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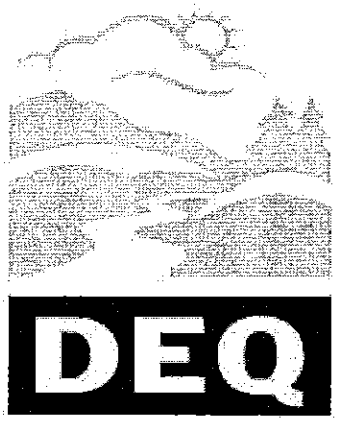
# 12/4/1970

# OREGON
# ENVIRONMENTAL QUALITY
# COMMISSION MEETING
# MATERIALS




State of Oregon
**Department of Environmental Quality**

# AGENDA

## Environmental Quality Commission Meeting

December 4, 1970

Room 36, State Office Building, 1400 S.W. 5th Avenue, Portland, Oregon

10:00 a.m.

1 ✓ A. Public hearing re: sewage disposal for Rancho Klamath Falls

2. ✓ B. Minutes of October 30, 1970, meeting

3. ✓ C. Project plans for October, 1970

5. ✓ D. City of North Bend sewage disposal for Simpson Heights area

8. ✓ E. Waste discharge permit for Grants Pass

F. Coos Bay pollution sources - Mr. Jerry O. Lesan

6. ✓ G. Multnomah County resolution regarding Pacific Meat Co.

H. Northwest Environmental Defense Center petition re:motor vehicles

7. ✓ I. Waste discharge permit denials

✓ (1) Willow Creek Mobile Villa

✓ (2) W. D. Clark Trailer Park

J. Authorization for Public Hearings

(1) Board Products Industries, Emission Standards and Regulations

(2) Sulfur Dioxide Ambient Air Standards

K. Receipt of Variance from Columbia Willamette Air Pollution Authority

L. Status Reports

(1) Bend Air Quality - Brooks Willamette Corp.
Brooks Scanlon, Inc.

4. ✓ (2) Hub Lumber Company, Roseburg

2:00 p.m.

M. Public Hearing re: PGE Trojan Nuclear Power Plant

MINUTES OF THE EIGHTEENTH MEETING

of the

Oregon Environmental Quality Commission

December 4, 1970

The eighteenth regular meeting of the Oregon Environmental Quality Commission was called to order by the Chairman at 10:00 a.m., Friday, December 4, 1970, in Room 36 of the State Office Building, 1400 S.W. 5th Avenue, Portland, Oregon.

PUBLIC HEARING REGARDING RANCHO KLAMATH FALLS

Appropriate notice having been given as required by statute and administrative rules, the public hearing in the matter of the domestic sewerage system of Rancho Klamath Falls was held by the Commission members with B.A. McPhillips, Storrs S. Waterman, George A. McMath and Arnold M. Cogan being present.

Mr. C. Kent Ashbaker was sworn in by Mr. A.B. Silver as the first witness for the Department. He explained that the Rancho Klamath Falls development is located on the former Oregon Technical Institute campus which initially had been constructed as the Marine Barracks during World War II. He stated that the existing sewage treatment works had been designed to serve a population of 3,000 and to handle a flow of 300,000 gpd, that as a consequence they are much too large to serve the 23 families, 1 office and 1 industry which now occupy the property, that presently there are no sludge handling facilities, no chlorination and no secondary treatment, that the inadequately treated effluent flows into an intermittent stream bed and thence onto private property where it constitutes a nuisance and definite health hazard, that Mr. and Mrs. Bruno Proell and Mr. T.S. Yuriko Nakano are present owners, that they have no approval for by-passing sewage and no waste discharge permit, and that they have posted no performance bond.

Mr. Silver introduced two exhibits for the record. Exhibit No. 1 is a letter dated November 13, 1970 from Bruno Proell and Exhibit No. 2 is a copy of the deed for the property in question.

In response to a question by Mr. Waterman, Mr. Ashbaker estimated that a sewer connection to the city of Klamath Falls would require a pipe line 1-1/2 to 2 miles long.

The Chairman read aloud Exhibit No. 1 which referred to installation of a holding pond. Mr. Ashbaker said such a pond had been proposed only as interim facilities until permanent disposal works could be installed.

Mr. Cogan stated that two alternatives appeared possible - one would be to build permanent facilities and the other would be to close the development down. He inquired as to the time required to accomplish each alternative. Mr. Ashbaker estimated that the first alternative could be accomplished by mid-summer of 1971 or maybe a little later. Mr. Silver said that for alternative No. 2 the Commission could file a lawsuit for eviction or work through the County Health Officer. He estimated 30 to 60 days would be required.

Mr. Bruno Proell was present and represented himself without benefit of counsel. He claimed that when he purchased the property a year ago he had no knowledge of the sewage disposal problem. He claimed also that a sprinkling system had since been installed to dispose of the sewage effluent on his own property and that sewage effluent was not now running off his property. (Note: In a letter addressed to the Departmnent and dated November 28, 1970, from Ray M. Budden and two other property owners it was alleged that raw sewage was being drained onto their land from the Rancho Klamath Falls property.)

Mr. Ashbaker said some improvements had been made by Mr. Proell but that they were not being properly operated and maintained.

Mr. Silver then offered the records of the Department's Bend District Office as further evidence in this matter.

Mr. Proell again claimed that no sewage effluent was presently leaving his property and that currently only 11 families live there. He admitted it was not feasible to operate a 3,000 PE sewage treatment plant for only about 40 persons.

Following further discussion by the Commission members, it was MOVED by Mr. Waterman, seconded by Mr. McMath and carried that the owners of the Rancho Klamath Falls provide without delay the necessary interim facilities to abate the health hazard, and a suitable permanent facility by July 31, 1971, that a time schedule be established for engineering and installation of facilities, that notice be given to the occupants that they will have to move out within 30 days of any of the scheduled dates if progress is not made accordingly, and that in the interim there be no increase in the occupancy.

The hearing was then adjourned and the regular meeting was continued by the Chairman.

