# INITIAL STATEMENT OF REASONS FOR RULEMAKING

# STAFF REPORT/EXECUTIVE SUMMARY

# FINAL REPORT ON THE IDENTIFICATION OF FORMALDEHYDE AS A TOXIC AIR CONTAMINANT

Prepared by the Staffs of the Air Resources Board and the Office of Environmental Health Hazard Assessment

July 1992

## Preface

In accordance with Health and Safety Code section 39662, the California Environmental Protection Agency's Air Resources Board identified formaldehyde as a toxic air contaminant on March 12, 1992. No control measures for formaldehyde were proposed or adopted at the hearing. Formaldehyde will not enter the risk management, or control phase where a report on the need for, and appropriate degree of, control measures to reduce formaldehyde emissions will be developed in accordance with Health and Safety Code sections 39665 and 39666.

July 1992

Formaldehyde was identified as a toxic air contaminant by the Board on March 12, 1992. However, in response to written and oral comments, the Board directed the ARB and the OEHHA staff to work with industry to make clarifications to the report. This is the final report on the formaldehyde identification document which incorporates these clarifications.

Once a compound is selected to enter the TAC identification process, the ARB requests relevant information from the public and a written evaluation of available health effects information (Part B of the Technical Support Document) from the OEHHA. The OEHHA staff's evaluation is required to contain an estimate of the threshold exposure level above which the compound causes or contributes to adverse health effects. In the case where no threshold of significant adverse health effects can be determined, the OEHHA is required to state the range of risk to humans resulting from current or anticipated exposure.

Simultaneous with the preparation of the OEHHA health evaluation, the ARB staff prepares an exposure assessment (Part A of the Technical Support Document) including information on the compound's usage, emissions or potential emissions, environmental persistence, and available ambient and indoor exposure levels.

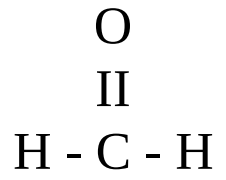
Following a public comment period, the Staff Report/Executive Summary and Parts A, B, and C of the Technical Support Document are formally reviewed by the Scientific Review Panel (SRP) at a public meeting. Upon reviewing the data, assessments, and conclusions of the report and ascertaining that appropriate scientific methods were used to gather and analyze the data presented, the SRP submits written findings to the ARB (the Board). At a public hearing, the Board decides whether or not the evidence in the Technical Support Document supports the identification of the compound as a TAC and, if so, whether there is evidence of a threshold exposure below which adverse effects are not expected to occur. Once a compound is identified as a TAC and listed in section 93000 of Title 17 of the California Code of Regulations, the ARB staff prepares a report on the need and appropriate degree of regulation pursuant to sections 39665-39668 of the Health and Safety Code.

## What is a toxic air contaminant?

According to Section 39655 of the California Health and Safety Code, a toxic air contaminant is "an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health." In addition, "substances which have been identified as hazardous air pollutants pursuant to Section 7412 of Title 42 of the United States Code shall be identified by the state board as toxic air contaminants."

## What is formaldehyde?

Formaldehyde is a colorless, flammable gas with a pungent, irritating odor. Formaldehyde can undergo a variety of chemical reactions, many of which are useful in commercial processes. The commercial forms of formaldehyde use include paraformaldehyde, formalin solutions, and polymers. Formaldehyde synonyms include methanal, methyl aldehyde, methylene oxide, formic aldehyde, and oxymethylene. The molecular formula of formaldehyde is HCHO.



