10 measured during exposure showed maximum depressions to 22 to 41% of preexposure rates in
11 all exposure groups. Body weight measurements showed transient decreases on day 2 after
12 exposure to 320 mg/m³ for 15 or 30 minutes and 150 mg/m³ or 1450 mg/m³ for 60 minutes.
13 Macroscopic examinations showed effects indicative of respiratory irritation (blood around the
14 nose, red nasal and tracheal mucosa, bloody fluid in the trachea, dark red lungs, and red or dark
15 spots on the lungs) particularly in animals that died during the study. The animals surviving to
16 study termination showed only red or dark spots on the lungs. In addition, the stomach and
17 small intestines were distended with gas and the liver was swollen in animals exposed to ≥ 320
18 mg/m³. Absolute and relative lung weights were elevated in rats exposed to 320 or 390 mg/m³.
19 Only one animal each exposed to 300, 390, or 1450 mg/m³ showed microscopic effects in the
20 lungs. Although it appeared that the observed effects were caused by exposure to peracetic acid,
21 most effects also showed increased severity with the increased concentrations of measured acetic
22 acid and hydrogen peroxide. Based on lethality data, it is unlikely that acetic caused the effects
23 observed in the rats; however, a contributing effect cannot be ruled out for either constituent.
24 See Section 4.4.4 for a brief discussion of the toxicity of acetic acid and hydrogen peroxide
25 (Janssen, 1989a).
26

TABLE 4. Effects of nose-only inhalation exposure to Proxitane 15077 in male rats							
Group No.	Exposure time (min)	Concentration (mg/m ³) ^a			Effects		
		Peracetic acid	Acetic acid	H ₂ O ₂	Mortality	Clinical signs & body weight ^a	Gross pathology
10 (control)	60	<70	<70	<50	0/5	+	URT (0/5); LRT (1/5)
8	15	300	767	<50	0/5	+, bw (no effect)	URT (0/5); LRT (2/5)
3	15	320	2000	<70	1/5	+, ++, wt. loss	URT (1/5); LRT (1/5)
6	30	130	210	10	0/5	+, bw (no effect)	URT (0/5); LRT (0/5)
9	30	300	767	<50	0/5	+, ++, bw (no effect)	URT (0/5); LRT (1/5)
4	30	320	2000	<70	3/5	+, ++, +++, bw (no data)	URT (2/5); LRT (5/5)
7	60	150	290	9	0/5	+, ++, ↓ bw	URT (0/5); LRT (1/5)
5	60	390	2800	4	2/5	+, ++, +++, bw (no data)	URT (2/5); LRT (4/5)
2	60	1450	6600	450	5/5	+, ++, +++, bw (no data)	URT (3/5); LRT (2/5)

Source: Janssen, 1989a

^a+, ++, +++ refer to slight, moderate, and severe clinical signs, respectively.

bw = body weight; ↓ = decrease; URT = upper respiratory tract; LRT = lower respiratory tract

1
2
3 Janssen and Van Doorn (1994) conducted a 4-hour acute inhalation study in rats with
4 Proxitane AHC[®]. The chemical composition of the test material was as follows: 4.7–5.4% (~5%)
5 peracetic acid, 19% (minimum) hydrogen peroxide, 10% acetic acid, water, and 1% surfactant.
6 Groups of five male and five female Wistar derived rats were exposed to aerosols of the test
7 material by nose-only inhalation in an aluminum chamber with the inside walls coated with
8 silver and a thin layer of polytetrafluoroethylene. The test concentrations of peracetic acid in the
9 chamber were analyzed as total peroxygen concentration corrected for the amount of hydrogen
10 peroxide. The concentrations of peracetic acid and other constituents are presented in Table 5.
11 Each group was exposed to the test atmospheres for 4 hours and surviving animals were
12 observed for 14 days. An unexposed control group was included. The mortality response is
13 summarized in Table 5. In Group B exposed to peracetic acid at 267 mg/m³, four of five male
14 rats died by day 3 and all females had died by day 4 (four died before day 2). In Group D
15 exposed to 185 mg/m³, two males died on day 1 and two females had died by day 3. The LC₅₀
16 for the combined sexes was 204 mg/m³. Numerous clinical signs including apathy, respiratory
17 difficulties, reduced respiratory rate, noisy breathing, cyanosis, lacrimation, salivation, ptosis,
18 twitching, hypothermia, abnormal gait and posture, crusts on nose, and blood under cage were
19 observed in rats of all groups except lacrimation, cyanosis, and salivation were not observed at
20 87 mg/m³. Fewer clinical signs were observed in the lowest exposure group compared with the
21 highest exposure groups. The clinical signs disappeared after day 1 for males or day 3 for
22 female rats exposed to 87 mg/m³ and after day 3 or 4 for the remaining groups. The clinical
23 signs were considered to be related to the corrosive/irritant properties of the test material. The
24 body weights of rats exposed to the test atmospheres were much less than those of the controls
25 on day 2 after exposure due to pronounced weight losses of 36 to 52 g for males and 19 to 34 g

1 for females ($p < 0.01$ all groups compared with controls). Body weights of all exposed groups
 2 showed signs of recovery between day 2 and 7 after exposure. Absolute and relative lung
 3 weights were elevated in all groups. Gross examination showed no abnormalities in male or
 4 female rats exposed to 87 mg/m^3 . Red or brown staining or blood around the nose and/or mouth
 5 was observed in rats exposed to $\geq 163 \text{ mg/m}^3$. In addition, red spots were observed on the lungs
 6 of rats receiving $\geq 163 \text{ mg/m}^3$, and lung consolidation or edema was observed in animals that
 7 died due to exposure. It is unlikely that acetic acid or hydrogen peroxide was the cause of
 8 mortality in the rats. The lowest lethal concentration for a 4-hour exposure of rats to acetic acid
 9 ($39,216 \text{ mg/m}^3$) is about 30 times greater than the LC_{50} (1283 mg/m^3) calculated from the acetic
 10 acid concentrations in Table 5. Likewise, the LC_{50} for hydrogen peroxide reported for rats (1972
 11 mg/m^3) is almost 3 times greater than the LC_{50} (684 mg/m^3) calculated from the data in Table 5
 12 Therefore, the concentrations of acetic acid and hydrogen peroxide appear too low to have
 13 caused the deaths among the rats exposed to peracetic acid.
 14

Parameter	Concentration (mg/m^3)			
	Group C	Group A	Group D	Group B
Peracetic acid	87	163	185	267
Acetic acid	441	887	1337	1598
Hydrogen peroxide	200	467	595	1075
Mortality				
Males	0/5	0/5	2/5	4/5
Females	0/5	0/5	2/5	5/5
Combined	0/10	0/10	4/10	9/10
sexes				

$LC_{50} = 204 \text{ mg/m}^3$, 95% confidence limits = $186\text{--}233 \text{ mg/m}^3$

Source: Janssen and van Doorn, 1994

15

16

17 3.1.2. Mice

18

19 Merka and Urban (1978) conducted a study in which groups of ten mice were exposed in
 20 a dynamic chamber to aerosols of Persteril[®] (commercial product containing 40% peracetic acid)
 21 or laboratory peracetic acid produced from equimolar concentrations of acetic acid and hydrogen
 22 peroxide and using sulfuric acid as the catalyst. In contrast to Persteril, the laboratory product
 23 contained no sulfuric acid. The mice were exposed to peracetic acid concentrations at 150, 300,
 24 450, 600, 800, 1000, 1300, or 1600 mg/m^3 for 60 minutes. The animals were observed for 20
 25 days. Animals exposed to peracetic acid (specific concentrations not reported) showed signs of
 26 eye and respiratory irritation during exposure (restlessness, bristling fur, half closing of eyelids,
 27 and nose rubbing along with respiratory distress, gasping, and increased respiration, which
 28 varied with concentration). The eyelids were red and swollen and a secretion was observed
 29 around the eyes and snout within the first 24 hours; hair loss occurred later. The LC_{50} was 524
 30 mg/m^3 for laboratory peracetic acid and 512 mg/m^3 for Persteril. The similar LC_{50} values
 31 showed that the small amount of sulfuric acid in Persteril had no effect on lethality in the mouse.

