FORMALDEHYDE
Original ERPG published: 1988
Document reaffirmed: 2011

**ERPG–3:** 40 ppm (49.2 mg/m³)
The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

**ERPG–2:** 10 ppm (12.3 mg/m³)
The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual’s ability to take protective action.

**ERPG–1:** 1 ppm (1.23 mg/m³)
The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.
EMERGENCY RESPONSE PLANNING GUIDELINE

FORMALDEHYDE (2011)

ERPG-3: 40 ppm (49.2 mg/m³)
ERPG-2: 10 ppm (12.3 mg/m³)
ERPG-1: 1 ppm (1.23 mg/m³)

I. IDENTIFICATION

Chemical Name: Formaldehyde
Synonyms: Methanal, oxomethane, oxymethylene, methylene oxide, formicaldehyde
CAS Number: 50-00-0
DOT Number: UN 2209
Molecular Formula: CH₂O
Structural Formula: HCHO

II. CHEMICAL AND PHYSICAL PROPERTIES

Physical State: Gas (used industrially as a gas, available commercially as Formalin, a 37% aqueous solution with 10-15% methanol)
Molecular Weight: 30.03
Conversion Factors: 1 ppm = 1.23 mg/m³; 1 mg/m³ = 0.814 ppm
Boiling Point: -19.5°C (3.1°F)
Vapor Density: 1.08
Flash Point: 50°C (Formalin: 37% Formaldehyde, 15% Methanol)
Flammability Limits: 7–73 %
Autoignition Temperature: 430°C (806°F)
Reactivity: Polymerizes readily in absence of inhibitor.
Solubility in water: Very Soluble

III. ANIMAL TOXICITY DATA

A. Acute Toxicity

1. Oral

LD₅₀ in rats 800 mg/kg(2)

2. Eye Irritation

One drop of formalin to rabbit eyes caused edema of the cornea and conjunctiva and iritis.(3)

3. Dermal Toxicity

LD₃₀ in rabbits 270 mg/kg(4)

4. Inhalation Toxicity

a) Lethal Exposures

<table>
<thead>
<tr>
<th>Species</th>
<th>Concentration</th>
<th>Duration</th>
<th>Result</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>815 ppm</td>
<td>0.5 hr</td>
<td>LC₅₀</td>
<td>5¹</td>
</tr>
<tr>
<td>Rat</td>
<td>478 ppm</td>
<td>4 hr</td>
<td>LC₅₀</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(6 to 10 M Rats/group)</td>
</tr>
<tr>
<td>Rat</td>
<td>250 ppm</td>
<td>4 hr</td>
<td>ALC</td>
<td>7</td>
</tr>
<tr>
<td>Mouse</td>
<td>2162 ppm</td>
<td>10 min</td>
<td>LC₅₀</td>
<td>8</td>
</tr>
<tr>
<td>Mouse</td>
<td>900 ppm</td>
<td>2 hr</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Mouse</td>
<td>731 ppm</td>
<td>2 hr</td>
<td>LC₁₀₀</td>
<td>10</td>
</tr>
<tr>
<td>Mouse</td>
<td>700 ppm</td>
<td>2 hr</td>
<td>LC₅₀</td>
<td>9</td>
</tr>
<tr>
<td>Mouse</td>
<td>410 ppm</td>
<td>2 hr</td>
<td>LC₅₀</td>
<td>6</td>
</tr>
<tr>
<td>Mouse</td>
<td>320 ppm</td>
<td>100 min</td>
<td>LC₅₀</td>
<td>11</td>
</tr>
<tr>
<td>Mouse</td>
<td>320 ppm</td>
<td>55 min</td>
<td>LC₅₀</td>
<td>11</td>
</tr>
<tr>
<td>Mouse</td>
<td>16.3 ppm³</td>
<td>10 hr</td>
<td>Killed 48/50</td>
<td>12</td>
</tr>
<tr>
<td>Mouse</td>
<td>15.4 ppm³</td>
<td>10 hr</td>
<td>Killed 17/50</td>
<td>12</td>
</tr>
<tr>
<td>Rabbit</td>
<td>16.3 ppm³</td>
<td>10 hr</td>
<td>Killed 1/5</td>
<td>12</td>
</tr>
<tr>
<td>Rabbit</td>
<td>15.4 ppm³</td>
<td>10 hr</td>
<td>Killed 3/5</td>
<td>12</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>16.3 ppm³</td>
<td>10 hr</td>
<td>Killed 1/20</td>
<td>12</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>15.4 ppm³</td>
<td>10 hr</td>
<td>Killed 8/20</td>
<td>12</td>
</tr>
</tbody>
</table>
1. The histological findings noted in animals dying from exposure to formaldehyde were hemorrhages and intra-alveolar and peri-vascular edema in the lungs. A purulent bronchitis and diffuse bronchial pneumonia were observed in one animal dying 15 days post-exposure.