Formaldehyde (HCHO)

## Does the Air Resources Board staff recommend identification of fomaldehyde as a toxic air contaminant?

Yes, the ARB staff recommends that the Board adopt the proposed amendment to section 93000, Titles 17 and 26 of the California Code of Regulations identifying formaldehyde as a TAC because:

- there is sufficient evidence that exposure to formaldehyde poses a public health hazard,
- formaldehyde is detected in ambient and indoor air and does not break down in the atmosphere at a rate that would eliminate public exposure,
- formaldehyde is listed as a hazardous air pollutant by the federal government pursuant to section 7412 of Title 42 of the United States Code; therefore, pursuant to section 39655 of the California Health and Safety Code, formaldehyde is required to be identified as a toxic air contaminant, and
- the OEHHA staff recommends that formaldehyde be identified as a toxic air contaminant and that formaldehyde be treated as having no threshold exposure level below which no significant adverse health impacts are anticipated.

## What are the sources of formaldehyde emissions?

Formaldehyde is directly emitted into the atmosphere and formed in the atmosphere as a result of photochemical oxidation of reactive organic gases (ROG) in polluted atmospheres containing ozone and nitrogen oxides. Photochemical oxidation can contribute as much as 90 percent of annual formaldehyde concentrations in the outdoor ambient air. The amount of formaldehyde formed from photochemical oxidation can vary significantly depending on the season, location, and time of day. The largest sources of directly emitted formaldehyde are from combustion of fuels from mobile sources and process emissions from oil refineries.

Indoor formaldehyde sources include such diverse products as building materials, clothing, furniture, draperies, paper products, and fingernail hardeners. A potentially large indoor source of formaldehyde is pressed wood products made with urea-formaldehyde resins. Such products include hardwood plywood, particle board, and medium-density fiberboard. Older pressed wood products, as a result of the off-gassing of formaldehyde over time, are believed to make a smaller contribution to indoor formaldehyde concentrations. Formaldehyde is also emitted from indoor combusion sources, including cigarettes.

## How much formaldehyde is produced from photo-oxidation of precursors in ambient air?

ARB staff estimates approximately 150,000 tons per year of formaldehyde in California are produced from photochemical oxidation processes. This estimate, based on information from the 1987 emissions data system, could vary by 50 percent.

## How much formaldehyde is released directly into outdoor California air?

Total direct outdoor formaldehyde emissions from mobile, stationary, and area sources, as based on ARB's emission inventory in California are estimated to be approximately 18,000 tons per year. Although most of the outdoor formaldehyde is photochemically formed, the highest ambient formaldehyde concentrations have been measured in urban areas dominated by direct mobile source emissions during conditions of stagnation. Mobile sources contribute approximately 80 percent of direct emissions to California's atmosphere.

## What are the effects of the ARB motor vehicle control program on formaldehyde?

Large reductions in emissions from individual motor vehicles have been achieved because of the ARB motor vehicle emission control program. For example, the standards for exhaust emission levels for total hydrocarbons from 1988 model-year passenger vehicles are over 90 percent lower than the exhaust levels of the pre-controlled 1965 models. As a result, emissions of formaldehyde from these vehicles have been reduced accordingly, although the magnitude of these reductions are not well known.

To address the need to further reduce motor vehicle emissions in California, the staff of the ARB developed a plan, approved by the Board, to ensure continued progress toward attainment of the federal and state air quality standards. The plan includes the adoption of more stringent emission standards, use of cleaner burning fuels, or a combination of the two. According to the plan, automobile formaldehyde emissions are anticipated to be the same or lower than emissions from currently available automobile fuels.

## What are the ambient outdoor air concentrations of formaldehyde?

Formaldehyde is routinely monitored at the statewide ARB toxics monitoring network. Basin-specific population-weighted mean annual concentrations vary from a minimum of 3.2 ppbv (3.9 ug/$m^3$) in the San Francisco Bay Area Air Basin to a maximum of 5.1 ppbv (6.3 ug/$m^3$) in the South Coast Air Basin (based on 24 hour sample averages). The overall estimated mean statewide exposure, weighted by population, is estimated to be 4.4 ppbv (5.4 ug/$m^3$). The population-weighted exposure is based on 20 million people represented by the toxics monitoring network (out of the 30 million total California population).