32 One or two mice died during exposure; other mice died during the observation period. The
 33 study authors did not report lethality data for individual groups. Histological examination of the
 34 animals that died and those that survived revealed lesions only in the lungs. None occurred in

1 the heart, liver, spleen, or kidneys. Lung lesions in mice that died within 2 days consisted of
2 extensive foci of hemorrhagic exudative inflammation involving the parenchyma of the entire
3 lungs; foci of alveolar inflammation with serous exudate, red blood cells (RBCs), macrophages
4 with phagocytosed aerosol particles; and desquamated epithelial cells. The severity of the
5 lesions increased with exposure concentration. The lungs of animals that died about day 6 after
6 exposure showed evidence of focal bronchopneumonia characterized by hyperemia of the
7 alveolar septa and serohemorrhagic exudate containing desquamated epithelial cells and macro-
8 phages with phagocytosed aerosol particles. The lungs of animals surviving to 20 days showed
9 diffuse inflammatory lesions at concentrations $>600 \text{ mg/m}^3$ and focal inflammatory lesions at
10 $\leq 600 \text{ mg/m}^3$.

11 **3.2. Nonlethal Toxicity**

12 **3.2.1. Rat**

13
14
15 Janssen (1989b) exposed groups of five CPB-WU Wistar derived male rats by nose-only
16 inhalation to aerosols of Proxitane 1507[®] (15% peracetic acid, ~28% acetic acid, 14% hydrogen
17 peroxide, ~1% stabilizer, and ~43% water) at concentrations and exposure durations listed in
18 Table 6. The test concentrations of peracetic acid were analyzed as total peroxygen corrected for
19 the amount of hydrogen peroxide. The concentrations of acetic acid in the chamber atmospheres
20 were not reported by the study author. The study author also did not comment on the greater
21 than zero concentration of hydrogen peroxide in the control atmosphere. The exposure
22 conditions and chamber were the same as described by Janssen (1989a) (Section 3.1.1). The
23 animals were observed for 7 or 14 days after exposure; body weights were measured on days 2,
24 7, and 14 (where appropriate). Necropsies were performed on all animals, the lungs were
25 weighed, and the lungs and nasal cavities were processed for microscopic examination. The
26 group exposed to peracetic acid at 589 mg/m^3 for 60 minutes and one control group were
27 necropsied after 14 days; all others were necropsied after 7 days. The results are summarized in
28 Table 6. The only clinical signs observed during exposure were “struggling” and irregular or
29 shallow breathing patterns after 5–10 minutes and gasping in the group exposed to 589 mg/m^3
30 for 60 minutes. Clinical signs observed after exposure were indicative of effects on coordination
31 and muscle tone, extreme discomfort, and respiratory irritation as described by Janssen (1989a)
32 (Section 3.1.1). Rats exposed to 578 or 589 mg/m^3 (30 or 60 minutes) showed slight to severe
33 clinical signs; rats in all other exposure groups showed slight to moderate clinical signs; rats in
34 the control group showed no clinical signs. The study author noted that a twofold increase in
35 exposure time produced a smaller effect on clinical signs than a twofold increase in exposure
36 concentration indicating that effects are due more to exposure concentration than duration. Two
37 rats exposed to 589 mg/m^3 for 60 minutes were killed moribund about 24 hours after exposure,
38 and the remaining animals survived to study termination. Absolute body weights were not
39 significantly different from those of controls except for the group exposed to 578 mg/m^3 for
40 30 minutes. Almost all groups including controls lost weight during the first two days of the
41 study; however, the groups exposed to peracetic acid for 30, 60, and 90 minutes lost significantly
42 more weight than controls (except for Group 6). There were no treatment-related macroscopic or
43 microscopic findings in the lungs, and lung weights were similar in the treated and control
44 groups. Slight to moderate to severe squamous metaplasia of the nasal turbinates and/or lateral
45 walls and epithelial atrophy of the dorsal meatus were observed in all treated groups. The study
46 author noted that the chamber atmospheres for Groups 3 and 6 did not reach equilibrium during
47 sampling.

1

Group No.	Exposure time (min)	Concentration (mg/m ³) ^a		Effects ^b		
		Peracetic acid	H ₂ O ₂	Clinical signs and body weight gain	Pathology	
					Gross	Microscopic
1 (control)	90	<16	<16	bw, slight ↓	0/5	0/5
2 (control)	90	<16	<16	bw, slight ↓	3/5	0/5
3	15	499	172	+, ++; bw, no change	0/5	5/5
6	30	304	111	+, ++; bw, slight ↓	1/5	4/5
4	30	578	193	+, ++, +++; bw, marked ↓	1/5	5/5
7	60	329	115	+, ++; bw, moderate ↓	2/5	5/5
5	60	589	233	+, ++, +++; bw, marked ↓	2/5	4/5
9	90	172	63	+, ++; bw, moderate ↓	0/5	5/5
8	90	355	119	+, ++; bw, moderate ↓	1/5	5/5

Source: Janssen, 1989b

^a Concentration reported as mg/L by the study author converted to mg/m³.

^b +, ++, +++ refer to slight, moderate, and severe clinical signs, respectively; body weight gain: slight ↓ = ≤5 g, moderate ↓ = >5-15 g, marked ↓ = >15 g.

bw = body weight; ↓ = decrease

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In a preliminary study, Janssen (1989c) examined the effect of peracetic acid on the respiratory rate in groups of three CPB-WU Wistar derived male rats exposed by nose-only inhalation for 25 minutes to aerosols of Proxitane 1507[®] containing peracetic acid and hydrogen peroxide at the concentrations presented in Table 7. The chamber and exposure conditions were the same as described by Janssen (1989a) (Section 3.1.1). The test concentrations of peracetic acid were analyzed as total peroxygen concentration corrected for the amount of hydrogen peroxide. A plethysmograph was used to measure respiratory rates before, during, and after exposure to the test material. The rats were killed and necropsied 24 hours after exposure. The lungs were weighed and processed for microscopic examination along with the trachea and nasal cavities. The mean percent of the greatest (extreme) depression in respiratory rates ranged from 31.9-67.1% in groups exposed to peracetic acid concentrations ranging from 8.4-36.3 mg/m³ (Table 7). The depression in respiratory rates did not show a clear exposure-related trend. The mean RD₅₀ for all groups was 22.7 mg/m³, 21.5 mg/m³ with Group 1 omitted, and 24.1 mg/mg³ with Group 3 omitted. According to the investigator, depression in the respiratory rate was considered biologically significant only if it exceeded 20% of the preexposure rate. After exposure, the respiratory rates of all animals returned to approximately normal rates. The only observed clinical sign of toxicity was a slightly hunched appearance after removal of the plethysmograph. No abnormalities were observed during necropsy, lung weight was not affected, and no treatment-related microscopic findings were observed in the nose, trachea, or lungs.

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24

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	Concentration (mg/m ³)				
	Group 3	Group 1	Group 5	Group 2	Group 4
Peracetic acid	8.4 mg/m ³	12.2 mg/m ³	13.9 mg/m ³	17.4 mg/m ³	36.3 mg/m ³
H ₂ O ₂	3.3	3.3	1.9	5.4	13.1
Extreme depression, mean (%)	46.9	32.6	31.9	44.2	67.1

Source: Janssen, 1989c

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In a follow-up study, Janssen (1990) examined the effect of higher concentrations of Proxitane 1507[®] (15% peracetic acid, ~28% acetic acid, 14% hydrogen peroxide, ~1% stabilizer, and ~43% water) aerosols on the respiratory rate in groups of three CPB-WU Wistar derived male rats. The animals were exposed to the test substance by nose-only inhalation for 25 minutes as described by Janssen (1989c). The test concentration of peracetic acid were analyzed as total peroxygen concentration corrected for the amount of hydrogen peroxide. Respiratory rates were measured using a plethysmograph before, during, immediately after, and 24 hours after exposure to the test atmospheres. The concentrations of peracetic acid and hydrogen peroxide in the exposure chambers and the percent depression of respiratory rates are presented in Table 8. The respiratory rates were depressed 76-78% during exposure of each group. The respiratory rates improved after exposure and returned to normal in two Group 3 rats exposed to the lowest concentration of peracetic acid. The respiratory rate had returned to normal in Group 1 and 2 animals by 24 hours. Necropsy revealed no gross abnormalities; however, microscopic examination showed moderate to severe necrosis in the nasal turbinates of all animals exposed to the test material. Evidence of very slight to slight pulmonary inflammation was observed in one or two animals of each group, but no control group was included for comparison. Therefore, the pulmonary effects should not be considered treatment related.

	Concentration (mg/m ³) ^a		
	Group 3	Group 2	Group 1
Peracetic acid	221.0 mg/m ³	315.3 mg/m ³	461.5 mg/m ³
Hydrogen peroxide	22.4	23.1	59.8
% Respiratory depression, mean ^b	76.3	78.4	76.3
	16.0	29.6	49.2

Source: Janssen, 1990

^aAverage of two measurements of atmospheres taken during exposure: just before and during measurement of respiratory rate.^bTop row, % of extreme depression during exposure compared with pre-exposure respiratory rate; bottom row, % of depression after exposure compared with pre-exposure respiratory rate.

