

State of California  
AIR RESOURCES BOARD

Staff Report: Initial Statement of  
Reasons for Proposed Rulemaking

Public Hearing to Consider the Adoption  
of a Regulatory Amendment Identifying  
Cadmium as a Toxic Air Contaminant

Agenda Item No.: 87- 2-1  
Scheduled for Consideration: January 22, 1987  
Release Date: December 5, 1986

(This report has been reviewed by the staffs of the California Air Resources Board and the California Department of Health Services and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board or the Department of Health Services, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.)

## **INTRODUCTION AND RECOMMENDATION**

State law defines a toxic air contaminant as an air pollutant which the Air Resources Board or the Department of Food and Agriculture finds "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". The staffs of the Air Resources Board and Department of Health Services have reviewed the available scientific evidence on the presence of cadmium in the atmosphere of California and its potential adverse effect on public health. Based on the conclusion of the Department of Health Services staff that cadmium meets this definition, the staff of the Air Resources Board recommends that cadmium be identified by the Board as a toxic air contaminant. The ARB staff is unable to, based on available scientific information, identify a level below which adverse health effects are not expected to occur, and therefore is unable to recommend a threshold level.

Cadmium was chosen for evaluation because: it had been identified by the International Agency for Research on Cancer (IARC) as an animal carcinogen with epidemiological evidence of carcinogenicity in humans; its presence in the atmosphere had been documented; it is emitted from many sources in the state, and may be emitted in increased amounts in the future.

## **SOURCES OF CADMIUM**

Cadmium is emitted from both stationary and mobile sources. Stationary sources which are likely to emit cadmium include secondary smelters, cement manufacturing plants, cadmium electroplating facilities, plants burning oil or coal, and sewage sludge incinerators. Mobile sources which emit cadmium include gasoline and diesel vehicles and particles resulting from tire wear. An emissions inventory compiled by ARB staff indicates that a total of from 16 to 18 tons/year of cadmium are emitted in California; stationary sources account for eighty percent

or more of cadmium emissions. Cadmium emissions from fossil fuel combustion and vehicles are projected to increase due to expected increase in fuel use.

### **EXPOSURE TO ATMOSPHERIC CADMIUM**

General population exposure to atmospheric cadmium was estimated using data on cadmium concentrations for the first six months of 1985 in various locations in the state. We believe that these averages are reasonably representative of annual average concentrations. We estimate that 10 million people are exposed to an average cadmium concentration of 1.0 to 2.5 ng/m<sup>3</sup>, and that one million people are exposed to an average cadmium concentration of 1.8 to 5.6 ng/m<sup>3</sup>. Neither size distribution nor the compound forms of cadmium were determined in the ARB's measurements. Work done by others on the size distribution of atmospheric cadmium indicates that atmospheric cadmium occurs principally on the surface of respirable particles (those less than 2.5 micrometers (um) in diameter).

Exposure to atmospheric cadmium near sources is expected to be higher than general population exposure. To estimate exposure to atmospheric cadmium near sources, ARB staff used an air quality model to calculate the ambient concentration of atmospheric cadmium in the South Coast Air Basin due to emissions from three secondary copper smelters. These emissions were estimated to result in annual average exposure to atmospheric cadmium of up to 40 ng/m<sup>3</sup> for a population of 57,000 and 14 up to ng/m<sup>3</sup> for a population of 285,000.

### **HEALTH EFFECTS OF CADMIUM**

Concentrations of cadmium measured in the atmosphere are much lower than those which are associated with chronic adverse health effects in occupational settings or which have produced acute effects in animal experiments. Because of this, and because cadmium is thought to exhibit a

threshold effect for non-cancer health effects, adverse health effects other than cancer are not expected to occur due to inhalation of cadmium at current or anticipated atmospheric concentrations.

Two separate cancer risk assessments were developed, both of which assumed that cadmium carcinogenicity operates through a nonthreshold mechanism. One was based on a mortality study of workers in a cadmium production plant; for exposure to 1 ng/m<sup>3</sup> cadmium, a best estimate of excess lifetime cancer risk of 2 per million, and an upper 95% confidence limit (UCL) of 12 per million, were derived. The other cancer risk assessment was based on rat lung tumor incidence; risk estimates derived from these studies were higher than the human-based estimates. The DHS staff has determined that the possible roles of chance, bias and confounding factors in distorting the true dose-response relationship in the occupational study were likely to have been small. Because the human data for exposure and for response were not found to have any major deficiencies, and because a conservative linear extrapolation was used, DHS staff recommends reliance on the human-based risk assessment.