Participating staff members were Kenneth H. Spies, Director; E.J. Weathersbee, Deputy Director; Arnold B. Silver and John Osburn, Legal Counsel; Harold M. Patterson, Air Quality Control Division Director; J.A. Jensen, Municipal Sewerage Section Chief Engineer; C. Kent Ashbaker, District Engineer; Harold L. Sawyer and E.R. Lynd, Supervising Engineers; and Harold H. Burkitt, F.G. Odell and R.C. Sherwood, Associate Engineers. Mr. E.C. Harms, Jr., Member, arrived a short time later.

MINUTES OF OCTOBER 30, 1970 MEETING

It was MOVED by Mr. Waterman, seconded by Mr. Cogan and carried that the minutes of the October 4, 1970 meeting held in Portland be approved as prepared.

PROJECT PLANS FOR OCTOBER AND NOVEMBER, 1970

It was MOVED by Mr. McMath, seconded by Mr. Waterman and carried that the actions taken by the staff during the months of October and November, 1970 on the following 70 municipal sewerage, 16 industrial waste, 4 solid waste and 10 air quality control projects be approved:

Water Pollution Control

| Date | Location | Project | Action |
|---|---|---|---|
| Municipal Projects (70) | | | |
| 10-5-70 | Pendleton | Change Order #1 (STP) | Approval |
| 10-6-70 | Cottage Grove | East Main Renewal Project | Prov. app. |
| 10-7-70 | Arlington | Preliminary report | Comments |
| 10-9-70 | Canby | Predesign study | Approved |
| 10-9-70 | Hillsboro | Edwards Meadows Subdivision | Prov. app. |
| 10-9-70 | Sherwood | Lincoln Street district | Prov. app. |
| 10-12-70 | Winston | Park Street sewer | Prov. app. |
| 10-12-70 | Unified Sew. Agency | Hamlin Subd. (Aloha) | Prov. app. |

Water Pollution Control

| Date | Location | Project | Action |
|---|---|---|---|
| Municipal Projects (70)- continued | | | |
| 10-13-70 | Lake Oswego | Patton St. interceptor & Latter Day Saints ext. | Prov. app. |
| 10-13-70 | Gresham | SE 242nd Dr. & SE Chase Rd. | Prov. app. |
| 10-13-70 | Newberg | Change Order No. 1 to STP | Prov. app. |
| 10-13-70 | Valsetz | System and treatment | Prov. app. |
| 10-15-70 | Riddle | Football field pump station | Prov. app. |
| 10-16-70 | Curry County | Comprehensive report | Approval with comments |
| 10-19-70 | USA (Tigard) | Lang Hill Subdivision | Prov. app. |
| 10-19-70 | Portland | Change Order #1, plant site preparation contract | Approval |
| 10-19-70 | Gresham | Rowe Road san. sewer | Prov. app. |
| 10-19-70 | McMinnville | Change Order #2 to treatment plant | Approval |
| 10-19-70 | Nyssa | Change Order #1 & #2 to plant contract | Approval |
| 10-19-70 | USA (Aloha) | Jersey Park Subdivision | Prov. app. |
| 10-21-70 | McMinnville | South McMinnville sewerage study | Approved |
| 10-22-70 | Eugene | 5 sewer projects | Prov. app. |
| 10-22-70 | Myrtle Point | Report on sewage treatment requirements | Approved with comments |
| 10-22-70 | USA | Valley Hills Subdivision | Prov. app. |
| 10-22-70 | Lake Oswego | Condo-Lea Subdivision | Prov. app. |
| 10-22-70 | West Linn | Iron Tree Subdivision | Prov. app. |
| 10-23-70 | North Powder | Change Orders #1, 2 & 3 | Approved |
| 10-23-70 | Cedar Hills | Forest Village Patio Develop. | Prov. app. |
| 10-26-70 | Gresham | U.P. Rockwood Industrial Area | Prov. app. |
| 10-26-70 | West Linn | Change Orders 1, 2 & 3 Schedule I. Change Orders 1 & 2, Schedule S | Approved |
| 10-26-70 | Jefferson | Union Street extension | Prov. app. |
| 10-26-70 | Multnomah County | Inverness sewer, Unit #3 | Prov. app. |
| 10-27-70 | Hood River | Indian Creek interceptor, Phase II | Prov. app. |
| 10-28-70 | USA | SW Southview Street extension | Prov. app. |
| 10-29-70 | USA | Four Seasons #7 & Monterey Pk. | Prov. app. |
| 11-2-70 | Roseburg | Fairgrounds system | Prov. app. |
| 11-2-70 | Multnomah Co. (E) | Mt. States Airport Park sewage treatment plant | Prov. app. |
| 11-4-70 | Philomath | Sewage treatment plant modifications | Prov. app. |
| 11-4-70 | East Salem S&D #1 | Satter Drive, N.E. sewer extension | Prov. app. |
| 11-9-70 | Aumsville | Change Order No. 1 | Approved |