Studies conducted in the South Coast Air Basin since 1980 report short-term (30 minute to 2 hour sample averages) ambient outdoor concentrations that vary from

<1 ppbv (1.23 ug/$m^3$) to 86 ppbv (105 ug/$m^3$). The most recent concentrations measured during the 1987 South Coast Air Quality Study range from 3 to 35 ppbv (4 to 43 ug/$m^3$). These higher than annual average statewide exposures are due to daily variations in photochemical formation and direct source emissions of formaldehyde.

## Is there evidence of indoor air exposure to formaldehyde?

Yes. The results of recent California surveys of randomly-selected residences indicate that formaldehyde concentrations inside California residences can range from less than 10 ppbv to almost 500 ppbv. Mean concentrations were 24 ppbv for office and public buildings, 50 ppbv for conventional homes, and 72 ppbv for mobile homes. In California, mobile homes may present a particularly high exposure environment because they have the highest indoor formaldehyde concentrations and are occupied by proportionately more retired people, who may spend more time indoors. While it appears that formaldehyde off-gases from pressed wood products over time, indoor levels are expected to remain higher than outdoor levels due to new materials brought into the home as a consequence of remodeling or purchasing new furnishings. Other indoor sources such as gas stoves and cigarettes contribute intermittently to indoor formaldehyde levels.

In general, indoor environments consistently have higher concentrations than outdoor environments, because many building materials and consumer products emit formaldehyde. Since Californians spend most of their time indoors, indoor inhalation is a significant portion of total exposure to formaldehyde.

## Are there near source exposures to formaldehyde in California?

Yes. Areas that are expected to have above average ambient air concentrations are near commercial production sources, facilities producing pressed wood products, congested freeways, and oil refineries. In urban areas, combustion sources and periods of high photochemical reactivity produce short-term formaldehyde concentrations above statewide population-weighted annual average ambient air levels.

Modeling of near source areas was not done for this report; however, information from the Air Toxic "Hot Spots" Information and Assessment Act of 1987 (AB 2588; Health and Safety Code sections 44300-44384) will be used to prioritize and estimate near source exposures in the control phase if formaldehyde is identified as a toxic air contaminant.

## Are there other routes of exposure to formaldehyde?

Yes. Although inhalation is the primary route of exposure, other routes include dermal contact and ingestion of food and water. Exposures to formaldehyde from food and water are very small under normal circumstances. Therefore, the potential carcinogenicity of formaldehyde through the ingestion route is probably not significant. Absorption of formaldehyde through the

skin appears to be negligible, and thus is assumed to pose a negligible risk. However, dermal sensitization (contact dermatitis) and irritation from formaldehyde exposure is clearly documented.

## What is the persistence of formaldehyde in the atmosphere?

The dominant atmospheric removal mechanism for formaldehyde is by photolysis and oxidation by hydroxyl radicals during daylight hours. Depending on the atmospheric conditions, the overall tropospheric lifetime of formaldehyde is estimated to be approximately 0.3 days. Therefore, there is sufficient time to allow dispersal throughout an air basin. Rain or fog or both can shorten atmospheric lifetimes of formaldehyde.

## What are the health effects of formaldehyde exposure?

The health effects of formaldehyde exposure have been reviewed and evaluated to determine whether formaldehyde meets the definition of a toxic air contaminant. The following text summarizes the OEHHA staff findings regarding the health effects of formaldehyde exposure.

## What evidence exists that exposure to formaldehyde poses a public health hazard?

The OEHHA staff agrees with the International Agency for Research on Cancer (IARC) and the U.S. Environmental Protection Agency (EPA) classification of formaldehyde (IARC-Group 2A, EPA-Group B1) as a probable human carcinogen based on adequate evidence for carcinogenicity in animals and limited evidence in humans. Formaldehyde is carcinogenic in rodents, producing squamous cell carcinomas in the nasal passages of male and female rats and male mice. Several types of benign tumors, including polyploid adenomas and squamous cell papillomas, have also been observed. Epidemiological evidence for human cancer from exposure to formaldehyde is limited.