2. ALC = Approximate Lethal Concentration; 2/6, 3/6, or 4/6 male rats died as a result of a 4-hour exposure

3. Animals were exposed for 10 hours or until death to concentrations of 16.3 ppm and 15.4 ppm. Exposures were described as formal in aerosol and formalin “vapor,” respectively. The aerosol was actually a mixed exposure of vapor and aerosol.

b) Non-Lethal Exposures

See Table I

c) Inhalation Sensitization

Formaldehyde was found to be negative in a respiratory local lymph node assay where male BALB/c mice were exposed to 3 ppm of formaldehyde for three days for periods of 45, 90, 180 or 360 minutes per day. Nasal squamous hyper/metaplasia was observed in 3 of 6 mice exposed for 360 minutes per day.

B. Subacute Toxicity.

No data used in evaluation.

C. Subchronic Toxicity

See Table II

D. Chronic Toxicity and Carcinogenicity

The carcinogenic potential of formaldehyde was evaluated in Fischer-344 rats. 120 rats, sex/group, exposed to 2, 5.6, or 14.3 ppm formaldehyde for 6 hours/day, 5 days/week, for 24 months. Dose-related histopathologic changes were observed, including rhinitis, epithelial hyperplasia, and squamous metaplasia of the turbinates. Three rats were found to have nasal cavity squamous cell carcinomas after 12 months of exposure to 14.3 ppm, and 36 tumors were found at 18 months. A total of 95 squamous cell carcinomas were detected in rats exposed to 14.3 ppm formaldehyde for up to 24 months. A few tumors also were seen at 5.6 ppm but not at 2 ppm. In a similar group of B6C3F1 mice similarly exposed, two neoplasms of the nasal turbinates were found in mice exposed to 14.3 ppm formaldehyde but not at 2 or 5.6 ppm after 24 months of exposure.

Groups of 100 male rats were exposed 6 hours a day, 5 days a week, for their lifetime to 0 or 15 ppm of formaldehyde. No tumors were observed in the controls. In the group exposed to 15 ppm of formaldehyde, there were 38 squamous cell carcinomas, 1 fibrosarcoma, and 1 mixed carcinoma observed.