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Benes et al. (1966) showed that rats exposed to peracetic acid at concentrations ranging from 7.2 to 72 mg/m³ aerosol for 4 hours exhibited signs of restlessness, lacrimation, and nasal discharge, whereas labored breathing and lung edema were seen at 237 mg/m³. Repeated exposure to 7.2 mg/m³ for 1 hour/day for 28 days was without effects, whereas repeated exposure to 22 mg/m³ for the same time period resulted in increased lung and liver weights,

1 depression of body weight gain, and inflammation in the lungs. No additional information was
2 available for this study.

3
4 Whitman (1991) conducted a study in which a group of 10 Sprague-Dawley rats (5 males
5 and 5 females) were exposed to an aerosol/vapor mixture generated from a 0.15% use dilution of
6 peracetic acid. A 5% peracetic acid solution was diluted with distilled water to prepare the
7 0.15% dilution. The study author did not describe the content of other constituents in the test
8 material. The animals were exposed for 4 hours in a dynamic chamber. The theoretical
9 equilibration time was 23 minutes. The nominal concentration (calculated based on amount of
10 material lost and total air flow through the chamber) was 66.171 mg/L; the analytical
11 concentration of total test material was 7.669 mg/L; and the analytical concentration of peracetic
12 acid was 0.0117 mg/L (11.7 mg/m³). The animals were observed for 14 days and were sacrificed
13 and subjected to gross examination after the observation period. A control group for comparison
14 was not included in this study. A dense fog was formed in the chamber during exposure
15 inhibiting the observation of a few animals. During exposure, the animals closed their eyes, had
16 decreased activity, and had material on their fur. The study author considered these responses
17 normal for aqueous aerosol exposure. After exposure, all animals had wet, matted fur, two had
18 clear ocular discharge, and one had fine tremors attributed to mild hypothermia because of wet
19 fur. Almost all animals had recovered by the second day after exposure except for one that had a
20 clear oral and ocular discharge and wet and matted fur on day 8 post-exposure and a dry red
21 nasal discharge on day 9 postexposure. This animal was normal for the remainder of the
22 observation period. Five rats lost a small amount of weight the day after exposure; otherwise, all
23 rats gained weight during the observation period. At necropsy, one animal had mottled, red to
24 dark red lungs and two rats had dark red foci on the mandibular lymph nodes. All animals
25 survived to study termination.

26 27 **3.2.2. Mice**

28
29 Merka and Urban (1978) conducted a study in which groups of 10 mice were exposed in
30 a dynamic chamber to laboratory peracetic acid aerosols at concentrations of 70–140 mg/m³ for
31 60 minutes, three times/week for 4 weeks and observed for an additional 2 weeks. The animals
32 exposed to peracetic acid showed retarded weight gain compared with controls not exposed to
33 the test chemical. Isolated small foci of inflammation were seen in the lungs of mice killed at the
34 end of the 14-day observation period.

35
36 Heinze et al. (1979) reported that exposure of mice (no descriptive information provided)
37 to 30 mg peracetic acid (1.2 mL volume of a 6.25% solution of Wofasteril) released in a 20-L
38 room for 45 minutes had no effect on immune function as tested on animals given an erysipelas
39 vaccine and challenged with erysipelas “germ” (bacteria). Atmospheric peracetic acid
40 concentrations were not quantified by an analytical procedure.

41 42 **3.2.3. Other Species**

43
44 Heinze et al. (1979) examined the effect of daily releases of 2 mL of a 6.15% Wofasteril
45 solution/m³ of air (50 mg peracetic acid/m³) on uninfected and *Chlamydia*-infected (by
46 intratracheal instillation) calves and pigs. The animals were exposed 1 hour/day for an unspeci-
47 fied period of time. The droplet size of the aerosol was 0.5 to 0.6 μm. Peracetic acid-treated

1 animals developed a transient severe irritative cough accompanied by nasal secretion, lacrima-
2 tion, and salivation. Transient vomiting and labored breathing and weight loss were also
3 observed after day 19 in treated pigs. Increased pulse and breathing rates, decreased erythrocyte
4 count and hemoglobin concentration, and lesions in the lungs, kidneys, and liver were observed
5 after exposure to peracetic acid. There was no evidence that effects of *Chlamydia* infection were
6 exacerbated by exposure to peracetic acid.

7
8 Calves and young pigs exposed daily to peracetic acid at 50 mg/m³ exhibited decreased
9 body weight gain, decreased serum aspartate aminotransferase activity, and histologic evidence
10 of lung irritation (Friebig and Reuter, 1975). The duration of exposure was not reported.

11
12 According to Uhlemann (1971) guinea pigs and a pig were not affected by a single
13 inhalation exposure to peracetic acid aerosols (50 μm droplet size) at concentrations of 250 or
14 500 mg/m³, whereas rabbits exhibited labored breathing at the higher concentration but not at the
15 lower concentration.

16 17 **3.3. Carcinogenicity**

18
19 There are no studies on the carcinogenicity of peracetic acid administered by inhalation.
20 Bock et al. (1975) conducted a study in which groups of 30 female ICR Swiss mice (55 to 69
21 days of age) received repeated topical applications of peracetic acid in water or acetone. In one
22 study, groups of mice received a single topical application of 125 μg of 7,12-dimethylbenz[a]
23 anthracene (DMBA) to the shaved dorsal skin followed by topical applications of 0.2 mL of 0,
24 0.3, 1.0, or 3.0 % peracetic acid in water 5 days/week for 66 weeks. By the end of the treatment
25 period, 0, 7, 27, and 80% of the mice in each group, respectively, had developed skin tumors; 3%
26 of the mice receiving 1.0% peracetic acid alone and 17% of the mice receiving 3.0% peracetic
27 acid alone developed "skin cancer." In another experiment, groups of mice received no topical
28 applications of peracetic acid, topical applications of 1.0% peracetic acid in acetone, or topical
29 applications of 2.0% peracetic acid in water (5 days/week) without prior treatment with DMBA.
30 After 52 weeks, 10% of the group receiving peracetic acid in water developed skin tumors; none
31 were skin cancer. Tumors did not develop in mice receiving no peracetic acid or in mice
32 receiving peracetic acid in acetone. Topical application of 2% decomposed peracetic acid in
33 water or 1% decomposed peracetic acid in acetone to DMBA-initiated mice for 58 weeks
34 resulted in a very low incidence of skin tumors (7%); the low incidence was not considered
35 treatment-related. The study authors concluded that peracetic acid is a strong skin tumor
36 promoter and a weak complete carcinogen. Bock et al. (1975) also reported that 4% peracetic
37 acid was "excessively lethal." They provided no additional information on the number of
38 applications required to cause lethality.

39 40 **3.4. Genotoxicity**

41
42 Agnet et al. (1976) tested peracetic acid in *Salmonella typhimurium* spot test to detect
43 point, frame-shift, and deletion mutations. Peracetic acid induced deletion but not point or
44 frame-shift mutations. Lai et al. (1996) reported that peracetic acid induced unscheduled DNA
45 synthesis (no additional information was provided). Peracetic acid was negative in the SOS
46 chromotest (Yin et al., 1989).

47

1 Koch et al. (1989) conducted an in vivo test in which Wofasteril[®] (40% peracetic acid,
2 27% acetic acid, and 14% hydrogen peroxide) was injected intraperitoneally into male ICR mice
3 once per day for 5 consecutive days at a concentration of 0.1% or 0.05% in a volume of 0.2
4 mL/34 g body weight (2.6 or 1.3 mg/kg/day, respectively). Sperm abnormalities, indicative of
5 mutagenic potential, were evaluated 36 days after the first injection. At 2.6 mg/kg/day,
6 Wofasteril[®] induced a twofold increase in abnormal sperm compared with controls receiving 0.2
7 mL of distilled water. No increase was observed at 1.3 mg/kg/day. A mouse bone marrow test
8 conducted by Paldy et al. (1984) showed an increase in "mutated" chromosomes (17% vs 3% for
9 controls) in mice injected (intraperitoneal) once a day for 5 days with 1.6 mg peracetic
10 acetic/kg/day ().

11 3.5. Summary

12 Lethality studies on peracetic acid were conducted with products containing different
13 concentrations (weight %) of peracetic acid, acetic acid, and hydrogen peroxide. Sulfuric acid
14 may have been present at very low concentrations in some products. The LC₅₀ values for
15 inhalation exposure to peracetic acid aerosols were 476 mg/m³ for rats and 512–514 mg/m³ for
16 mice exposed for 1 hour and 204 mg/m³ for rats exposed for 4 hours. The study in mice showed
17 that the small amount of sulfuric acid that may have been present in the exposure chambers had
18 no effect on lethality of mice, because the LC₅₀ values were similar with or without possible
19 exposure to small amounts of sulfuric acid. Death was caused by severe damage to the lungs
20 (hemorrhage, consolidation, and edema). Respiratory effects were much less severe in survivors,
21 including those in groups where deaths occurred.