### **RISK DUE TO ATMOSPHERIC CADMIUM**

The hazard posed by atmospheric cadmium to residents of California was estimated by applying the unit risk estimate to cadmium concentrations measured in the state. The upper-bound excess lifetime cancer risk from estimated atmospheric concentrations of cadmium in California has been estimated to be 30 per million. For people near emission sources of cadmium, the upper-bound estimated excess lifetime cancer risk from 24-hour-per-day exposure to an average of 40 ng/m<sup>3</sup> of cadmium is 480 per million persons exposed. These are health-conservative estimates; the actual risks may lie below these values.

Exposures to cadmium via routes other than inhalation of ambient air were not considered in the risk assessment. The major nonoccupational exposures to cadmium are through food and

smoking. While the bulk of human intake is via food ingestion, this route of exposure has not been associated with an increased risk of cancer either in humans or in experimental animals.

DHS staff emphasizes that the risk estimates derived in conducting a risk assessment are not exact predictions, but rather represent best estimates based on current scientific knowledge and methods.

Based on the findings of cadmium-induced carcinogenicity and the results of the risk assessment, DHS staff finds that ambient cadmium 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.

#### **SUMMARY OF ENVIRONMENTAL IMPACTS OF THE IDENTIFICATION OF CADMIUM AS A TOXIC AIR CONTAMINANT**

The identification of cadmium as a toxic air contaminant is not in itself expected to result in any environmental effects. The identification of cadmium as a toxic air contaminant by the Board may result in the Board and air pollution control districts adopting toxic control measures in accordance with the provisions of state law. Any such toxic control measures may result in reduced emissions of cadmium to the atmosphere, resulting in reduced ambient concentrations, concurrently reducing the health risk due to cadmium. Therefore, the identification of cadmium as a toxic air contaminant may ultimately 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.

Amend Title 17, California Administrative Code. 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, 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
Benzene (C <sub>6</sub> H <sub>6</sub> )	None identified
Ethylene Dibromide (BrCH <sub>2</sub> CH <sub>2</sub> Br; 1,2-dibromoethane)	None identified
Ethylene Dichloride (ClCH <sub>2</sub> CH <sub>2</sub> Cl; 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
<u>Cadmium</u>	<u>None identified</u>

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

\*Note: Compounds identified by an asterisk have been identified as toxic air contaminants by the Air Resources Board but not yet approved by the Office of Administrative Law.

## Notice of Public Availability of Modified Text

Public Hearing to Consider the Adoption of a Regulatory Amendment Identifying Metallic Cadmium and Cadmium Compounds as Toxic Air Contaminants

Public Hearing Date: January 23, 1987  
Public Availability Date: February 9, 1987

At a January 23, 1987 public hearing, the Air Resources Board ("ARB" or the "Board") considered the adoption of a proposed regulatory amendment to list cadmium as a toxic air contaminant for which there is not sufficient available scientific evidence to support the identification of a threshold exposure level. At the hearing the Board approved the proposed amendment with modifications to the originally proposed text. The modification to the originally proposed text is described below. Attached is a copy of Board Resolution 87-9 approving the proposed amendments with modifications. Attached to the resolution is the approved language, with additions to the original proposal shown by double underlining. The unchanged portion of the original proposal is shown by a single underline.

The originally proposed text listed "cadmium" as a toxic air contaminant. Airborne cadmium is generally understood to mean both airborne metallic cadmium and airborne cadmium compounds. Further, the analysis in the staff report to the Air Resources Board applies to both metallic cadmium and cadmium compounds. Staff believes that the term cadmium refers to both forms of cadmium, but decided that the listing of cadmium in the regulation should be made explicit in order to avoid any confusion as to the scope of the Board's action. The Board approved the staff's modified recommendation to include "metallic cadmium and cadmium compounds" in parentheses after "cadmium."

In accordance with Section 11346.8 of the Government Code, the Board directed the Executive Officer to adopt the approved regulatory amendments after making them available to the public for comment regarding the changes to the regulation as originally proposed for a period of at least 15 days provided that the Executive Officer shall consider written comments received and make minor modifications to the language as appropriate in response to comments, and shall present the regulations to the Board for further consideration if he determines that this is warranted in light of the written comments received. Only comments concerning the modified definition of cadmium will be considered during this comment period.

Comments must be submitted to the Board Secretary, Air Resources Board, P. O. Box 2815, Sacramento, CA 95812, no later than March 2, 1987 for consideration by the Executive Officer.