Water Pollution Control - continued

| Date | Location | Project | Action |
|---|---|---|---|
| Municipal Projects (70)-continued | | | |
| 11-9-70 | Newberg | Oakwood Subdivision | Prov. app. |
| 11-9-70 | Inverness | Hollyview No. 1 | Prov. app. |
| 11-9-70 | Salem | Three sewer proj. extensions | Prov. app. |
| 11-9-70 | West Linn | Linn's Third Addn. sewer | Prov. app. |
| 11-9-70 | Cannon Beach | Change Order No. 1 | Approved |
| 11-9-70 | Tualatin | Apache Bluff No. 4 | Prov. app. |
| 11-9-70 | Ashland | Sunset Avenue extension | Prov. app. |
| 11-9-70 | Lake Oswego | Shannon View Subdivision | Prov. app. |
| 11-9-70 | Oak Lodge S.D. 2 | Holly Hills No. 2 | Prov. app. |
| 11-9-70 | Portland | Change Order No. 90 | Approved |
| 11-9-70 | Hillsboro | Change Orders #6, 7, 8 & 9 (sewage treatment plant) | Approved |
| 11-9-70 | Hillsboro | Change Order #1 (Westside interceptor) | Approved |
| 11-9-70 | Parkdale San. Dist. | Change Order No. 3 | Approved |
| 11-9-70 | Medford | Change Orders #6 through 12 (sewage treatment plant) | Approved |
| 11-9-70 | St. Helens | Change Orders #1 & 2 | Approved |
| 11-10-70 | Columbia County | Westport School sewage treatment plant | Prov. app. |
| 11-13-70 | Parkdale San. Dist. | Change Order No. 5 | Approved |
| 11-13-70 | Clackamas County | River Bend Mobile Ranch sewage treatment plant | Prov. app. |
| 11-16-70 | Eugene | River Road-Beltline Area | Prov. app. |
| 11-17-70 | Gresham | Rembold Ridge Subdivision | Prov. app. |
| 11-18-70 | Forest Grove | "B" Street Schedule II and "A" Street Schedule I | Prov. app. |
| 11-19-70 | Beaverton | S.W. Hargis Road | Prov. app. |
| 11-20-70 | Lake Oswego | Berwick Road sewer (L.I.D. #128) | Prov. app. |
| 11-20-70 | Salem | Cannon Street sewer | Prov. app. |
| 11-20-70 | Ka-Nee-Ta | Ka-Nee-Ta No. 2 | Prov. app. |
| 11-20-70 | Vernonia | Louisiana Avenue | Prov. app. |
| 11-20-70 | Tualatin | Tualatin Trailer Park | Prov. app. |
| 11-23-70 | Unified Sew. Agency | Park Knoll Local Improvement District | Prov. app. |
| 11-24-70 | Unified Sew. Agency | Metzger plant modification | Prov. app. |
| 11-27-70 | North Bend | Simpson Heights pump station and interceptor | Prov. app. |
| Industrial Projects (16) | | | |
| 9-3-70 | Milton-Freewater | Harris Feedlot | Disapproved |
| 9-15-70 | Eugene | J.H. Baxter | Approved |
| 9-23-70 | Sumner | Fred Messerle & Sons Dairy | Approved |

Water Pollution Control - continued

| Date | Location | Project | Action |
|---|---|---|---|
| Industrial Projects (16) - continued | | | |
| 9-23-70 | Coos County | Frank Rood Dairy | Approved |
| 9-24-70 | Tillamook | Wayne Barker Dairy | Approved |
| 9-25-70 | Tillamook | Ed Myers Dairy | Approved |
| 10-2-70 | Lane County | Johnson Ranch Co. | Approved |
| 10-13-70 | Tillamook County | MacDonald Dairy | Comm. sub. |
| 10-14-70 | Nehalem | Hibbs Dairy | Approved |
| 10-15-70 | Cottage Grove | Weyerhaeuser Co. san. sewer | Prov. app. |
| 10-16-70 | Blachly | Griffith Dairy | Approved |
| 10-19-70 | Yamhill County | Northwest Premium Pork | Approved |
| 10-21-70 | Myrtle Point | Reynolds Feedlot | Approved |
| 10-21-70 | Junction City | Pilney Dairy | Approved |
| 11-2-70 | Milton-Freewater | Harris Feedlot | Approval |
| 11-18-70 | St. Helens | City of St. Helens outfall to Columbia River | Approval |
| Solid Waste Disposal (4) | | | |
| 10-16-70 | Klamath County (near Merrill) | Tire disposal site | Prov. app. |
| 10-23-70 | Portland | Black & Veatch engineering report | Comm. sub. |
| 11-16-70 | Lake County | Chemical-Waste, Inc. Alkali Lake Disposal Site for metallic chloride wastes | Prov. app. |
| 11-30-70 | Deschutes County | Knott Pit Sanitary Landfill | Prov. app. |

Air Quality Control (10)

| Date | Location | Project | Action |
|---|---|---|---|
| 10-2-70 | Douglas County | Winston Paving Company Control System | Not app. Modification req. |
| 10-9-70 | John Day | G.L. Pine Company Waste Burner | Not approved Insuf. info. |
| 10-9-70 | Prineville | Coin Millwork Waste Burner | Not approved Mod. req. |
| 10-16-70 | Brookings | Brookings Plywood Waste Burner & System Schedule | Approved |
| 10-27-70 | Sutherlin | L & H Lumber Company Residue Disposal | Cond. app. |
| 11-6-70 | Douglas County | Winston Paving Co. Installation of Control Equipment | Cond. app. |
| 11-6-70 | Jackson County | Review of Lausmann Process for Wigwam Waste Burner | Comm. sub. |

Air Quality Control (10) - continued

| Date | Location | Project | Action |
|---|---|---|---|
| 11-6-70 | Klamath County | Control Equipment Compliance Schedule and Plans | Accepted |
| 11-30-70 | Deschutes County | Brooks-Willamette Corp. Plans for Baghouse Installation | Approved |
| 11-30-70 | Crook County | Hudspeth Pine, Inc. Wigwam Waste Burner | Approved |

HUB LUMBER CO., ROSEBURG - STATUS REPORT

Mr. Burkitt reviewed the staff report dated November 27, 1970 which outlined the status of the Hub Lumber Company's program for abatement of air pollution caused by the operations of its wigwam burner at Roseburg. The company had previously been given a deadline of December 1970 for phase-out of its burner. Because of its inability to develop a market for utilization of all the wood waste, the company was unable to meet this deadline. Mr. Burkitt recommended that the deadline be extended until June 1, 1971 for phase-out or modification of the burner and if the latter alternative is chosen the company submit necessary plans and specifications by April 1, 1971.

Mr. Charles Teague was present to represent the company and to explain the reasons for the delay in meeting the deadline.

It was MOVED by Mr. Cogan, seconded by Mr. McMath and carried that the Hub Lumber Company be required to submit necessary plans and specifications by April 1, 1971 for modification of its waste burner in accordance with criteria developed by the Forest Research Laboratory at Oregon State University, that the modification of the burner be completed by June 1, 1971, and that if either of these dealines is not met the company be required to discontinue operation of the burner.

FEDERAL ENVIRONMENTAL PROTECTION AGENCY

Mr. Herbert C. Clare of the Portland Office of the former Federal Water Quality Administration was present and requested the opportunity to notify the Commission that on December 2, 1970 the new Federal Environmental Protection Agency had been officially organized to take over

responsibilities in air quality control, water quality control, solid waste disposal, pesticides and radiation which previously had been vested in the Department of Interior, U.S. Public Health Service (HEW), Department of Agriculture, and Atomic Energy Commission. He reported further that Mr. James L. Agee had been appointed as Interim Regional Coordinator for this region.