Formaldehyde has been shown to cause a number of genotoxic effects in a variety of cell culture and in vitro assays, including DNA-protein crosslinks, sister chromotid enhances, gene mutations, single strand breaks, and chromosomal aberrations.

Exposure of experimental animals to formaldehyde does not appear to result in any significant teratogenic or reproductive effects. There is no evidence in humans that clearly demonstrates that formaldehyde exposure causes adverse reproductive effects.

A number of adverse noncancer health effects have been associated with formaldehyde exposure. Acute effects include nausea, headaches, and irritation of the skin, eyes, and mucous membranes. Formaldehyde can also induce long-term allergic sensitization. For most individuals the lowest observed level of effects occurs at exposures ranging from 0.1 to 3 ppm. For sensitive individuals the effects may occur at exposure levels as low as 0.03 to 0.07 ppm. These

concentrations are commonly encountered in indoor environments where concentrations generally exceed levels of 30 ppbv. The Occupational Safety and Health Administration (OSHA) has recently proposed a reduction in its permissible exposure limit (PEL) from the existing level of 1 to .075 ppm (for an 8 hour average) to avoid noncancer effects in workers.

**What is the cancer risk assessment for exposure to formaldehyde?**

Since there is limited information regarding the carcinogenicity of formaldehyde to humans from epidemiological studies, data from animal bioassays must be extrapolated to estimate cancer risk in humans. After reviewing available studies on formaldehyde carcinogenicity, the OEHHA staff estimates the upper bound risk of contracting cancer from continuous exposure to 1 ppbv to range from 0.3 to 40 x $10^{-6}$ $ppbv^{-1}$ [0.25 to 33 x $10^{-6}$ $(ug/m^3)^{-1}$]. This corresponds to up to 1 to 40 potential excess cancers among a million people continuously exposed to 1 ppbv formaldehyde over a 70-year lifetime.

The OEHHA considered both the uncertainty surrounding the rate of formaldehyde metabolism and the quality of cancer potency studies in animals in estimating the best value for risk of cancer due to formaldehyde exposure. The OEHHA estimates that the best value for the 95 percent upper confidence limit of cancer risk to be 7 x $10^{-6}$ $ppb^{-1}$ [6 x $10^{-6}$$(ug/m^3)^{-1}$]. This corresponds to up to 7 potential excess cancers among a million people continuously exposed to 1 ppbv formaldehyde over a 70-year lifetime.

In this report, the cancer burden reflects a person's actual daily exposure to indoor and outdoor concentrations. The cancer burden is determined by multiplying the average dose rate (ug/day) with OEHHA's best value for unit risk. Using OEHHA's best value for unit risk of 7 x $10^{-6}$ $ppbv^{-1}$ [6 x $10^{-6}$ $(ug/m^3)^{-1}$] and the corresponding dose rate for indoor and outdoor environments, the number of excess cancer cases due to indoor and outdoor exposure to formaldehyde is estimated to be 230 and 5 per million, respectively. This corresponds to a cancer burden of 7,000 and 150 for indoor and outdoor exposures, respectively, for a California population of 30 million. Excess potential cancer cases for exposure to indoor and outdoor formaldehyde concentrations are presented in the following table on page 9.

Because air is constantly exchanged between indoor and outdoor environments, emissions from outdoor sources contribute somewhat to indoor concentrations and emissions from indoor sources contribute to outdoor concentrations. If it is assumed that the 4.4 ppb statewide ambient outdoor concentration contributes fully to the indoor concentration, an upper bound estimate can be made for outdoor source contribution. The outdoor source estimate would be 31 potential lifetime cancers per million; the indoor source contribution would be 204 potential lifetime cancers per million; with a total risk of 235 potential lifetime cancers per million.