22 Data concerning effects of peracetic acid at nonlethal concentrations are summarized in
23 Table 9. These studies showed effects on the respiratory tract and body weight gain.
24 Concentrations of peracetic acid aerosols ranging from 8.4–36.3 mg/m³ caused 28 to 65%
25 decreases in respiratory rate during a 25-minute exposure, and the RD₅₀ was 22.7 mg/m³
26 (Janssen, 1989c); concentrations ranging from 71 to 156 ppm caused 71–74% decreases during a
27 similar exposure time (Janssen, 1990). In rats, respiratory irritation was slight to moderate,
28 weight loss was moderate, and nasal lesions were slight to moderate after inhaling about 304–329
29 mg/m³ 30 or 60 minutes, whereas respiratory irritation was slight to severe, weight loss was
30 marked, and nasal lesions were slight to moderate or severe after inhaling about 578–589 mg/m³
31 for 30 to 60 minutes (Janssen, 1989b). Rats that inhaled 172 or 355 mg/m³ for 90 minutes had
32 slight to moderate respiratory irritation and moderate weight loss, and slight to severe nasal
33 lesions (Janssen, 1989b). Inhalation of 7.2–72 mg/m³ for 240 minutes caused restlessness,
34 lacrimation, and nasal discharge, and 237 mg/m³ for 240 minutes caused labored breathing and
35 lung edema (Benes et al., 1966). Rats showed no effects when exposed to 2.3 ppm for
36 60 minutes/day for 28 days; however exposure to 7 ppm under similar conditions caused
37 increased lung and liver weight, depressed weight gain, and lung inflammation (Benes et al.,
38 1966). Similar effects were observed in mice that inhaled 70–140 mg/m³, 1 hour/day, 3 times per
39 week, for 4 weeks (Merka and Urban, 1978). Effects of exposure to peracetic acid were more
40 prevalent and more severe after exposure was terminated than during exposure. In addition,
41 effects were more severe after doubling the exposure concentration than doubling the exposure
42 duration.

1

TABLE 9. Summary of Nonlethal Effects of Peracetic acid in Experimental Animals				
Species/Strain/ Sex	Exp. time	Exp. conc. (mg/m ³)	Effect	Reference
Rat/Wistar/M	15 min	499	Slight to moderate signs of respiratory irritation; no change in body weight	Janssen, 1989b
	25 min	8.4	47% Depression in respiratory rate	Janssen, 1989c
	25 min	12.2-13.9	32-33% Depression in respiratory rate	
	25 min	17.4	44% Depression in respiratory rate	
	25 min	36.3	67% Depression in respiratory rate	
	25 min	221-462	76-78% Depression in respiratory rate; moderate to severe necrosis of nasal turbinates	Janssen, 1990
	30 min	304	Slight to moderate signs of respiratory irritation, slight transient weight loss, slight to moderate nasal lesions	Janssen, 1989b
	30 min	578	Slight to severe signs of respiratory irritation, marked transient weight loss, slight to severe nasal lesions	Janssen, 1989b
	60 min	329	Slight to moderate signs of respiratory irritation, moderate transient weight loss, slight to moderate nasal lesions	Janssen, 1989b
	60 min	589	Slight to severe signs of respiratory irritation, marked transient weight loss, slight to moderate nasal lesions	Janssen, 1989b
	60 min × 28 d	7.2	No effects	Benes et al., 1966 ^a
	60 min × 28 d	22	Increased lung and liver weight, depressed weight gain, lung inflammation	Benes et al., 1966 ^a
	90 min	172	Slight to moderate signs of respiratory irritation, moderate transient weight loss, slight to severe nasal lesions	Janssen, 1989b
	90 min	355	Slight to moderate respiratory irritation, moderate transient weight loss, slight to severe nasal lesions	Janssen, 1989b
	240 min	7.2-72	Restlessness, lacrimation, and nasal discharge	Benes et al., 1966 ^a
240 min	237	Labored breathing and lung edema	Benes et al., 1966 ^a	
240 min	11.7	Clear ocular and oral discharge, transient weight loss, gross findings in the lungs	Whitman, 1991	
Mouse	1 h, 3×/wk, 4 wks	70-140	Retarded weight gain, small foci of inflammation in lungs 14 days after treatment terminated	Merka and Urban, 1978

^aCited from secondary source

2

3

4. SPECIAL CONSIDERATIONS

4.1. Metabolism/Disposition/Kinetics

6

7

No studies on the uptake, distribution, metabolism, or elimination of inhaled peracetic acid were found in the sources searched. Peracetic acid is freely soluble in water (O'Neil et al., 2001) and should be effectively scrubbed in the upper respiratory tract. Effects on the lower

8

9

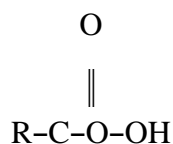
1 respiratory tract would occur only at concentrations that exceed the scrubbing capacity of the
2 nasal passages.

4 4.2. Mechanism of Toxicity

5
6 Peracetic acid is a corrosive chemical; therefore, it causes irritation to mucous
7 membranes. Lacrimation and respiratory tract irritation were observed in humans (Fraser and
8 Thorbinson (1986) and rats (Janssen, 1989a,b; Janssen and Van Doorn, 1994) and eye and
9 respiratory tract irritation were observed in mice (Merka and Urban, 1978) exposed to peracetic
10 acid. The effects in some cases were delayed. For example, deaths caused by exposure to
11 peracetic acid occurred 1 or more days after exposure depending upon the atmospheric
12 concentration. Exposures to extremely high concentrations are expected to cause deaths during
13 exposure.

15 4.3. Structure/Activity Relationship

16 Peracetic acid is a peroxy acid that has the following general structure:



19
20
21
22 Peroxy acids are irritating to skin, eyes, and mucous membranes of the respiratory tract.
23 Peroxy acids are members of a broader group of chemicals called organic peroxides. Many of
24 these chemicals are also considered to be respiratory irritants (Galvin and Farr, 1993).

26 4.4. Other Relevant Information

27 4.4.1. Species Variability

28
29 The LC₅₀ values for 1-hour exposures to the rat (476 mg/m³) and mouse (512-524 mg/m³)
30 are similar, indicating a similar species response to inhalation exposure to peracetic acid.
31 Whether the animals died or survived after exposure to peracetic acid, the effects were indicative
32 of respiratory tract irritation in mice and rats. Effects of inhalation exposure on calves and pigs
33 were qualitatively similar to those observed in rodents. Lacrimation occurred in humans
34 exposed to 15.6 mg/m³ for 3.5 minutes and respiratory tract irritation occurred at concentrations
35 > 1.56 mg/m³ with only mild effects occurred at the lower concentrations (Fraser and
36 Thorbinson, 1986); Janssen and van Doorn (1994) reported no lacrimation in rats exposed to 87
37 mg/m³ for 4 hours, but serious respiratory effects were observed. In contrast, Benes et al.(1966)
38 reported lacrimation and upper respiratory tract effects in rats exposed to 7.2-72 mg/m³ for 4
39 hours. These results show that similar effects are observed in humans and animals and that
40 humans may be slightly more sensitive to exposure to peracetic acid than animals.

41

4.4.2. Susceptible Subpopulations

Peracetic acid is a corrosive and extremely irritating substance that attacks mucous membranes of the respiratory tract and eyes; therefore, very little difference in sensitivity is expected among individuals within the general population. No data were available on the response of asthmatics to inhaled peracetic acid.

4.4.3. Concentration-Exposure Duration Relationships

The n-value of 1.6 was estimated from the rat lethality data by determining the value of n, which, when applied to the 1-hour LC₅₀ of 476 mg/m³ (Janssen, 1989a), would closely predict the 4-hour LC₅₀ of 204 mg/m³ (Janssen and Van Doorn, 1994). Although only two LC₅₀ values were available for estimating the n-value, the estimated value is considered more appropriate than using default values.

4.4.4. Concurrent Exposure Issues

Two constituents in peracetic acid are acetic acid and hydrogen peroxide, and these may have contributed to the observed toxic effects of peracetic acid. Aerosols or vapors will contain these constituents in addition to peracetic acid. It appears, however, that acetic acid and hydrogen peroxide are considerably less toxic than peracetic acid. The following toxicity information on hydrogen peroxide and acetic acid was cited from secondary sources.