Mr. Cogan suggested that it might be desirable for the Commission and staff to hold a meeting with the EPA regional officials to coordinate respective programs.

CITY OF NORTH BEND SIMPSON HEIGHTS SEWAGE DISPOSAL

Mr. Jensen summarized the staff's memorandum report dated November 18, 1970 pertaining to this matter. He said that in the meantime the plans and specifications for the required interceptor sewer had been received and approved by the Department of Environmental Quality.

Mr. John F. (Jack) Isadore, City Administrator was present to represent the city of North Bend. He said the city had encountered some unavoidable delays because of engineering problems and new industrial development proposals in the area which made it necessary to postpone until November 24, 1970 the public hearing previously scheduled for July 14.

He said further that at the City Council meeting scheduled for December 8 action would be taken to increase the sewer user charge to $2.50 per connection per month and to schedule a $550,000 bond election for January 19, 1971. He estimated that the construction could be completed within 150 calendar days after award of the contract. He stated that bids would be advertised on December 10, 17 and 24, 1970 and opened on January 8, 1971.

After some discussion about lack of communications between the city and the Department of Environmental Quality, it was MOVED by Mr. Cogan, seconded by Mr. Waterman and carried that the Commission approve the time schedule outlined by Mr. Isadore for construction of the Simpson Heights interceptor system and that if there should be a delay in any portion of the time schedule a hearing be authorized for initiating abatement proceedings.

MULTNOMAH COUNTY RESOLUTION RE: PACIFIC MEAT COMPANY

On November 20, 1970 a resolution adopted by the Multnomah County Board of Commissioners was received requesting that a public hearing be held by the Environmental Quality Commission at the earliest possible date regarding the waste discharge permit and present waste discharge practices of the Pacific Meat Company located adjacent to Columbia Slough. Attached to the resolution was a statement prepared by the District Attorney's office.

Mr. Sherwood reviewed the program for pollution abatement which had been adopted by the State Sanitary Authority members at their public meeting held in Portland on September 27, 1968. (Prior to that meeting copies of the proposed program had been sent to all interested parties including Multnomah County officials.) He pointed out that under said program all organic waste discharges are to be eliminated from Columbia Slough by July 1971 and that under the individual waste discharge permits issued since January 1968 a deadline of June 1, 1971 for elimination of such discharges has been established. He indicated that connection to the Portland municipal sewerage system was the logical solution to this problem.

Mr. Howard Nelson was present to represent Pacific Meat Company. He stated that they had recently petitioned for annexation to the city of Portland and hope to be able to meet the June 1, 1971 deadline for removal of their wastes from the slough.

In answer to his question Mr. Cogan was advised that the company's present waste discharge permit expires on September 30, 1971.

Mr. Nelson said about 2,000 feet of sewer line would be required to make the connection to the city sewer system and that although no engineer has yet been retained he plans to hire one shortly as he had already interviewed 3 different firms.

In answer to a question by the Chairman Mr. Nelson said they would connect to the city sewers as soon as possible after annexation is approved.

Mr. Spencer H. Vail of the Portland City Planning Commission was also present and stated that on December 2, 1970 the City Council had referred the company's annexation petition to the Department of Public Works for review. He estimated that 2 or 3 weeks would be required for that department to make its recommendations. He said a meeting between the city and company officials had been arranged for December 7, 1970. He stated further that if annexation should be delayed the city would be willing to enter into a contract with the company to provide waste disposal. He promised full cooperation of the city.

In reply to a question by the Chairman he stated that 30 days should be sufficient to work out the details.

Mr. Roy Young was also present to represent the city and explained the information that would be required by the City Department of Public Works before final requirements could be determined.

After being advised by Mr. Nelson that no easement problems were involved, Mr. Weathersbee estimated that 60 days would be required for design and construction of the necessary project.

Because it appeared that everything possible was now being done to expedite this project, it was MOVED by Mr. McPhillips, seconded by Messrs. Cogan and Waterman and carried that this item be placed on the agenda of the next meeting and that Mr. Nelson be requested to appear at that time to give a progress report of what has been accomplished and what remains to be done.

Mr. Tom Gallagher of the Multnomah County District Attorney's office was present and stated that they still demand that a public hearing be held by the Environmental Quality Commission and that the Pacific Meat Company's waste discharge permit be revoked or revised pursuant to the court decree rendered in 1961.

Mr. McMath asked Mr. Gallagher where the County was in 1968 when the present program for abatement of pollution in Columbia Slough was adopted by the State Sanitary Authority. Mr. Cogan said that it appears that major developments have taken place recently for solving this problem.

It was then MOVED by Mr. McPhillips, seconded by Mr. McMath and carried that the petition for a hearing be denied.

The Chairman then read the following statement: "I see by the papers that the Oregon Environmental Quality Commission is under fire from certain District Attorneys in the state and I would like to comment. It's about time that Oregon District Attorneys discovered pollution! The State Sanitary Authority and the Environmental Quality Commission have been trying to clean up Oregon's waters for 31 years and during this time we couldn't find a DA who would touch a pollution case with a 10-foot pole. Where were you when we needed you? Now that the DA's have finally decided to get into the pollution battle, they have rushed in to deliver their first blow at the Environmental Quality Commission. I suggest they find out who the enemy is before they start throwing punches! Seriously, we welcome the DA's to the fight to keep and make Oregon livable. We need their help. And if they are ready to put their briefs where their mouths are, I suggest that we all work together and get on with the job."

Mr. Stanley Sharp was also present to represent the Multnomah District Attorney's office and comment on their position regarding the Pacific Meat case.

Mr. Charles Merten, attorney-at-law, appeared and urged the Commission members to reconsider their vote in this matter.

It was MOVED by Mr. McMath, seconded by Mr. Waterman and carried that, in the event any of those industries on Columbia Slough which are operating under permits requiring elimination of waste discharges by June 1, 1971 fail to meet that deadline, the Environmental Quality Commission institute immediate abatement proceedings.

The meeting was recessed at 12:15 p.m. and reconvened at 1:30 p.m.