State of California  
AIR RESOURCES BOARD

Resolution 87-9

January 23, 1987

Agenda Item No.: 87-2-1

WHEREAS, Sections 39600 and 39601 of the Health and Safety Code authorize the Air Resources Board (the "Boards") to do such acts and to adopt such regulations as may be necessary for the proper execution of the powers and duties granted to, and imposed upon, the Board by law;

WHEREAS, Chapter 3.5 (commencing with Section 39650) of Part 2 of Division 26 of the Health and Safety Code establishes procedures for the identification of toxic air contaminants by the Board;

WHEREAS, Section 39655 of the Health and Safety Code defines a "toxic air contaminant" as 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;

WHEREAS, Section 39662 of the Health and Safety Code directs the Board to list, by regulation, substances determined to be toxic air contaminants, and to specify for each substance listed a threshold exposure level, if any, below which no significant adverse health effects are anticipated;

WHEREAS, in California, cadmium (metallic cadmium and cadmium compounds, hereinafter "cadmium") is emitted from certain industrial processes such as secondary smelting operations, cement manufacturing, and combustion of fossil fuels, and has been measured in the atmosphere;

WHEREAS, pursuant to the request of the Board, the Department of Health Services (DHS) evaluated the health effects of cadmium in accordance with Section 39660 of the Health and Safety Code;

WHEREAS, DHS concluded in its evaluation that cadmium is an animal carcinogen with epidemiological evidence of carcinogenicity in humans; cadmium should be treated as a substance without a carcinogenic threshold; health effects other than cancer are not expected to occur at existing or expected ambient levels of cadmium; and the maximum excess lifetime cancer risk from cadmium exposure is estimated to range from 2 to 12 cases per million people exposed per nanogram per cubic meter;

WHEREAS, for the reasons set forth in its evaluation, DHS has concluded that, in the absence of strong positive evidence that cadmium acts only through mechanisms which ought to have a



threshold, cadmium should be treated as acting without a threshold, and DHS has determined that there is not sufficient available scientific evidence at this time to support the identification of a cadmium exposure level below which carcinogenic effects would not have some probability of occurring;

WHEREAS, upon receipt of the DHS evaluation, staff of the Board prepared a report including and in consideration of the DHS evaluation and recommendations and in the form required by Section 39661 of the Health and Safety Code and, in accordance with the provisions of that section, made the report available to the public and submitted it for review to the Scientific Review Panel (SRP) established pursuant to Section 39670 of the Health and Safety Code;

WHEREAS, in accordance with Section 39661 of the Health and Safety Code, the SRP reviewed the staff report, including the scientific procedures and methods used to support the data in the report, the data itself, and the conclusions and assessments on which the report was based, considered the public comments received regarding the report, and on October 30, 1986, adopted for submittal to the Board findings which included the following:

- “1. Cadmium is an animal carcinogen for which there is epidemiologic evidence of carcinogenicity in humans exposed in occupational settings.
- “2. Cadmium is emitted into the air by a variety of sources in California, and its presence has been documented in the ambient air around the state.

The SRP notes that the sub-population of Californians who smoke tobacco or breathe second-hand tobacco smoke will be exposed to cadmium at concentrations several orders of magnitude greater than the exposure of the general population.

The SRP also wishes to emphasize that estimates of cumulative exposure to cadmium should account for cadmium levels in Indoor air which, in the absence of tobacco smoke, may be lower than those in outdoor air.

- "3. Adverse health effects other than cancer are not expected to occur at measured or predicted cadmium concentrations in the ambient air.
- “4. Based on available scientific information, a cadmium exposure level below which carcinogenic effects are not expected to occur cannot be identified.
- “5. Based on an interpretation of available scientific evidence by DHS, the range of lifetime excess cancer risk from exposure to  $1 \text{ ng/m}^3$  of atmospheric cadmium based on the best estimate of risk and the upper 95% confidence limit is estimated to be 2 to 12 cases per million people exposed; it is unlikely that the risk will exceed this range, and may be lower.

**"NOTE:** DHS has assumed that the carcinogenic dose response of cadmium is linear and that dose rate does not influence the magnitude of carcinogenic effects. These assumptions are justified by DHS on the basis of being health conservative. While the SRP understands the reasons for this, weighing of the available scientific evidence indicates that the upper bound of the low dose risk estimate obtained by using these assumptions is likely to be high. The available data are also consistent with the possibility that the risk of lung cancer from current ambient exposures to cadmium in California may be vanishing small."