CANCER RISK FROM INDOOR AND OUTDOOR FORMALDEHYDE EXPOSURES IN CALIFORNIA[1]

| LOCATION | AVERAGE CONCEN-TRATION (ug/m3) | PERCENT OF TIME IN LOCATION | AVERAGE AIR VOLUME (m3/day) | DOSE RATE (ug/day) | POTENTIAL EXCESS CANCER CASES PER 30 MILLION |
|---|---|---|---|---|---|
| INDOORS | | | | | |
| AT HOME | 62 (51 ppbv) | 62 | 10.3 | 640 | 5,400 |
| AWAY FROM HOME | 30 (24 ppbv) | 25 | 6.4 | 190 | 1,600 |
| TOTAL INDOORS | | 87 | 16.7 | 830 | 7,000 |
| OUTDOORS | 5.4 (4.4 ppbv) | 13 | 3.3 | 18 | 150 |

[1] Refer to Table IV-12, page A-62 of the Part A formaldehyde report in the Technical Support Document for table description.

## Is there a threshold level for formaldehyde?

The Environmental Protection Agency (EPA) concluded that there is no carcinogenic threshold level for formaldehyde. The OEHHA staff agree with this conclusion.

## What are the alternatives to identifying formaldehyde as a TAC?

California Government Code Section 11346.14 requires agencies to describe alternatives to the regulation considered by the Agency and the Agency's reasons for rejecting those alternatives. The only alternative to identifying formaldehyde is not to identify it. We are not recommending this alternative because we believe that formaldehyde meets the statutory definition of a toxic air contaminant. In addition, formaldehyde is listed as a hazardous air pollutant by the federal government pursuant to Section 7412 of Title 42 of the United States Code; therefore, pursuant to Section 39655 of the Health and Safety Code, formaldehyde is required to be identified as a Toxic Air Contaminant.

## What would be the environmental impact of the identification of formaldehyde as a toxic air contaminant?

The identificaiton of formaldehyde as a toxic air contaminant through the AB 1807 risk assessment program is not expected to result in any adverse impact on the environment. The Board's identification of formaldehyde as a toxic air contaminant and the subsequent analysis of the need to control emissions in the AB 1807 risk management program may result in the adoption of control measures pursuant to Health and Safety Code sections 39665 asnd 39666. In considering the adoption of control measures the ARB will consider all potential impacts of the measures on human health as well as the potential benefits to public health by reducing

formaldehyde emissions. Therefore, the identification of formaldehyde as a toxic air contaminant may ultimately result in control measures that will result in environmental benefits. Environmental impacts identified with respect to specific control measures will be included in the consideration of such control measures pursuant to Health and Safety Code sections 39665 and 39666.

**What would be the economic impact of the identification of formaldehyde as a TAC?**

The Board's identification of formaldehyde will not directly affect formaldehyde production and use facilities. Should the Board decide to formally identify formaldehyde as a TAC, it will enter the control phase of the program. During the development of control measures, the impact of these measures on businesses will be fully assessed by the ARB and the air pollution control districts in a public forum where the need, degree, and cost of control would be evaluated.

As discussed previously, roughly 90 percent of the formaldehyde in the atmosphere is formed from photochemical reactions. Motor vehicle emissions are the most important source of directly emitted formaldehyde. Oil refineries, facilities producing pressed wood products and plated materials, and facilities utilizing combustion devices such as engines, boilers, and incinerators, are also sources of formaldehyde. Oil refineries located in California do not meet the definition of a small business. However, other facilities may meet the definition. Examples may include some pressed wood product manufacturing facilities, cogeneration facilities, agricultural operations, food processing operations, plating operations, sterilizers, and waste incinerators.

There may be indirect economic impacts on these types of sources associated with individual district rules. Districts have the authority to require that public exposure to particular toxic substances not exceed levels deemed by the district to be protective of public health. Some districts permitting requirements mandate that no new or modifying facilities exceed a specific risk level based on the OEHHA recommended cancer risk numbers for specific toxic substances. These requirements may result in operators needing to purchase control equipment or being denied a permit.