WASTE DISCHARGE PERMIT DENIALS

Mr. Sawyer reviewed the staff memorandum dated November 25, 1970 regarding the Willow Creek Mobile Villa waste discharge permit and the November 5, 1970 department letter regarding the W.D. Clark mobile home park permit. These are both for proposed projects that were never built.

It was MOVED by Mr. McPhillips, seconded by Mr. Harms and carried that the application for renewal of the Willow Creek Mobile Villa waste discharge permit be denied.

It was MOVED by Mr. Waterman, seconded by Mr. Harms and carried that the application for renewal of the William D. Clark mobile home park waste discharge permit be denied.

WASTE DISCHARGE PERMIT FOR GRANTS PASS

Mr. Lynd reviewed the staff's proposal for modification of the Grants Pass waste discharge permit. A total of 346 equivalent single-family connections would be permitted as a maximum during the next two years while the improved sewage collection and treatment works projects are under construction. Mr. Silver pointed out that the court case brought against the Commission by the city had been dismissed.

It was MOVED by Mr. Harms, seconded by Mr. Waterman and carried that, in view of the city's progress and its specific construction program, the Commission authorize the issuance of a modified waste discharge permit for the city of Grants Pass as proposed by the staff.

AUTHORIZATION FOR PUBLIC HEARINGS

Mr. Odell reviewed the staff's request for authorization to hold public hearings regarding adoption of (1) proposed regulations for air contaminant emissions from board products industries and (2) proposed ambient air standards for sulfur dioxide.

It was MOVED by Mr. Harms, seconded by Mr. McMath and carried that the staff be authorized to hold public hearings for the above purposes at the February meeting of the Commission.

VARIANCE GRANTED BY CWAPA

Mr. Patterson reviewed the staff memorandum pertaining to the one-time variance granted by CWAPA to Mrs. Marjorie Kvamme of Boring to burn certain land clearing debris.

It was MOVED by Mr. Harms, seconded by Mr. Cogan and carried that said variance be filed and that it be noted in the minutes that the Environmental Quality Commission members are not in agreement with this type of variance.

STATUS REPORT - BEND AIR QUALITY

This matter was deferred until a later meeting.

COOS BAY POLLUTION SOURCES

This matter was also deferred.

NORTHWEST ENVIRONMENTAL DEFENSE CENTER PETITION

A 15-page petition dated November 23, 1970 and signed by Billy L. Williamson, President, had been received from the Northwest Environmental Defense Center asking the Environmental Quality Commission to take certain actions for controlling automobile emissions in the Portland metropolitan area.

Elizabeth Wieting appeared and read a 4-page prepared statement explaining their reasons for filing the petition plus numerous attached reference materials. A copy of the petition, explanatory statement and reference materials has been made a part of the Department's files in this matter.

Mr. Cogan said that in general he is sympathetic to their proposals.

The Chairman then proceeded to comment on the individual requests contained in the petition as follows:

A. Mr. Silver, Legal Counsel for the Environmental Quality Commission, is already working on needed revisions to the Department's rules governing administrative procedures.

B. The Department of Environmental quality does not have the staff, equipment or finances for taking measurements of contaminants at various locations during peak traffic periods both on the streets and inside automobiles. Such measurements should be made by the regional authority.

C. The Department for some time has been working with CWAPA to develop an emergency alert plan.

D. The Environmental Quality Commission definitely encourages the development and use of mass transit.

Mr. Cogan also commented on this particular item. It was MOVED by Mr. Cogan, seconded by Mr. Waterman and carried that the Environmental Quality Commission go on record as encouraging all bodies that undertake regional transportation planning to give full consideration to air pollution problems and air pollution concentrations and to make them a primary factor in their planning process.

E. The Department of Environmental Quality does not have the authority or resources to undertake a program of state-wide motor vehicle inspection.

F. The Department of Environmental Quality likewise cannot conduct studies and research of concentrations of lead in the air, plant and animal life.

G. The Environmental Quality Commission and Department of Environmental Quality are anxious to cooperate with other agencies and persons for the abatement and control of motor vehicle emissions.

Mr. Billy Williamson was also present but made no specific comments.

The regular meeting was then adjourned at 2:30 p.m. in order to allow time for the public hearing regarding the PGE Trojan nuclear power plant which was convened by the Chairman at 2:35 p.m.

Respectfully submitted,

Kenneth H. Spies

Kenneth H. Spies
Director

SUMMARY OF PUBLIC HEARING REGARDING
PROPOSED PGE TROJAN NUCLEAR POWER PLANT
Held By
Oregon Environmental Quality Commission
December 4, 1970

Proper notice having been given as required by statute and administrative rules, a public hearing with respect to the effect upon air and water quality of the construction and operation of the proposed Trojan Nuclear Power Plant to be located in Columbia County, Oregon, by Portland General Electric Company, et al, was called to order by the Chairman at 2:35 p.m., Friday, December 4, 1970 in Room 36 of the State Office Building, 1400 S.W. 5th Avenue, Portland, Oregon.

The members present were B.A. McPhillips, Chairman, E.C. Harms, Jr., Arnold M. Cogan, George A. McMath and Storrs S. Waterman.

In opening the hearing the Chairman made the following statement:

"The purpose of the hearing is to develop all available facts with respect to the effect of the proposed project upon air and water quality and also to consider the application of the proponents for a certification of the facility under Section 21(b) of the Federal Water Pollution Control Act.

By letter dated November 13, 1970, PGE requested that the state of Oregon acting by and through the Environmental Quality Commission and the Department of Environmental Quality certify that there is reasonable assurance that the Trojan Nuclear Power Plant will be constructed and operated in a manner which will not violate applicable water quality standards for the Columbia River.

It should be pointed out that the certification required under Section 21(b) of the Federal Water Pollution Control Act pertains only to water quality.

As indicated in the public notice of this hearing the statements to be presented are to be limited to effects on air and water quality.

This will be conducted as an informal legislative-type hearing. Testimony will not be given under oath. Questions will be asked only by members of the Commission. There will be no cross-examination or

questions of the witnesses by anyone else.

Everyone who wishes to present a statement at this hearing is asked to fill out a slip and submit it to me.

There are undoubtedly many persons who wish to be heard and we want to hear everyone who has factual information to present. We therefore request that the presentations be as brief as possible. The Chair reserves the right to limit each presentation to not more than 10 minutes. It is also requested that repetition of information already given by a previous speaker be avoided as much as possible in order to conserve time. Written statements will be accepted in lieu of oral presentations from anyone who prefers not to appear in person.