Table I: Inhalation Toxicity: Non-Lethal Exposures

<table>
<thead>
<tr>
<th>Species</th>
<th>Concentration</th>
<th>Duration</th>
<th>Result</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>350 ppm</td>
<td>4 hr</td>
<td>No deaths</td>
<td>6</td>
</tr>
<tr>
<td>Rat</td>
<td>35 ppm</td>
<td>18 hr</td>
<td>Labored breathing, nasal irritation, liver injury, no deaths</td>
<td>13</td>
</tr>
<tr>
<td>Rat</td>
<td>13.8 ppm</td>
<td>15 min</td>
<td>RD50</td>
<td>14</td>
</tr>
<tr>
<td>Rat</td>
<td>10.0 ppm</td>
<td>30 min</td>
<td>RD50</td>
<td>15</td>
</tr>
<tr>
<td>Mouse</td>
<td>1000 ppm</td>
<td>10 min</td>
<td>No deaths</td>
<td>8</td>
</tr>
<tr>
<td>Mouse</td>
<td>98 ppm</td>
<td>2 hr</td>
<td>No deaths</td>
<td>6</td>
</tr>
<tr>
<td>Mouse</td>
<td>3.1 ppm</td>
<td>10 min</td>
<td>RD50</td>
<td>16</td>
</tr>
<tr>
<td>Species</td>
<td>Concentration</td>
<td>Exposure</td>
<td>Effect</td>
<td>Reference</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Rats</td>
<td>0, 1, 10, 20 ppm</td>
<td>6 hours/day, 5 days/week, 13 weeks</td>
<td>1 ppm: minimal focal hyperplasia in the nose</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 ppm: moderate squamous hyperplasia of the nasal respiratory epithelium</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 ppm: growth retardation, squamous metaplasia.</td>
<td></td>
</tr>
<tr>
<td>Rats</td>
<td>0, 0.7, 2, or 6 ppm</td>
<td>6 hours a day, 5 days a week for up to 3 weeks</td>
<td>6 ppm: increased cell proliferation and squamous metaplasia at day 5 and epithelial hyperplasia at day 15; gene changes at 2 and 6 ppm; NOEL = 0.7 ppm</td>
<td>19</td>
</tr>
<tr>
<td>Rats</td>
<td>0, 1, or 2 ppm</td>
<td>8 hours/day, 5 days/week, 13 weeks</td>
<td>1 or 2 ppm exposure = No effects</td>
<td>20</td>
</tr>
<tr>
<td>Rats</td>
<td>2 or 4 ppm</td>
<td>8 X 30 min/day 30 min off/hour 13 weeks</td>
<td>Nasal effects only at 4 ppm. Squamous metaplasia, basal cell hyperplasia, keratinization of respiratory epithelium.</td>
<td>20</td>
</tr>
<tr>
<td>Rats</td>
<td>0, 10, or 20 ppm</td>
<td>6 hours/day, 5 days/week, for 4, 8, or 13 weeks</td>
<td>Growth retardation at 10 and 20 ppm; 20 ppm: nasal respiratory and olfactory epithelium changes; 10 ppm: changes of the respiratory epithelium, olfactory epithelium was not visibly affected in rats of this group; no NOEL</td>
<td>21</td>
</tr>
<tr>
<td>Rats and mice</td>
<td>0, 4, 12, or 40 ppm</td>
<td>6 hours/day, 5 days/week, 13 weeks</td>
<td>Dose-related increase in ulceration or necrosis of the nasal turbinate mucosa; the effect was more severe in rats than in mice; no NOEL</td>
<td>22</td>
</tr>
<tr>
<td>Mice</td>
<td>0, 2, 4, 10, 20, or 40 ppm</td>
<td>6 hours/day, 5 days/week, 13 weeks</td>
<td>10 ppm: nasal lesions; 20 ppm: nasal, laryngeal, and tracheal lesions; 40 ppm: death, ataxia, body weight depression; NOEL = 4 ppm</td>
<td>23</td>
</tr>
<tr>
<td>Monkeys, rats, and hamsters</td>
<td>0, 0.2, 1, and 3 ppm</td>
<td>22 hours/day, 7 days/week, for 6 months</td>
<td>3 ppm: inflammation with metaplasia and hyperplasia of the tissue lining the forepart of the nose was detected in monkeys and rats; NOEL = 1 ppm (3 ppm for hamsters)</td>
<td>24</td>
</tr>
</tbody>
</table>
Groups of 32 male F-344 rats were exposed by inhalation to gaseous formaldehyde at 0.3, 2, and 15 ppm 6 hours/day, 5 days/week for 28 months. Nasal tumors were macroscopically evident in the 15 ppm group from the 14th month and 8 of 32 rats bore such tumors at the 24th month. Histopathological examination at the end of the exposure period revealed both squamous cell papillomas (3/32) and carcinomas (13/32). No nasal tumors were observed in the lower exposure groups. (28)

Groups of male rats were exposed 6 hours a day, 5 days a week, for 28 months to 0, 0.1, 1.0 or 10 ppm of formaldehyde vapor. There was no significant increase in the incidence of nasal tumors. (29)

Male Syrian golden hamsters were exposed to 10 ppm of formaldehyde 5 hours a day, 5 times a week, for their lifetime. Survival of the treated animals was reduced relative to unexposed controls. No tumors were observed in histologic sections of respiratory tract tissues from either unexposed or treated animals. Only a minimal increase in hyperplastic and metaplastic areas was observed in nasal epithelium of exposed animals. (30)