Some districts already include formaldehyde in their list of substances affected by permitting rules. Other districts may add formaldehyde upon its identification as a TAC. Districts must conduct socioeconomic analyses, as well as public workshops and hearings before identified TACs are added to their programs.

Districts are also required by state legislation to implement the AB 2588 Air Toxics "Hot Spots" program. Under this program, districts prioritize, require risk assessments, and determine which facilities must notify the public of potential health risks posed by emissions of toxic substances. Formaldehyde is already included in this program. The program is supported by fees paid by the affected industries. The fees are specified by state and district regulations which are updated each year through a public process, including public workshops and public hearings. The amount of "Hot Spots" fees due from facilities that emit formaldehyde will not be affected by the

identification of formaldehyde as a toxic air contaminant.

Finally, Health and Safety Code (HSC) Section 42311 authorizes local air pollution control districts to assess permit fees to recover the cost of district programs required or authorized by state law. Some districts may charge facilities that emit formaldehyde a fee to cover the costs of developing and implementing the controls required by HSC section 39666 if the ARB requires controls on the basis of the risk management report. The amount of these fees are generally determined by the district resources needed to implement the control requirements. The fees are established by district rulemaking action, and districts must conduct socioeconomic impact analyses, workshops, and public hearings before adopting or revising any fee rule.

In the above described, district permitting, notification, and fee programs which have included formaldehyde, districts have been using the EPA cancer risk number. The recommended OEHHA risk number is one half the EPA number. Therefore, the cancer risk number that the facilities use will be lower, which may provide a benefit in their ability to meet district permitting, notification, and fee requirements.

## What are the findings of the Scientific Review Panel?

Findings of the Scientific Review Panel on
THE REPORT ON FORMALDEHYDE
As Adopted at the Panel's December 5, 1991 Meeting

In accordance with the provisions of Health and Safety Code section 39661, the Scientific Review Panel (SRP) has reviewed the report "Proposed Identification of Formaldehyde as a Toxic Air Contaminant" of the staffs of the Air Resources Board (ARB) and the Office of Environmental Health Hazard Assessment (OEHHA) on the public exposure to, and health effects of formaldehyde. The Panel also reviewed the public comments received on this report. Based on this review, the SRP finds that the report on formaldehyde is without serious deficiencies and agrees with the staffs of the ARB and OEHHA that:

1. There is evidence that exposure to fomaldehyde results in animal carcinogenicity and probable human carcinogenicity. Both the International Agency for Research on Cancer (IARC) and the United States Environmental Protection Agency (EPA) have classified formaldehyde as a probable human carcinogen, on the basis of sufficient evidence for carcinogenicity in animals and limited evidence in humans.

2. Because formaldehyde is listed as a hazardous air pollutant under Section 112 of the United States Clean Air Act of 1990, identification of formaldehyde as a toxic air contaminant is required by the California Health and Safety Code section 39655.
3. Based on available scientific information, a level of formaldehyde exposure below which no carcinogenic effects are anticipated cannot be identified.

4. Based on a health protective interpretation of available scientific evidence, the upper 95 percent confidence limits on the lifetime risk of cancer from formaldehyde range at ambient concentrations from 0.3 to 40 x $10^{-6}$ $ppbv^{-1}$ [0.25 to 33 x $10^{-6}$ $(ug/m^3)^{-1}$]. Furthermore, 7 x $10^{-6}$ $ppbv^{-1}$ [6 x $10^{-6}$ $(ug/m^3)^{-1}$] is the best value of the upper confidence limit of risk. Appendix I compares the best value of upper-bound formaldehyde cancer unit risk with those of other compounds reviewed by the SRP (the dates these compounds' identification reports were approved by the SRP are included in Appendix I). These 95 percent upper confidence limits for excess lifetime risks are health-protective estimates; the actual risk may be significantly lower.