The record of the hearing will be kept open for an additional 15 days from this date to allow time for submission of further written statements. Such statements will be given the same consideration as if they were presented orally here today.

The record of this hearing is being made by means of a tape recorder. In order that the record will be as good as possible each person who presents a statement is asked to use the microphone. Speak clearly and start by stating your name and address.

I will call first upon PGE whose representative will present a brief statement about their proposed project."

Mr. H.H. Phillips, Corporate Counsel for PGE, then appeared and made a statement for the company. He read portions of the Oregon State Sanitary Authority Staff Evaluation Report on PGE's application for a waste discharge permit which had been acted on and approved by the Authority on June 27, 1969. He reported that some $15,000,000 had been invested to-date by the company for site selection and development, design and plan preparation. He mentioned all of the reviews and approvals which the proposed project had already received from state and federal agencies and he requested again that the Commission grant pursuant to the company's application of November 13, 1970 the certification required under Section 21(b) of the Federal Water Pollution Control Act.

Senator Ted Hallock was the next witness called on by the Chairman. He presented the following statement:

"Mr. Chairman I am Ted Hallock and reside at 2445 N.W. Irving Street in Portland. I believe that the potential of and the argument for a zero release reactor were ineptly approached by the interveners at the recent AEC hearing in St. Helens (AEC docket 5344). Your department has issued PGE a waste discharge permit for Trojan, Permit No. 456 expiring December 31, 1973, a year before scheduled operation, containing the following requirements:

Requirements, Limitations and Conditions.

Section 3 - Facilities for control of air and water quality shall be designed, constructed and operated at all times so as to keep heated waters, radioisotopes and residual chemical discharges to the river at the lowest practicable levels.

Section 14 - This permit is subject to change if the Sanitary Authority (DEQ) finds that there has been a material change in quantity or character of the waste or method of waste disposal.

I believe Mr. Chairman that the above language made it mandatory to the state of Oregon to show an intense interest as intervener when in May of 1970 a new method of waste disposal that would perhaps significantly increase the "lowest practicable level of waste discharged" was announced - the zero release reactor. The fact that the interveners didn't could perhaps be construed as gross neglect on the part of the state of Oregon. Proper intervention would have pursued the following:

Once it was established by the Westinghouse witness that the zero release reactor was an auxiliary package, what is the size of the auxiliary package? Does the present Westinghouse concept envision its being entirely assembled in the reactor containment structure? As seen in the Trojan artwork, does the concept envision a backset capability; a term that is more and more being used in entertaining these approaches? Had the state asked questions like these it might have done PGE a great service. Sooner or later every nuclear plant in the United States will have to have such a device. PGE would be better off to design their plant to accommodate one before they start to pour concrete.

The law of the land requires the lowest practicable level of radioisotope release. And it is important to note that practicable is a precise word. Its root meaning is capable of being practiced. The zero release reactor will be practicable by 1976. Mr. E.C. Itschner, Vice President of PGE, in his letter to Dr. Peter Morris of the AEC, dated October 12, 1970, paraphrased DEQ's waste discharge permit No. 456 in the following manner: "Radioisotopes and residue (That's a new treatment. By the way, in your discharge permit you refer to "any". He says suddenly "residue") chemical discharges (It poses a question in itself) to the river to the lowest practical level." The word practical, Mr. Chairman, is more ambiguous than practicable. Mr. Itschner may have a preference, for the choice of words is a personal matter. But for the record the ICRP prefers practicable.

Unfortunately, the present day attitude of the federal government enforcement agencies toward this whole matter is expressed in this section of HEW's review of PGE's environmental statement:

"Although more efficient technology has recently become available for PWR systems, it's not reasonable at this time to require the design changes necessary to use all these systems. Some of the systems such as additional treatment of gaseous and liquid wastes may be feasible and should be encouraged where practicable."

To me terms like "reasonable" and "encouraged" suggest a rather soft attitude for an agency trusted with the responsibility to enforce the law.

I think, Mr. Chairman, with this we have established two things: First, there is no doubt about it DEQ has issued a legal and valid and very effective waste discharge permit. The people of Oregon have environmental safeguards, the kinds that are being bitterly fought for in other parts of the land. The citizens of Michigan are trying to get a cooling tower at the Pallisades plant is a case in point. This permit of yours was issued in June 1969. And just that long ago or that recently very few people were listening to what John Mosser and Dick Poston and Ken Spies were saying as they fought, and yourself, for these safeguards.

Second point: The real nitty gritty of the thing is enforcement. And I would like to underline that to date your strategy has been aimed at rolling back pollution with plants that have been in existence for years. And the patience and perseverance that you have used to clean up the Willamette and Tualatin so successfully will not necessarily be applicable to Trojan.

With nuclear plants you've got to stop the pollution at its source from the beginning. This is a new and challenging responsibility for you. The matter of jurisdiction over radioactive effluent (I am surprised that counsel was surprised the words "radioactive effluent" would be introduced at the hearing today) the matter of your jurisdiction over that effluent is a ticklish one. But I don't think that we are all in a state of suspended animation waiting the court's decision in Minnesota, or in Washington, D.C., before we can act in this area. Maryland and Vermont claimed radioactive emissions as part of their domain.

Your stand in waste discharge permit No. 456 also claims this domain. Here's the word "radioisotopes." How you will use this may tax your legal imagination. You could take such action, you the Commission, as a Qui Tam suit "he who sues for the crown as well as himself." But in any event should you get in legal entanglements because of a real violation of waste discharge permit No. 456 it will be the violator, I submit, not you, who will have to sweat out Minnesota vs AEC through the supreme court. It won't matter Mr. Chairman, that nuclear power plants are controversial and I know this is not the forum for it but I can't help but make one comment, however. The proponents of nuclear power plants claim their difficulties will disappear once the public is informed. At the recent AEC hearing, 21 of the 36 limited appearances were informed expressions critical of Trojan in its implications. The difficulties didn't disappear. Perhaps the most pertinent was a question asked by a physician from Lake Oswego, "And if you are wrong about the damage caused by the radioactivity released into the atmosphere how will you reverse the damage?"