E. Reproductive and Developmental Toxicity

Sprague-Dawley rats were exposed to 0, 5, 10, 20 or 40 ppm formaldehyde for 6 hours a day from Days 6 to 20 of gestation. On Day 21 of gestation the rats were killed for evaluation of maternal reproductive and fetal parameters. No effects on embryonic or fetal lethality, or significant alterations in the external, visceral or skeletal appearance of the fetuses were noted in any of the exposed groups. Significant concentration-related reduction of fetal body weight occurred at 20 and 40 ppm, and at 40 ppm fetal body weights were 20% less than those of the controls. Maternal toxicity, indicated by significant reduction in body weight and absolute weight gain, was observed at 40 ppm. The results of this study show that formaldehyde is slightly fetotoxic at 20 ppm. Neither embryolethal nor teratogenic effects were observed following inhalation exposure at levels up to 40 ppm. (31)

No visible fetal malformations were observed in rats continuously exposed during pregnancy to 0.8 ppm formaldehyde. (32) No adverse gonadotropic or reproductive effects were observed in male rats administered formaldehyde at 0.1 ppm in drinking water or 0.4 ppm in the air for 6 month. (33) Pregnant dogs fed diets containing 125 or 375 ppm formaldehyde on Days 4–56 of pregnancy showed no evidence of teratogenesis. (34) There was no effect on the course of pregnancy and no malformations in the offspring when rats were exposed to 4 ppm formaldehyde for 4 hours a day during days 1-19 of pregnancy. (35)

F. Genotoxicity Data

There are a variety of genotoxicity data available for formaldehyde. Some representative data are found below:

<table>
<thead>
<tr>
<th>Test System</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella typhimurium, with or without S9</td>
<td>Negative (36)</td>
</tr>
<tr>
<td>Cytogenetics, human lymphocytes</td>
<td>Positive (37)</td>
</tr>
<tr>
<td>CHO/HGPRT</td>
<td>Negative (38)</td>
</tr>
<tr>
<td>Mouse lymphoma/L5178Y</td>
<td>Positive (39)</td>
</tr>
<tr>
<td>In vitro unscheduled DNA synthesis</td>
<td>Positive (40)</td>
</tr>
<tr>
<td>Dominant lethal Swiss Mice</td>
<td>Negative (41)</td>
</tr>
<tr>
<td>Cell transformation C3H/10T 1/2</td>
<td>Negative (42)</td>
</tr>
<tr>
<td>In vivo induction of DNA-protein crosslinks</td>
<td>Weak (43-45)</td>
</tr>
</tbody>
</table>

The available data indicate that formaldehyde is highly cytotoxic in vitro and is genotoxic under certain conditions of test. It exhibits at most, however, a weak potential to bind to DNA in vivo.

G. Metabolism / Pharmacokinetics

Formaldehyde (HCHO) is readily absorbed in the respiratory and gastrointestinal tracts. Dermal absorption of HCHO appears to be very slight. Increases in blood concentrations were not detected in rats or humans exposed to HCHO through inhalation because of rapid metabolism. Metabolites are incorporated into macromolecules via one-carbon pathways or are eliminated in the expired air (CO₂) and urine. Formaldehyde that escapes metabolism can react with macromolecules at the site of entry. DNA-protein cross-links have been detected in tissues exposed directly to HCHO, but not in tissues remote from the absorption site. (46)

IV. HUMAN EXPERIENCE

A. Odor Data

Formaldehyde has a pungent odor. (47) The odor recognition threshold in air varies considerably among individuals but generally lies between 0.1 and 0.5 ppm. (47-49) There may be adaptation to odor as contact continues. (1,49) No distinct odor was reported by the volunteers exposed for 1 hour to 0.40 ppm of formaldehyde. (50)
B. Toxicity Data

No change was found in lung function (measured as a change in FEV₁, FVC, or PEF) in volunteers exposed to 0.4 ppm formaldehyde for 1 hour. The 12 volunteers (7 men and 5 women) ranged in age from 18 to 44 years. All had been diagnosed with intermittent asthma and allergy to pollen. Exposure to formaldehyde had no effect on lung function. Pre-exposure to formaldehyde had no significant deleterious effect on air allergen responsiveness (methacholine challenge following inhalation of a standardized pollen extract) or sputum inflammatory markers including eosinophilic response. Subjective symptoms were similar between the air only and formaldehyde exposures. No distinct odor was reported by the volunteers.\(^{50}\)

For a total of 37 minutes, 33 subjects were exposed to formaldehyde at 0.03–3.2 ppm. The reported irritation thresholds were 1.2 ppm for nose and eye irritation and the “desire to leave the room,” 1.7 ppm for increased eye blinking rate, and 2.1 ppm for throat irritation.\(^{51}\)