5. The major identified sources of outdoor ambient formaldehyde are direct emissions from mobile sources and oil refineries and secondary formation by photochemical reactions.

6. Based on data collected by the ARB's ambient toxic air contaminant monitoring network, the estimated mean annual population-weighted outdoor ambient exposure for approximately 20 million Californians is 4.4 ppbv.

7. Based on the ARB emission inventory, areas that are expected to have formaldehyde levels higher than the mean statewide concentration are near commercial production sources, reconstituted wood processing plants, oil refineries, and in urban areas congested freeways. However, the emission inventory is incomplete and a number of potential hot spots have not yet been adquately evaluated.

8. Based on its gas-phase reactivity from photolysis and oxidation by the hydroxyl radical, formaldehyde's estimated tropospheric lifetime is approximately 0.3 days.

9. Results from indoor monitoring in California's conventional and mobile homes, offices, and public buildings indicate that people are exposed frequently to much higher indoor concentrations than outdoor formaldehyde concentrations due to the abundance of building materials and other domestic products in buildings that emit formaldehyde. The results of recent surveys indicate that formaldehde concentrations inside California residences generally range from less than 10 ppbv to 500 ppbv. Mean concentrations can range from 24 ppbv in office and public buildings to 72 ppbv for mobile homes, with a mean concentration of 50 ppbv found in conventional homes.

10. A number of adverse health effects have been associated with formaldehyde exposure. Acute effects include irritation of the skin, eyes, and mucous membranes, as well as causing nausea and headaches. Skin contact with formaldehyde can induce long-term allergic dermal sensitization, and limited evidence suggests that inhalation of high concentrations of formaldehyde can cause respiratory tract sensitization. Adverse health effects other than cancer are not expected to occur at mean statewide outdoor ambient concentrations. However, there is sufficient evidence that adverse acute health effects may result from exposure to levels found in indoor environments for those sensitive to formaldehyde.

11. Based on the OEHHA staff's best value for cancer unit risk of 7 x $10^{-6}$ $ppbv^{-1}$ and the

ARB staff's population-weighted outdoor ambient exposure of 4.4 ppbv, up to 31 potential excess cancers per million are predicted if exposed to this level over a 70 year lifetime. In addition, the staff's of ARB and OEHHA have developed cancer risk based on relative exposure to indoor and outdoor concentrations. Using the OEHHA staff's best value for cancer unit risk of $7 \times 10^{-6}$ $ppbv^{-1}$ and the corresponding concentrations found in indoor and outdoor environments, formaldehyde is estimated to be 230 and 5 per million, respectively, for a 70 year lifetime. This corresponds to an excess cancer burden of 7,000 and 150 for indoor and outdoor exposures, respectively, for a California population of 30 million.

12. Based on available scientific evidence indicating that formaldehyde is an animal and a probable human carcinogen, we conclude that formaldehyde should be identified as a toxic air contaminant.

For these reasons, we agree with the ARB staff recommendation to its Board that formaldehyde be listed by the ARB as a toxic air contaminant.

I certify that the above is a true and correct copy of the findings adopted by the Scientific Review Panel on December 5, 1991

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Dr. James N. Pitts, Jr.
Chairman, SRP

APPENDIX I

COMPOUNDS APPROVED BY THE SCIENTIFIC REVIEW PANEL FROM 1984 TO 1992
(in order of cancer potency)