Hydrogen peroxide has a vapor pressure of 5 mm Hg at 30°C, and it is miscible in water (ACGIH, 1991). The LC₅₀ value for hydrogen peroxide is 1418 ppm (1972 mg/m³) for a 4-hour exposure to rats and the LC_{LO} is 227 ppm (316 mg/m³) for an unknown exposure time to mice (NIOSH, 1994). The LC₅₀ for the rat exposed to hydrogen peroxide is about 10 times greater than the LC₅₀ for rats exposed to peracetic acid. Dogs exposed to 7 ppm (10 mg/m³) vapor concentration of 90% hydrogen peroxide for 6 hours/day for 6 months developed skin irritation, sneezing, lacrimation, and bleached hair, and rabbits exposed to 22 ppm (31 mg/m³) (frequency not reported) for 3 months developed bleached hair and skin irritation (Oberst et al., 1954). The carcinogenicity of hydrogen peroxide has been tested by the oral, subcutaneous, intramuscular, and topical routes of exposure, and IARC (1985) considers the evidence for carcinogenicity as limited for experimental animals.

Acetic acid has a vapor pressure of 11.4 mm Hg at 20°C, and it is freely soluble in water (Katz and Guest, 1994). Inhalation of acetic acid vapor is reported to cause marked irritation to the eyes, nose, and throat in humans at concentration of 816–1226 ppm (2000–3005 mg/m³) for 3 minutes, and exposure to ≥50 ppm (123 mg/m³) is reported to be intolerable because of intense irritation (NIOSH, 1994). Exposure to acetic acid at 10 ppm is reported to be relatively nonirritating (Sterner, 1943), 20–30 ppm (49–74 mg/m³) has been reported to be without danger, and occupational exposure to 60 ppm plus 1 hour daily exposure to 100–260 ppm (245–637 mg/m³) for 7–12 years caused only slight irritation (Vigliani and Zurlo, 1956). The LC₅₀ for acetic acid is 5000–5620 ppm (12,255–13,775 mg/m³) for a 1-hour exposure to mice. The lowest lethal concentration for a 4-hour exposure of rats to acetic acid is 16,000 ppm (39,216 mg/m³) (Katz and Guest, 1994), which is about 190 times greater than the LC₅₀ for a 4-hour exposure to peracetic acid. The data show that acetic acid and peracetic acid may produce

1 similar effects on the respiratory tract, but peracetic acid is markedly more toxic than acetic acid.
2 The RD_{50} was reported as 163 ppm (400 mg/m^3) for the mouse (NIOSH, 1994). Exposure to
3 concentrations >1000 ppm (2451 mg/m^3) produces irritation to the conjunctiva and upper
4 respiratory tract of mice (Katz and Guest, 1994).

5
6 Sulfuric acid also is found in some commercial grades of peracetic acid. Humans
7 exposed to sulfuric acid at concentrations of 1 mg/m^3 for 10–15 minutes did not detect the
8 substance by odor, taste, or irritation (these data were cited in NRC, 1984). The LC_{50} for
9 inhalation exposure to sulfuric acid aerosols ranged from 19 to 59.8 mg/m^3 for guinea pigs
10 (ATSDR, 1997). In rats, 2/2 animals died after exposure to 699 mg/m^3 for 7 hours or after
11 exposure to 1470 mg/m^3 for 3.5 hours. No rats died after exposure to 461 mg/m^3 for 7 hours or
12 after exposure to 718 mg/m^3 for 3.5 hours. In mice, 2/5 animals died after exposure to 699
13 mg/m^3 for 7 hours or after exposure to 549 mg/m^3 for 3.5 hours (secondary citation by ATSDR,
14 1997). LC_{50} values were not reported for the rat or mouse, but the data indicate that they are
15 much less sensitive to sulfuric acid than are guinea pigs.

16 17 **4.4.5. Other Data**

18
19 Peracetic acid was used at a concentration of 0.2% to disinfect the hands of personnel in
20 a virus laboratory over a 5 year period and caused no adverse effects; a concentration of 0.5%,
21 however, was irritating to the skin (Mucke, 1970).

22
23 Peracetic acid caused irritation to the skin of guinea pigs following direct contact (Bulnes
24 et al., 1982). Application of 3% peracetic acid to depilated guinea pig skin for 2, 3, or 5 hours
25 caused microscopic lesions characterized by congestion, hemorrhage, edema of the dermis,
26 capillary vasodilation, perivascular effect (neutrophil granulocytes), and gelatinous edema of the
27 dermis. Application of 3% peracetic acid for 1 hour or 1% for up to 5 hours was without
28 macroscopic or microscopic effects.

29 30 **5. DATA ANALYSIS AND PROPOSED AEGL-1**

31 **5.1. Human Data Relevant to AEGL-1**

32
33 McDonagh (1997) reported that exposure to peracetic acid at $1.56\text{--}1.87 \text{ mg/m}^3$ was not
34 immediately irritating, but would have been considered “unpleasant for an extended period;”
35 $0.40\text{--}0.53 \text{ mg/m}^3$ was tolerable and not unpleasant for up to 3 hours. According to Fraser and
36 Thorbinson (1986), exposure to $3.12\text{--}4.67 \text{ mg/m}^3$ for 15–20 minutes is not expected to cause
37 discomfort to mucous membranes, and $1.56\text{--}3.12 \text{ mg/m}^3$ for 25–30 minutes is expected to cause
38 only mild or tolerable discomfort. No discomfort is expected for subjects exposed to ≤ 1.56
39 mg/m^3 for 35–45 minutes.

40 41 **5.2. Animal Data Relevant to AEGL-1**

42
43 Rats exposed to peracetic acid at $12.2\text{--}13.9 \text{ mg/m}^3$ for 25 minutes showed a reduction of
44 only 32–33% in respiratory rate, whereas rats that inhaled a slightly lower concentration of 8.4
45 mg/m^3 showed a greater reduction of 47% (Janssen, 1989c). These data show the inconsistency
46 of the results regarding depression of respiratory rates in rats exposed to peracetic acid. Only
47 mild effects were observed in rats exposed to 11.7 mg/m^3 (closed eyes, decreased activity, clear

1 ocular discharge) for 4 hours and observed for 14 days (Whitman, 1991). The study author did
 2 not mention that the rats had redness of the eyes or lacrimation during exposure. In a repeat
 3 exposure study using mice exposed to 70–140 mg/m³ for 60 minutes/day, 3 times/week, for 4
 4 weeks, only small foci of inflammation were observed when the animals were killed 14 days
 5 after the last exposure. If damage to the respiratory tract occurred during the exposure period, it
 6 was repaired during the post-exposure period.

8 **5.3. Derivation of AEGL-1**

10 Because decreases in respiratory rate in rats exposed to peracetic showed no clear
 11 concentration-response relationship, the human data are considered more appropriate and more
 12 relevant for deriving AEGL-1 values. In the study by Fraser and Thorbinson (1986), humans
 13 exposed to peracetic acid at ≤ 1.56 mg/m³ (concentrations reported as hydrogen peroxide)
 14 experienced no discomfort and McDonagh (1997) reported that 1.56 mg peracetic/m³ is not
 15 immediately irritating. An intraspecies uncertainty factor of 3 was applied because peracetic
 16 acid is a corrosive/irritant substance, the effects are confined to the upper respiratory tract, and
 17 the effects are expected to be similar for most individuals within the population. The same value
 18 is proposed for all exposure durations from 10 minutes to 8 hours. The rationale for proposing
 19 the same value is as follows: (1) effects of peracetic acid exposure appear to correlate more with
 20 concentration than with time, and (2) peracetic acid is freely soluble in water, and therefore,
 21 should be effectively scrubbed by the nasal tissues, particularly at the very low concentration
 22 proposed for AEGL-1. The proposed AEGL-1 values are summarized in Table 10.

24 TABLE 10. AEGL-1 Values for Peracetic Acid [mg/m³ (ppm)]				
25 10 min	30 min	1 h	4 h	8 h
0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)

26 **6. DATA ANALYSIS AND PROPOSED AEGL-2**

27 **6.1. Human Data Relevant to AEGL-2**

28
 29 Fraser and Thorbinson (1986) reported that lacrimation and extreme discomfort occurred
 30 after exposure to peracetic acid at 15.6 mg/m³ for only 7 minutes; extreme discomfort and
 31 unbearable irritation, but no lacrimation, was reported for exposures to concentrations ranging
 32 from 6.23–9.35 mg peracetic acid/m³ for 1 hour and 20–25 minutes (6.23 mg peracetic acid/m³
 33 for 55 minutes, 7.79–9.35 mg peracetic acid/m³ for 15 minutes, and 6.23 mg/m³ for 10–15
 34 minutes). Exposure to 6.23 mg peracetic acid/m³ was considered tolerable for 2 minutes.
 35 Effects in the lower respiratory tract were not noted even for exposure to 15.6 mg peracetic
 36 acid/m³, which is extremely irritating to the upper respiratory tract. Peracetic acid is freely
 37 soluble in water (O'Neil et al., 2001) and is expected to be effectively scrubbed in the upper
 38 respiratory tract.