Healthy, non-smoking subjects were exposed to formaldehyde for 3 hours in a controlled environmental chamber. Eye irritation increased linearly from 0.5 to 3.0 ppm. At 2 ppm, 6/19 of the subjects reported mild eye irritation and 4/19 moderate eye irritation; at 3 ppm, all 9 subjects experienced eye irritation, 5 as mild and 4 as moderate. For nose/throat irritation, a mild response was reported by 7/19 of the subjects at 2 ppm and 2/9 at 3 ppm. Exercise produced no significant increase in odor or eye irritation, however, nose/throat irritation increased significantly. The mean increase in nasal flow resistance with at-rest exposure was not significant at 2 ppm formaldehyde but was significant decrements in pulmonary function-forced vital capacity (FVC) forced expiratory flow rate 25–75% (FEF1) – during a 3-hour exposure or 24 hour post-exposure at 0.5 ppm formaldehyde at rest or at 2.0 ppm with exercise.\(^{52}\)

No significant changes in pulmonary function or airway reactivity were observed in nine non-smoking asthmatic volunteers exposed to 3 ppm formaldehyde for 3 hours. Eye and upper respiratory tract irritation was observed.\(^{53}\)

In an exposure chamber, 12 men were exposed to formaldehyde at 13.8 ppm for 30 minutes. The men reported considerable nasal and eye irritation when they first entered the area. After about 10 minutes in the chamber, however, they became acclimated to the exposure.\(^{54}\)

Formaldehyde has been reported to produce mild sensory irritation of the eyes, nose and throat at 2 to 5 ppm, becomes unpleasant at 5 to 10 ppm, and is intolerable at levels in excess of 25 ppm.\(^{48}\)

Inhalation of high concentrations of formaldehyde has caused severe irritation of the respiratory tract leading to death in two individuals. The exposure concentrations were unknown.\(^{55,56}\)

C. Workplace Experience

Relevant workplace information is incorporated in other sections of this document.

D. Epidemiology

An independent, international panel of scientists\(^{57}\) reviewed and evaluated the more than 30 investigations concerning formaldehyde and human cancer. The panel also took into account critiques and reviews of the published reports. The panel concluded that there is no convincing evidence of a relationship for malignancy in man with formaldehyde exposure and furthermore, if a relationship does exist, the excess risk, in absolute terms, must be small; three of these studies\(^{58-60}\) are briefly summarized below:

A cohort of 26,561 workers was followed for approximately 600,000 person-years. The authors concluded that “cancer overall was not related to formaldehyde exposure.” No excess of nasal cancer was reported.\(^{58}\)

No deaths from nasal cancer were reported (1.07 expected), and no excess mortality was found for cancers of any of the sites previously associated with formaldehyde in a cohort of 7680 men exposed to formaldehyde in the British chemical or plastics industry.\(^{60}\)

Based on information in the Danish Cancer Registry for the periods 1943–1976, no increased risk of lung cancer was observed among Danish physicians or other medical specialties exposed to formaldehyde in their work.\(^{59}\)

Epidemiological studies that led to a change in the classification of formaldehyde by the International Agency for Research on Cancer (IARC) in 2004 were reviewed as well as studies published thereafter, with the objective to examine whether occupational exposure levels for formaldehyde should be adapted. Cohort and case-control studies investigating the
association between occupational exposure to formaldehyde and nasopharyngeal cancer (NPC) and reporting estimates of formaldehyde exposure as well as the most recent meta-analyses, published after 1994, were reviewed. Evidence of an association between occupational formaldehyde exposure and NPC appears debatable. Results of the cohort in one study\(^6\) were key findings in the IARC evaluation. In this study, mortality from NPC was elevated compared with that of the US general population. However, internal comparison analysis using alternative categorization revealed that none of the relative risks for NPC were statistically significantly increased in any category of exposure\(^6\) and re-analyses of the data highlighted the inappropriateness of the exposure assessment used in two studies.\(^{61,62}\) Two other cohorts\(^{64,65}\) reported no increase in NPC. Two case-control studies brought some evidence of an increased risk of NPC but the assessment of exposure levels was uncertain. Human studies fail to raise a convincing conclusion concerning the carcinogenicity of formaldehyde and are not helpful to delineate a possible dose-response relationship. Experimental data indicate that in rats, the carcinogenic activity of formaldehyde is associated with cytotoxic/proliferative mechanisms. Therefore protecting from these effects associated with formaldehyde exposure should be sufficient to protect from its potential carcinogenic effects, if any in humans.\(^{66}\)