WHEREAS, the SRP found the staff report to be without serious deficiency, and included in its findings the statement that it agreed that cadmium should be listed by the Air Resources Board as a toxic air contaminant, and that there is not sufficient available scientific evidence at this time to support the designation of an exposure level below which carcinogenic effects would not have some probability of occurring;

WHEREAS, the California Environmental Quality Act and Board regulations require that no project having significant adverse environmental impacts be adopted as originally proposed if feasible alternatives or mitigation measures are available;

WHEREAS, a public hearing and other administrative proceedings have been held in accordance with provisions of Chapter 3.5 (commencing with Section 11340), Part 1, Division 3, Title 2 of the Government Code;

WHEREAS, in consideration of the staff report, including DHS' evaluation and recommendations, the available evidence, the findings of the SRP, and the written comments and public testimony it has received, the Board finds that:

Cadmium is an animal carcinogen with epidemiological evidence of carcinogenicity in humans;

Health effects other than cancer are not anticipated at existing ambient cadmium exposure levels;

There is not sufficient available scientific evidence to support the identification of a threshold exposure level for cadmium;and

Cadmium is an air pollutant which, because of its carcinogenicity, may cause or contribute to an increase in mortality and an increase in serious illness, and poses a hazard to human health; and

WHEREAS, the Board has determined, pursuant to the requirements of the California Environmental Quality Act and Board regulations, that this regulatory action will have no significant adverse impact on the environment.

NOW, THEREFORE BE IT RESOLVED, that the Board approves the proposed regulatory amendments to Section 93000, Title 17, California Administrative Code, as set forth in Attachment A.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to adopt the amendments, as set forth in Attachment A, after making it available to the public for a period of 15 days, provided that the Executive Officer shall consider such written comments regarding the changes in the regulations as originally proposed as may be submitted during this period, shall make such modifications as may be appropriate in light of the comments received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

I hereby certify that the above is a true and correct copy of Resolution 87-9, as adopted by the Air Resources Board.

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Harold Holmes, Board Secretary

Amend Title 17, California Administrative Code, Section 93000 to read as follows:

93000. Substances Identified As Toxic Air Contaminants.

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Ethylene Dibromide (BrCH <sub>2</sub> CH <sub>2</sub> Br; 1,2-dibromoethane)	None Identified
Ethylene Dichloride	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
<u>Cadmium (metallic cadmium and cadmium compounds)</u>	<u>None Identified</u>

**NOTE:** Authority cited: Sections 39600, 39601 and 39662, Health and Safety Code.  
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**SCIENTIFIC REVIEW PANEL FINDINGS ON  
THE REPORT TO THE AIR RESOURCES BOARD ON CADMIUM**

Findings of the Scientific Review Panel on  
the Report on Cadmium  
as adopted at the Panel's October 30, 1986 meeting

In accordance with the provisions of Health and Safety Code Section 39661, the Scientific Review Panel (SRP) has reviewed the reports of the staffs of the ARB and DHS on the public exposure and biologic and health effects of cadmium, and the public comments on these reports. Based on this review, the SRP finds that the reports are without serious deficiency and further finds that:

1. Cadmium is an animal carcinogen for which there is epidemiologic evidence of carcinogenicity in humans exposed in occupational settings.
2. Cadmium is emitted into the air by a variety of sources in California, and its presence has been documented in the ambient air around the state.

The SRP notes that the sub-population of Californians who smoke tobacco or breathe second-hand tobacco smoke will be exposed to cadmium at concentrations several orders of magnitude greater than the exposure of the general population.

The SRP also wishes to emphasize that estimates of cumulative exposure to cadmium should account for cadmium levels in indoor air which, in the absence of tobacco smoke, may be lower than those in outdoor air.

3. Adverse health effects other than cancer are not expected to occur at measured or predicted cadmium concentrations in the ambient air.
4. Based on available scientific information, a cadmium exposure level below which carcinogenic effects are not expected to occur cannot be identified.
5. Based on an interpretation of available scientific evidence by DHS, the range of lifetime excess cancer risk from exposure to  $1 \text{ ng/m}^3$  of atmospheric cadmium based on the best estimate of risk and the upper 95% confidence limit is estimated to be 2 to 12 cases per million people exposed; it is unlikely that the risk will exceed this range, and may be lower.

**NOTE:** DHS has assumed that the carcinogenic dose response of cadmium is linear and that dose rate does not influence the magnitude of carcinogenic effects. These assumptions are justified by DHS on the basis of being health conservative. While the SRP

understands the reasons for this, weighing of the available scientific evidence indicates that the upper bound of the low dose risk estimate obtained by using these assumptions is likely to be high. The available data are also consistent with the possibility that the risk of lung cancer from current ambient exposures to cadmium in California may be vanishing small.

For these reasons, we agree with the ARB staff recommendation to its Board that cadmium be listed by the ARB as a toxic air contaminant, and we agree there is not sufficient available scientific evidence at this time to support the designation of an exposure level below which carcinogenic effects would not have some probability of occurring.

I certify that the above is a true and correct copy of the findings adopted by the Scientific Review Panel on October 30, 1986

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Dr. Emil M. Mrak, Chairman  
Scientific Review Panel