40 **6.2. Animal Data Relevant to AEGL-2**

41
 42 Animal data relevant to deriving AEGL-2 values have been summarized in Table 9.
 43 Inhalation exposure to peracetic acid causes irritation to the mucous membranes of the

1 respiratory tract and eyes at concentrations below those causing death. Concentrations of
2 peracetic acid aerosols ranging from 8.4 to 36.3 mg peracetic acid/m³ caused 32 to 67%
3 decreases in respiratory rates during a 25-minute exposure, but not in a dose-related manner
4 (Janssen, 1989c). Exposure to peracetic acid concentrations ranging from 221 to 462 mg/m³ for
5 25 minutes caused decreases of 76-78% in the respiratory rates (Janssen, 1990). Generally,
6 respiratory irritation, weight loss, and nasal lesions in rats were slight to moderate at
7 concentrations ranging from 172-355 mg/m³ for exposure durations ranging from 30 to 90
8 minutes (Janssen, 1989b). Severe signs of respiratory irritation were observed in rats exposed to
9 578-589 mg/m³ for 30 or 60 minutes (Janssen, 1989b). Exposure to 7.2-72 mg/m³ for 240
10 minutes caused restlessness, lacrimation, and nasal discharge, and 237 mg/m³ for 240 minutes
11 caused labored breathing and lung edema (Benes et al., 1966). No effects were observed in rats
12 that inhaled 7.2 mg/m³, 1 hour/day repeatedly for 28 days, whereas restlessness, lacrimation, and
13 nasal discharge were observed in rats exposed one time to 7.2-72 mg/m³ for 4 hours (Benes et
14 al., 1966). Increased lung and liver weights, depressed weight gain, and lung inflammation were
15 reported for rats exposed to 21.8 mg/m³ under similar conditions (Benes et al., 1966). Similar
16 effects were observed in mice exposed to 70-140 mg/m³ 1 hour/day, 3 times per week, for 4
17 weeks (Merka and Urban, 1978). These studies showed that effects were more severe after
18 doubling the exposure concentration than after doubling the exposure duration.

19 20 **6.3. Derivation of AEGL-2**

21
22 For the most part, animals exposed to low concentrations of peracetic acid displayed the
23 most severe clinical signs after exposure was terminated, whereas humans exposed to low
24 concentrations reported only mucous membrane irritation during exposure. However, the
25 animals were restrained during exposure in some studies. The evidence further suggests that
26 humans may be slightly more sensitive to inhaled peracetic acid than animals. This conclusion is
27 supported by observations of lacrimation in humans exposed to 15.6 mg/m³ for 3.5 minutes
28 (Fraser and Thorbinson, 1986), no lacrimation but serious respiratory effects were observed in
29 animals exposed to 87 mg/m³ for 4 hours (Janssen and van Doorn, 1994) and lacrimation was
30 observed in animals exposed to 7.2-72 mg/m³ for 4 hours (Benes et al., 1966).

31
32 AEGL-2 values are derived from human data reported by Fraser and Thorbinson (1986).
33 They reported that exposure to peracetic acid at 6.23 mg/m³ for up to 1 hour caused extreme
34 discomfort and unbearable irritation, but exposure to 6.23 mg/m³ for 2 minutes was also
35 considered tolerable. A slightly lower concentration of 4.67 mg/m³ caused discomfort or slight
36 discomfort for exposure for durations up to 20 minutes. The effects at 6.23 peracetic acid mg/m³
37 appear to be more serious than those described by the definition of AEGL-2 and could hinder the
38 ability to escape. Although irritation to the upper respiratory tract was extreme, lower
39 respiratory effects did not occur even at concentrations as high as 15.6 mg/m³. Moreover,
40 peracetic acid is freely soluble in water and should be effectively scrubbed in the nasal passages
41 at the concentrations considered for deriving AEGL-2 values. Although the effects at 4.67
42 mg/m³ are slightly less severe than those defined by AEGL-2, this level is more appropriate for
43 deriving the AEGL-2 than the higher level of 6.23 mg/m³. An intraspecies uncertainty factor of
44 3 is applied because peracetic acid is a corrosive/irritant substance and the effects, which are
45 confined to the upper respiratory tract, are expected to be similar and not expected to vary by
46 more than a factor of 3 for most individuals in the population. The same value is proposed for
47 all exposure durations from 10 minutes to 8 hours. The rationale for proposing the same AEGL-

2 value for all exposure durations is as follows: (1) effects of peracetic acid exposure correlate with concentration more than time, and (2) peracetic acid is freely soluble in water and at low concentrations should be effectively scrubbed in the nasal passages. The proposed AEGL-2 values are summarized in Table 11.

10 min	30 min	1 h	4 h	8 h
1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)

7. DATA ANALYSIS AND PROPOSED AEGL-3

7.1. Human Data Relevant to AEGL-3

No data on human lethality caused by exposure to peracetic acid were found in the literature searched.

7.2. Animal Data Relevant to AEGL-3

Three animal lethality studies were available for deriving AEGL-3 values. In one study, rats were exposed to peracetic acid aerosol at concentrations 130 to 320 mg/m³ for 30 min, 150 to 1450 mg/m³ for 1 hour (Janssen, 1989a), and 87 to 267 mg/m³ ppm for 4 hours (Janssen and van Doorn, 1994). Proxitane 1505 (15% peracetic acid, ~28% acetic acid, and 14% hydrogen peroxide) was used for the 30-minute and 1-hour studies and Proxitane AHC (~5% peracetic acid, 10% acetic acid, and 19% hydrogen peroxide) was used for the 4-hour study. The mortality responses for the studies are presented in Tables 4 and 5. The LC₅₀ for peracetic acid was 476 mg/m³ for the 1-hour exposure and 204 mg/m³ for the 4 hour study; the LC₅₀ was not calculated for the 30-minute exposure because there were only two relevant concentrations. Clinical signs were primarily related to respiratory tract irritation and adverse effects on body weight gain. Animals that died showed gross or microscopic evidence of pulmonary hemorrhage, edema, or consolidation. Surviving animals showed less severe effects.

7.3. Derivation of AEGL-3

The proposed AEGL-3 values are derived from the study of Janssen (1989a). This study showed that rats exposed to Proxitane[®] 1507 (15% peracetic acid~28% acetic acid, 14% hydrogen peroxide, ~1% "stabilizer", and ~43% water) aerosols at peracetic acid concentrations of 130, 300, 320 mg/m³ for 30 min had mortality responses of 0/5, 0/5 and 3/5 rats, respectively. Exposures to aerosol concentrations of 150, 390, and 1450 mg/m³ for 60 minutes resulted in mortality responses of 0/5, 2/5, and 5/5, respectively. Clinical signs indicative of respiratory irritation were observed at all concentrations and increased in severity with exposure concentration for each exposure duration. The AEGL values were derived from the highest concentration that did not cause death at either exposure duration: 300 mg/m³ for a 30-minute exposure duration and 150 mg/m³ for a 60-minute exposure duration. An intraspecies uncertainty factor of 3 and an interspecies uncertainty factor of 3 (total uncertainty factor = 10) were applied to 300 mg/m³ and 150 mg/m³ for the 30- and 60-minute exposures, respectively. Uncertainty factors of 3 were applied because the mucous membranes of the respiratory tract are

not expected to show vast differences in response to corrosive/irritant substances at concentrations that cause severe physical damage or at the threshold for lethality regardless of species or the individuals in the population. The equation, $C^n \times t = k$, where $n = 1.6$ (estimated from the 1- and 4-hour rat lethality data), was used to scale the 60-minute exposure to 4- and 8-hour values and the 30-minute exposure to 10 minutes. The proposed AEGL-3 values are summarized in Table 12.

TABLE 12. AEGL-3 Values for Peracetic Acid [mg/m³]

10 min	30 min	1 h	4 h	8 h
60 mg/m ³	30 mg/m ³	15 mg/m ³	6.3 mg/m ³	4.1 mg/m ³

8. SUMMARY OF PROPOSED AEGLs

8.1. Proposed AEGLs

The AEGL-1 value was based on a concentration of peracetic acid that is not expected to be detectable, unpleasant, or cause discomfort (1.56 mg/m³) or no more than mild discomfort (1.56 - 3.12 mg/m³). An uncertainty factor of 3 was applied to 1.56 mg/m³ to account for human variability.

The AEGL-2 value of 1.6 mg/m³ for all exposure durations was based on human data showing slight to mild irritation or discomfort to mucous membranes due to exposure to peracetic acid at a concentration of 4.7 mg/m³. The same value is proposed for all exposure durations from 10 minutes to 8 hours. An uncertainty factor of 3 was applied to account for human variability.