To a physician Mr. Chairman, irreparable damage means death and the gentleman from AEC went back to Washington, D.C. without answering the physician. You live in the same state. How would you answer him?

Back on the subject of enforcement, there is no time like the present. The cause is not a violation, but a material change in the method of waste disposal; namely, the zero release reactor. Section 14 is cause for you to consider a change - action. There has been a material change in waste disposal methods since waste discharge permit No. 456 was issued. In 1969 there was the New York Times' story and other information on the zero release reactor in March of this year.

Mr. Chairman, I think you have no option but to send PGE notification that their waste discharge permit No. 456 is suspended for 60 days while it is under review as you consider whether failure to install a zero level reactor may be a violation under Section 3 which requires the design and construction achieve the lowest practicable level of radioisotope discharge. We assume zero is lower than the present level of release, although I acknowledge that zero is a misnomer. The Westinghouse public relations man misnomered that it is a tenth to the minus N reactor. I think there are extenuating circumstances why the Department of Environmental Quality did not actively intervene at the AEC hearing. Mr. Chairman, now is the time and the place for you, the Commission, to take your stand. It is my belief that if you do what is required of you, the AEC will require installation of a zero level reactor as part of a license requirement. PGE may consider this to be impractical; however, they have formerly stated the following policy in regard to ACRS review, the Advisory Committee on Reactor Safety, of the design features that have yet to be proven by any nuclear plant in operation and I quote verbatum from PGE. "Where design is required of a major component for which irrevocable commitments have been made, changes will be made providing the Commission finds that such changes will provide substantial additional protection which is required for the public health and the safety."

Further, the 1969 annual report of PGE contains the following statement in regard to Trojan. "The next major step in the licensing process is the public hearing to be held in mid 1970 concerning the company's application for a construction permit from the Atomic Energy Commission. In order to keep the plant on schedule and at its own risk, the company is proceeding with site preparation work."

Mr. Chairman, there is absolutely no reason in the world why the public has to share in this risk, and if you do not take action now, this is what you will be forcing the public to do. There is a general argument that the whole nuclear program is a balance of benefits against risks. Well, I think this is a spurious argument. The risks haven't been thoroughly explored. The benefits are overblown, but we are not all children who are going to be frightened by brownout threat of being put in the dark, but this again is not the forum for this argument so forgive me.

A 60-day suspension of the waste discharge permit will give a needed respite to the pace with which the Trojan horse has been steamrolled into Oregon. It will accomplish several things. First of all, Mr. Chairman, it will overlap these 45 days the AEC said it would need to deliberate on the issuing of the construction permit. It will give them a little more than the intervention does on record to think about. Second, it will give Ken Spies time to check with Ernie Tsviglou on the details of this tenths and minus release reactor and I think that Dr. Tsviglou knows Ken and thinks very highly of him, and I believe Ken will agree that Ernie is an expert in his field. Third, it will give your legal department time to assess the state's vulnerability to a possible Qui Tam suit by someone when waste discharge permit No. 456 is reissued after December 31, 1973. Wouldn't it be tragic if PGE built a $230 million plant and couldn't get a legal waste discharge permit to operate it with? And fourth, within this 60-day period the legislature will convene. I am sure some committees will be formed and will want to look into the whole matter and I know in fact one bill has already been proposed to attempt to freeze Trojan progress. I am equally sure that they will appreciate that you have acted responsibly.

For me I thank you for the time and I am very proud of you collectively and I know you will do the right thing."

Mr. Edward J. Whelan, President of the Oregon AFL-CIO, was the next witness and read a prepared statement supporting the project and urging the Commission to act without further delay to certify the project.

Mr. George Hansen of the State of Washington Department of Ecology was called on next and made the following statement:

"Mr. Chairman, Commissioners, Mr. Spies: My name is George Hansen. I am representing the State of Washington Department of Ecology. Your records show that we have reviewed and endorsed as the Water Pollution Control Commission, the excellent waste discharge permit prepared for the Trojan nuclear power plant being proposed by Portland General Electric Co. This was done by our letter of June 25, 1969. Since that time we have taken note of further improvements offered by the company. Further, as you know the state of Washington has now integrated the Environmental Protection into a new Department of Ecology. I would request and I appreciate the opportunity that you have given to hold the record open in order that our new Department might submit a restatement which will cover our broader responsibilities in maintaining the environment."

Ms. Christine Hansen of Longview, Washington, followed Mr. George Hansen and said she represented an ecology group with 86 members in the Longview area. She expressed grave concern about possible detrimental effects of increased water vapor in the atmosphere due to the emissions from the proposed cooling tower. She asked that an indirect cooling system be employed. She said they do not need any more water in the Longview area.

Mr. Tom Donaca, Legal Counsel, Associated Oregon Industries, Inc. read a prepared statement for that organization urging favorable consideration by the Environmental Quality Commission of the proposed nuclear power plant project.

Mr. Lawrence F. Williams, Executive Director of the Oregon Environmental Council, read portions of a 5-page statement prepared by him for that organization opposing the project and urging "that the Environmental Quality Commission not issue the discharge permit at this time."

Mr. Robert F. Abbey, President of the Rainier, Oregon, Chamber of Commerce, read a short statement and presented a copy of a resolution by that organization endorsing the proposed Trojan Nuclear Power Plant project.

Mr. Harry Butcher, who said he represented the National Health Federation, the Northwest Environmental Defense Center, the Oregon Citizens for Clean Air and the Field and Stream Environmental Action Group, was the next witness. In opposing the project he read a statement dated December 4, 1970 and signed by Dr. Alan G. Beardall, Chiropractic Physician of Lake Oswego.

Mr. James G. Ashbaugh then appeared and offered testimony in opposition to the project. He raised questions regarding the possibility of emissions from the cooling tower contributing to photochemical smog, increasing the rainfall in Portland and modifying the weather of the area. He questioned that a regional plan had been developed for the area and that adequate consideration had been given to alternative sites.

He urged that the project be delayed 1 or 2 years.

Mr. David Corkran read a short statement in behalf of the Columbia Group of the Sierra Club. He said that organization is opposed to the issuance of a waste discharge permit for the Trojan plant at this time because its members believe that the discharges of chemicals and radioactivity will befoul the Columbia River.