IARC stated that there was limited epidemiologic evidence that formaldehyde caused sino-nasal cancer in humans and there was insufficient evidence for a causal association between leukemia and formaldehyde. However, the group concluded that excesses in naso-pharangeal cancer in some studies with US workers indicated that formaldehyde is carcinogenic in man (Group 1).\(^{67}\)

E. Other

Because of its widespread use, exposure to formaldehyde is common in indoor and ambient environments. For example, exposure can occur in newly constructed buildings where off-gassing from modern building and insulating materials can lead to temporary formaldehyde concentration approaching 1 ppm in the air.\(^{68}\) In ambient air, emissions from auto exhaust, municipal incinerators, and other sources have produced levels as high as 0.12 ppm.\(^{69}\)

V. Cancer Risk Calculation

Using the method proposed by the National Research Council’s Committee on Toxicology\(^{70}\) which is based on a version of the multistage model for calculating cancer risk\(^{71,72}\) exposures below 357 ppm formaldehyde would not appear to pose a significant (1 in 10,000) carcinogenic hazard resulting from a 1-hour emergency exposure. Based on this method\(^{73}\) the excess cancer risk from a 1-hour exposure to hundreds of ppm of formaldehyde is negligible. Therefore, the ERPGs for formaldehyde are based on other toxicological effects, especially acute effects on the respiratory tract, which are more important at lower concentrations.

VI. Current Exposure Guidelines

A. The American Conference of Governmental Industrial Hygienists [ACGIH\(^8\)] recommends a ceiling value (TLV\(^8\)) of 0.3 ppm with an A2 carcinogen designation.\(^{73}\)

B. The Occupational Safety and Health Administration (OSHA) recommends a permissible exposure limit (PEL) of 0.75 ppm as an 8-hour TWA or 2 ppm as a 15-minute STEL (29CFR:1910.1048).

C. The National Research Council’s One-hour Acute Exposure Guideline Levels (AEGLs) (Interim Values) are\(^{75}\):

\[
\begin{align*}
\text{AEGL-3} & = 56 \text{ ppm (69 mg/m}^3) \\
\text{AEGL-2} & = 14 \text{ ppm (17 mg/m}^3) \\
\text{AEGL-1} & = 0.9 \text{ ppm (1.1 mg/m}^3)
\end{align*}
\]

VII. RECOMMENDED ERPGS™ AND SUPPORTING RATIONALS

A. ERPG–3: 40 ppm

It is believed that nearly all individuals could be exposed to 40 ppm for up to one hour without experiencing or developing life-threatening health effects. Four-hour lethal concentrations (nominal) in rats ranged from 250 ppm\(^{71}\) to 478 ppm (LC\(_{50}\)). The four-hour non-lethal level in the latter study was 350 ppm. Based on this information, formaldehyde concentrations of 40 ppm and greater for 1 hour could cause severe irritation of the respiratory tract, pulmonary edema, and possible mortality in a few sensitive individuals in a heterogeneous human population.

B. ERPG–2: 10 ppm

It is believed that 10 ppm is the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious adverse health effects or symptoms which could impair an individual’s ability to take protective action. Based on human exposure data, concentration of greater than 10 ppm formaldehyde for 1 hour
could produce eye, nasal, and throat irritation severe enough to impair the taking of protective action.\(^{52,54}\)

C. ERPG–1: 1 ppm

It is believed that 1 ppm is the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing effects other than mild transient health effects or without perceiving a clearly defined objectionable odor. Based on human exposure data, formaldehyde concentrations of greater than 1 ppm would be detected and perceived as objectionable by a large percentage of the population.\(^{1,31,52}\)

History of Formaldehyde ERPG

First published in 1988: ERPG-1 1 ppm; ERPG-2 10 ppm; ERPG-3 25 ppm

Updated in 2010 and republished in 2011: ERPG-1 and ERPG-2 unchanged; ERPG-3 raised to 40 ppm.

VIII. REFERENCES


20. Wilmer, J.W., R.A. Woutersen, L.M. Appelman, W.R. Leeman, and V.J. Feron: Subchronic (13-