The AEGL-3 values were based on NOELs for lethality in rats exposed to Proxitane 1507 (containing 15% peracetic acid) for 30 minutes and 1 hour. Uncertainty factors of 3 for intraspecies variability and 3 for interspecies sensitivity were applied to the NOELs. The equation $C^{1.6} \times t = k$ was used to scale the 30-minute exposure to 10 minutes and the 1-hour exposure was used to scale to 4 and 8 hours. The value of value of n was estimated from rat data.

The AEGL values are presented in Table 13.

TABLE 13. AEGL Values for Peracetic acid [mg/m³ (ppm)]

Classification	10 min	30 min	1 h	4 h	8 h	Endpoint /Reference
AEGL-1 (Nondisabling)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	Threshold for irritation (Fraser and Thorbinson, 1986; McDonagh, 1997)
AEGL-2 (Disabling)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	Mild irritation (Fraser and Thorbinson, 1986)
AEGL-3 (Lethal)	60 mg/m ³	30 mg/m ³	15 mg/m ³	6.3 mg/m ³	4.1 mg/m ³	Highest concentration causing no deaths (Janssen, 1989a)

8.2. Comparison of AEGLs with Other Standards and Criteria

There are no OSHA (Occupational Safety and Health Administration) standards, NIOSH (National Institute for Occupational Safety and Health) recommendations, or ACGIH TLV, AIHA-ERPG, or MAK values for peracetic acid. SOLVAY (1998) (Belgium manufacturer of peracetic acid) derived Emergency Exposure Indices (EEI) for accidental releases of peracetic acid based on the methodology of the European Chemical Industry Ecology and Toxicology Centre (ECETOC). These values are derived for general population exposures. The values are as follows:

SLV-EEI-3 (death/permanent incapacity)= 50 ppm (156 mg/m³): the threshold above which mortality and/or irreversible effects could be observed for an exposure of up to 60 minutes.

SLV-EEI-2 (disability) = 3 ppm (9 mg/m³): the threshold level above which intense lacrimation, extreme nose discomfort and transient incapacitation (inability of self-protection but without residual consequences) could be observed for an exposure of up to 60 minutes.

SLV-EEI-1(discomfort) = 0.15 ppm (0.45 mg/m³): the threshold level above which discomfort could be observed for an exposure of up to 8 hours per day.

8.3. Data Quality and Research Needs

Human data on exposure to peracetic acid were limited. This substance is corrosive to mucous membranes causing extreme discomfort depending on the concentration. Therefore, additional humans studies would not be feasible except for very low concentrations (below irritation levels in normal subjects) using healthy exercising subjects. The animal studies found in the literature were well conducted considering the circumstances. Peracetic acid occurs in mixtures with acetic acid, hydrogen peroxide, a stabilizer, and sometimes sulfuric acid. Commercial preparations vary in the concentrations of the three components. Because of the instability of peracetic acid, the aerosol or vapor may have different compositions of peracetic acid, acetic acid, and hydrogen peroxide. Variations in the composition of the test material could lead to inconsistencies in the observed effects. Therefore, acute inhalation studies using the same commercial product to study lethal and nonlethal effects after exposure for 30 minutes, and 1, 4, and 8 hours would aid in the evaluation of the toxicity of peracetic acid.

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APPENDIX A: DERIVATION OF AEGL VALUES FOR PERACETIC ACID

Derivation of AEGL-1 Values

Key Study:	McDonagh, 1997; Fraser and Thorbinson, 1986
Toxicity Endpoint:	Threshold for irritation
Time Scaling:	Not applicable
Uncertainty Factors:	NA for interspecies sensitivity (AEGL-1 derived from human data) 3 for intraspecies variability; peracetic acid is corrosive and response to upper respiratory tract and eyes is expected to be similar among individuals in the population
Modifying Factor:	1
Calculations:	$1.56 \text{ mg/m}^3/3 = 0.52 \text{ mg/m}^3$ Same values applied for 10-minute to 8-hour exposure durations

1 **Derivation of AEGL-2 Values**

2

3 Key Study: Fraser and Thorbinson, 1986

4

5 Toxicity Endpoint: Slight upper respiratory tract irritation

6

7 Uncertainty Factor: NA for interspecies sensitivity (AEGL-2 derived from human data)
8 3 for intraspecies variability; peracetic acid is corrosive and effects in
9 the upper respiratory tract are expected to be similar among
10 individuals in the population.

11

12 Modifying Factor: 1

13

14 Calculations:

15 $4.67 \text{ mg/m}^3 / 3 = 1.6 \text{ mg/m}^3$

16

17 The same value is applied to 10-minute to 8-hour durations.

18

DERIVATION OF AEGL-3 VALUES

1		
2		
3	Key Study:	Janssen, 1989a
4		
5	Toxicity Endpoint:	Highest non-lethal concentration of 96 ppm for a 30-minute exposure and 48 ppm for a 60-minute exposure in the rat
6		
7		
8	Time Scaling:	$C^n \times t = k$; $n = 1.6$ based on analysis of rat lethality data.
9		
10	Uncertainty Factors:	3, for interspecies sensitivity: mucous membranes of the respiratory tract of humans and animals are not expected to show vast differences in response to corrosive/irritant substances at concentrations that cause severe physical damage or at the threshold for lethality
11		
12		
13		
14		
15		3 for intraspecies variability: mucous membranes of individuals are not expected to show a great difference in response to a corrosive/irritant substance such as peracetic acid.
16		
17		
18		
19	Modifying Factor:	1
20		
21	Calculations:	
22		
23	10-minute AEGL-3	$C = (k/t)^{1/1.6} = (6927 \text{ mg/m}^3 \cdot \text{min}/10 \text{ min})^{1/1.6}$
24		$C = 59.6 = 60 \text{ mg/m}^3$
25		
26	30-minute AEGL-3	$300 \text{ mg/m}^3/10$ (uncertainty factor) = 30 mg/m^3
27		$C^n \times t = k$; $C = 30 \text{ mg/m}^3$, $t = 30$ minutes, $n = 1.6$
28		$k = 6927 \text{ mg/m}^3 \cdot \text{min}$
29		$C = (k/t)^{1/1.6} = (6927 \text{ mg/m}^3 \cdot \text{min}/30 \text{ min})^{1/1.6}$
30		$C = 30 \text{ mg/m}^3$
31		
32	1-hour AEGL-3	$150 \text{ mg/m}^3/10$ (uncertainty factor) = 15.0 mg/m^3
33		$C^n \times t = k$; $C = 15 \text{ mg/m}^3$, $t = 60$ minutes, $n = 1.6$
34		$k = 4569.8008 \text{ mg/m}^3 \cdot \text{min}$
35		$C = (k/t)^{1/1.6} = (4570 \text{ mg/m}^3 \cdot \text{min}/60 \text{ min})^{1/1.6}$
36		$C = 15 \text{ mg/m}^3$
37		
38	4-hour AEGL-3	$C = (k/t)^{1/1.6} = (4570 \text{ mg/m}^3 \cdot \text{min}/240 \text{ min})^{1/1.6}$
39		$C = 6.3 \text{ mg/m}^3$
40		
41	8-hour AEGL-3	$C = (k/t)^{1/1.6} = (4570 \text{ mg/m}^3 \cdot \text{min}/480 \text{ min})^{1/1.6}$
42		$C = 4.1 \text{ mg/m}^3$

1 **APPENDIX B: DERIVATION SUMMARY: ACUTE EXPOSURE GUIDELINES FOR**
 2 **PERACETIC ACID**
 3

AEGL -1 VALUES				
10 min	30 min	1 h	4 h	8 h
0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)	0.52 mg/m ³ (0.17 ppm)
<p>Key References:</p> <p>(I) McDonagh, J. 1997. Atmospheric Monitoring of Peracetic acid on the Existing Caprolactone Plant Distillation Houses A & B - Assessment of Results. Solvay Interlox, Warrington, Reference No. EE970192.M01, Memorandum to R.A. Haffenden et al. dated 30 April 1997;</p> <p>(II) Fraser, J. A. L.; Thorbinson, A. 1986. Fogging Trials with Tenneco Organics Limited (30th June, 1986) at Collards Farm.</p>				
<p>Test Species/Strain/Number: Humans/two subjects (I); number unknown (II)</p>				
<p>Exposure Route/Concentration/Durations: Inhalation, 0.40-0.53 mg/m³ (0.13-0.17 ppm) for up to 3 hours (I); 1.56-1.87 mg/m³ (0.5-0.6 ppm) for unknown time (I), <1.56-4.67 mg/m³ for 12 minutes; ≤1.56 to ≥6.23 mg/m³ for 45 minutes (II)</p>				
<p>Effects: 1.56-3.12 mg/m³: mild discomfort 1.56-1.87 mg/m³: no immediate irritation; may be unpleasant for extended period ≤1.56 mg/m³: no discomfort 0.40-0.53 mg/m³: detectable, but tolerable and not unpleasant</p>				
<p>Endpoint/Concentration/Rationale: Threshold for irritation of 1.56 mg/m³; the effects range from detectable but tolerable and not unpleasant to no discomfort</p>				
<p>Uncertainty Factors/Rationale: Total uncertainty factor: 3 Interspecies: NA Intraspecies: 3, individuals in the population are expected to respond similarly and by a factor no greater than 3 when exposed to corrosive/irritant agents that affect the upper respiratory tract.</p>				
<p>Modifying Factor: 1</p>				
<p>Animal to Human Dosimetric Adjustment: NA</p>				
<p>Time Scaling: NA</p>				
<p>Data Adequacy: Human data were limited but were generally supported by animal data. The human data showed that irritation or discomfort at concentrations ≤1.56 mg/m³ is expected to be absent or minimal. Neither study reported the number of subjects exposed to peracetic acid.</p>				