| Compound | Unit Risk $(ug/m^3)^{-1}$ | Unit Risk $(ppbv)^{-1}$ |
|---|---|---|
| Dioxins | $3.8x10^{1}$ | Particulate Matter |
| Chromium VI | $1.4x10^{-1}$ | Particulate Matter |
| Cadmium | $4.2x10^{-3}$ | Particulate Matter |
| Inorganic Arsenic | $3.3x10^{-3}$ | Particulate Matter |
| Nickel | $2.6x10^{-4}$ | Particulate Matter |
| Ethylene Oxide | $8.8x10^{-5}$ | $1.6x10^{-4}$ |
| Vinyl Chloride | $7.8x10^{-5}$ | $2.0x10^{-4}$ |
| Ethylene Dibromide | $7.lx10^{-5}$ | $5.5x10^{-4}$ |
| Carbon Tetrachloride | $4.2x10^{-5}$ | $2.6x10^{-4}$ |
| Benzene | $2.9x10^{-5}$ | $9.3x10^{-5}$ |
| Ethylene Dichloride | $2.2x10^{-5}$ | $8.9x10^{-5}$ |
| Perchloroethylene | $8.0x10^{-6}$ | $5.4x10^{-5}$ |
| **Formaldehyde** | **$6.0x10^{-6}$** | **$7.0x10^{-6}$** |
| Chloroform | $5.3x10^{-6}$ | $2.6x10^{-5}$ |
| Trichloroethylene | $2.0x10^{-6}$ | $1.1x10^{-5}$ |
| Methylene Chloride | $1.0x10^{-6}$ | $3.5x10^{-6}$ |
| [Asbestos | $1.9x10^{-4}$ per 100 fiber/$m^3$] | |

PROPOSED REGULATION ORDER

Amend Titles 17 and 26, California Code of Regulations, section 93000 to read as follows:

93000. Substances Identified as Toxic Air Contaminants.

Each substance identified in this section has been determined by the State Board to be a toxic air contaminant as defined in Health and Safety Code section 39655. If the State Board has found there to be a threshold exposure level below which no significant adverse health effects are anticipated from exposure to the identified substance, that level is specified as the threshold determination. If the Board has found there to be no threshold exposure level below which no significant adverse health effects are anticipated from exposure to the identified substance, a determination of "no threshold" is specified. If the Board has found that there is not sufficient available scientific evidence to support the identification of a threshold exposure level, the "Threshold" column specifies "None identified."

| Substance | Threshold Determination |
|---|---|
| Benzene ($C_6H_6$) | None identified |
| Ethylene Dibromide ($BrCH_2CH_2Br$; 1,2-dibromoethane) | None identified |
| Ethylene Dichloride ($C1CH_2CH_2C1$; 1,2-dichloroethane) | None identified |
| Hexavalent Chromium (Cr(VI)) | None identified |
| Asbestos [asbestiform varieties of serpentine (chrysotile), riebeckite, (crocidolite), cummingtonite-grunerite (amosite), tremolite, actinolite, and anthophyllite] | None identified |
| Dibenzo-p-dioxins and Dibenzofurans chlorinated in the 2, 3, 7 and 8 positions and containing 4, 5, 6 or 7 chlorine atoms | None identified |
| Cadmium (metallic cadmium and cadmium compounds) | None identified |
| Carbon Tetrachloride ($CC1_4$; tetrachloromethane) | None identified |
| Ethylene Oxide (1,2-epoxyethane) | None identified |
| Methylene Chloride ($CH_2C1_2$; dichloromethane) | None identified |

| | |
|---|---|
| Trichloroethylene ($CC1_2CHC1$, trichloroethene) | None Identified |
| Chloroform ($CHC1_3$) | None identified |
| Vinyl Chloride ($CH_3C1$, chloroethylene) | None identified |
| Inorganic Arsenic | None identified |
| *Nickel* | *None identified 1* |
| Perchloroethylene ($C_2C1_4$; tetrachloroethylene) | None identified |
| Formaldehyde (HCHO) | None identified |

NOTE: Authority cited: sections 39600, 39601 and 39662, Health and Safety Code. Reference: sections 39650, 39660, 39661, and 39662, Health and Safety Code.

1. Language in italics is not a part of this regulatory action. The Board adopted an amendment to section 93000, Title 17, California Code of Regulations, identifying nickel as a toxic air contaminant (August 8, 1991), however, the amendment has not yet been submitted to the Office of Administrative Law for review and filing with the Secretary of State.