1

AEGL -2 VALUES				
10 min	30 min	1 h	4 h	8 h
1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)	1.6 mg/m ³ (0.5 ppm)
Key Reference: Fraser, J. A. L.; Thorbinson, A. 1986. Fogging Trials with Tenneco Organics Limited (30th June, 1986) at Collards Farm.				
Test Species/Strain/Number: Humans, number exposed is unknown				
Exposure Route/Concentration/Durations: Inhalation, range of 15.6 mg/m ³ for 7 minutes; <1.56-4.67 mg/m ³ for 12 minutes; 6.23-9.35 mg/m ³ for 1 hour and 15 minutes; ≤1.56-6.23 mg/m ³ for 45 minutes				
Effects: All effects were associated with the upper respiratory tract or eyes 6.23-15.6 mg/m ³ : lacrimation, extreme upper respiratory discomfort or irritation 6.23 mg/m ³ : unbearable irritation or extreme discomfort, but tolerable for 2 minutes 3.13-4.67 mg/m ³ : slight or tolerable discomfort (upper respiratory tract and eyes) 1.36-3.12 mg/m ³ : mild discomfort; ≤1.56 mg/m ³ : no discomfort				
Endpoint/Concentration/Rationale: Slight upper respiratory tract irritation at 4.7 mg/m ³				
Uncertainty Factors/Rationale: Total uncertainty factor: 3 Interspecies: NA Intraspecies: 3, individuals in the population are expected to respond similarly and by a factor no greater than 3 when exposed to corrosive/irritant agents that affect the upper respiratory tract.				
Modifying Factor: 1				
Animal to Human Dosimetric Adjustment: NA				
Time Scaling: NA				
Data Adequacy: The number of subjects exposed to peracetic acid was not reported by the investigators. The AEGL-2 value was based on a concentration that caused discomfort or slight discomfort, which is below the definition for AEGL-2; the next higher concentrations caused unbearable irritation after 2 minutes. Therefore, the lower concentration was more appropriate for deriving AEGL-2 values. The rationale for selecting the same value for all time points is as follows: (1) effects of peracetic acid exposure correlate with concentration more than time, and (2) peracetic acid is freely soluble in water and should be effectively scrubbed in the nasal passages, particularly at the very low AEGL-2 concentration.				

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3

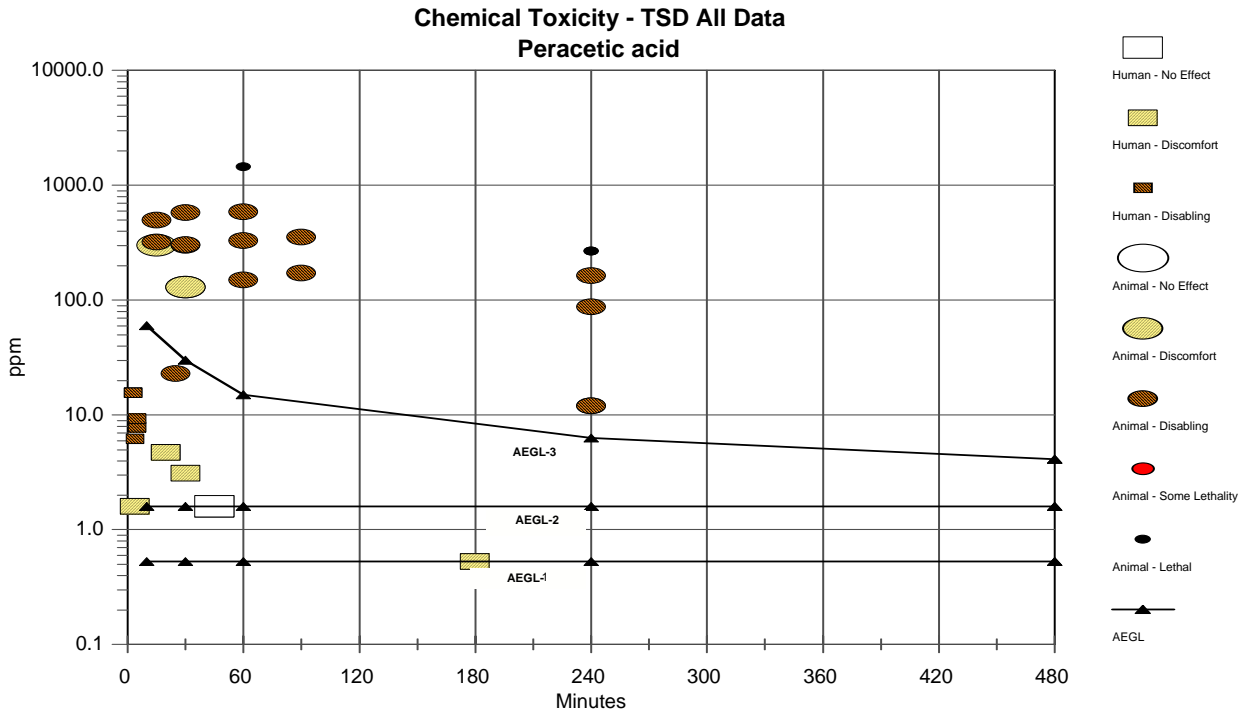
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AEGL -3 VALUES				
10 min	30 min	1 h	4 h	8 h
60 mg/m ³	30 mg/m ³	15 mg/m ³	6.3 mg/m ³	4.1 mg/m ³
Key Reference: Janssen, P.J.M. 1989a. Acute Inhalation Toxicity Studies of Proxidane 1507 in Male Rats (I) Duphar B.V., Report No. S. 8906, Int. Doc. No. 56645/25/89.				
Test Species/Strain/Number: Rat/ CPB-WU Wistar/5 males per group				
Exposure Route/Concentration/Durations: Inhalation: 130, 300, or 320 mg/m ³ for 30 minutes and 150, 390, or 1450 mg/m ³ for 60 minutes				
Effects: Clinical signs: signs of extreme respiratory irritation and discomfort, drooping eyelids, transient weight loss, reduced respiratory rate Gross pathologic effects: blood around nose, red nasal and tracheal mucosa, bloody fluid in trachea, dark red lungs, red or dark spots on lungs, elevated lung weight Mortality: 0/5 rats at 300 mg/m ³ and 3/5 at 320 mg/m ³ for 30 minutes; 0/5 at 150 mg/m ³ , 2/5 at 390 mg/m ³ , and 5/5 at 1450 mg/m ³ for 60 minutes				
Endpoint/Concentration/Rationale: Highest non-lethal concentrations for rats exposed for 30 or 60 minutes; the concentrations were 300 mg/m ³ for 30 minutes and 150 mg/m ³ for 60 minutes				
Uncertainty Factors/Rationale: Total uncertainty factor: 10 Interspecies: 3, mucous membranes of the respiratory tract of humans and animals are not expected to show vast differences in response to corrosive/irritant substances at concentrations that cause severe physical damage or at the threshold for lethality. Intraspecies: 3, mucous membranes of individuals are not expected to show a great difference in response to a corrosive/irritant substance such as peracetic acid.				
Modifying Factor: 1				
Animal to Human Dosimetric Adjustment: 1				
Time Scaling: $C^n \times t = k$, where $n = 1.6$ based on analysis of rat LC_{50} data for 1 and 4 hour exposures.				
Data Adequacy: The animal studies were well conducted; however, the different compositions of peracetic acid probably contributed to the inconsistencies of the results. The animal studies were conducted with aerosols instead of the vapor.				

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APPENDIX C: CATEGORY PLOT FOR PERACETIC ACID



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