Mrs. Beulah Hand, former state representative from Clackamas County, was the next person to testify. She said she represented herself and her friends. She expressed concern about the threat made by PGE officials that $15,000,000 had already been spent on the proposed project on the grounds that a waste discharge permit had been issued by the State Sanitary Authority in June 1969. She also expressed grave concern about the radioactive discharges, about how the radioactive solid wastes from the plant would be handled and particularly how they would be transported to the point of final disposal or processing. She referred to an article entitled "The Nuclear Threat Inside America" which appeared in the December 15, 1970 (Vol. 34, No. 25) issue of Look Magazine. She urged that the project not be certified.

Mrs. Norma Schell who said she represented a Women's Ecology Group of some 150 members testified that she is worried about the emissions of tritium from the nuclear power plant. She urged that the waste discharge permit previously issued to PGE be revoked by the Environmental Quality Commission.

Mrs. Joe H. Rand of 5411 S.E. Morrison Street, Portland and Chairman of the Better Environment Committee of the Portland YWCA read a prepared statement for that organization opposing the project and urging that the waste discharge permit be revoked and a moratorium be established on all nuclear power plants in Oregon.

Mr. Charles J. Merten, Attorney-at-Law, was the next person to appear and said he was testifying for himself. He claimed the fundamental issue is whether PGE has to prove its proposed project will not injure the environment or the public has to prove it will cause pollution of air or water. He discussed the legal authority in this matter and contended that the Environmental Quality Commission could and should concern itself about radioactive emissions.

Mr. John Osburn, Legal Counsel for the Environmental Quality Commission, read the opinion of the Attorney General dated February 3, 1970 which stated that the federal government had pre-empted the state's authority.

Mr. Charles D. Tauber, a student from Reed College, claimed that not enough research has been performed to determine possible harmful effects on the environment, not enough study has been made of the geology of the Trojan site, not enough study has been made of possible effects of thermal pollution on the Columbia River, and that other alternatives should be considered. He asked that the Environmental Quality Commission deny the company's application for a certificate.

Mr. Charles F. Glanzman, an engineering student from Oregon State University, claimed that the proposed power plant will result in population growth and that such growth should be regulated in order to protect the environment.

Mr. Richard T. Kasal, Architect, represented himself and urged that consideration be given to developing geothermal power sources rather than nuclear energy.

Mr. Charles E. Van Gorder, Mayor of the city of Rainier, testified in support of the project and said he and the members of the Rainier City Council urge the Environmental Quality Commission to grant the permit requested for the Trojan Nuclear Power Plant.

Mr. Steve Sellery of 6284 S.E. Jennings Avenue, Portland, said he represented an organization known as Citizens for Safe Power. He claimed that adequate safeguards have not been made by the company and therefore urged that the project not be certified by the Environmental Quality Commission. He submitted a copy of a petition that is being circulated by his organization requesting that Governor McCall declare a 4-year moratorium on issuance of any permit for construction and/or operation of any nuclear power plant in Oregon.

Mrs. Dolores Hurtado, 1835 Palisades Terrace, Lake Oswego, read a 3-page prepared statement expressing her concern about the future livability of the state and asking the Environmental Quality Commission in what ways it has exercised its responsibility to protect the environment in relation to the proposed Trojan project. She urged that approval of the project be deferred until complete assurance can be given that it will not constitute a potential danger to the environment.

Mr. Richard Chambers, Route 3 Box 754B, Salem, read a 3-page statement which he had prepared opposing the construction of the proposed Trojan project. He urged the Environmental Quality Commission to delay approval of it for at least one year.

Mr. John Bartels, student, said he represented a S.E. Portland neighborhood group for safe power. He opposed construction of the Trojan project at this time.

Mr. Bill Luch, 9212 N. Reno, Portland, appeared as the representative of the N.W. Steelheaders Assn. He expressed concern about too much industrial development along the Columbia River and the possibility that it would destroy the natural beauty of the area. He stressed the need for proper planning and zoning of the state's land resources.

At the beginning of the hearing the Chairman had announced that, if necessary, the hearing would continue until 10:00 p.m. to afford everyone who so desired an opportunity to be heard. Mr. Luch was the last person who asked to be heard and so the hearing was adjourned by the Chairman at 5:27 p.m. with the understanding that the record would be kept open for an additional 15 days for receipt of further written statements.

Attached to these minutes and made a part thereof are copies of the following statements submitted and read, either in whole or in part, at the hearing on December 4, 1970:

A1. Statement by Edward J. Whelan, President, Oregon AFL-CIO, dated December 4, 1970 (2 pages).

A2. Statement of Associated Oregon Industries by Thomas C. Donaca, dated December 4, 1970 (2 pages).

A3. Testimony of Oregon Environmental Council presented by Lawrence F. Williams, dated December 4, 1970 (5 pages).

A4. Statement and Resolution of Rainier Chamber of Commerce by Robert F. Abbey, dated December 4, 1970 and April 13, 1970, respectively (2 pages).

A5. Statement signed by Alan G. Beardall, D.C., and dated December 4, 1970, and read by Harry Butcher (3 pages).

A6. Statement of the Columbia Group of the Sierra Club read by David Corkran (1 page).

A7. Statement by Mrs. Joe H. Rand for the Better Environment Committee of the Portland YWCA (2 pages).

A8. Statement of the Rainier City Council by Mayor Charles Van Gorder, dated December 4, 1970 (2 pages).

A9. Petition for Further Study of Trojan Nuclear Power Plant from Citizens for Safe Power presented by Steve Sellery (1 page).

A10. Statement by Mrs. Dolores Hurtado, dated December 4, 1970 (3 pages).

A11. Statement by Richard Chambers, dated December 4, 1970 (3 pages).

Also attached to and made a part of these minutes are copies of the following statements or other exhibits which were received at or subsequent to the hearing and were not read at the hearing:

B1. Letter by Nick Steffanoff to Governor's Task Force, dated June 28, 1970 and replies from Congressman Wendell Wyatt, Congresswoman Edith Green, U.S. Senator Bob Packwood and Governor Tom McCall dated July 8, July 13, July 20 and July 24, 1970, respectively (6 pages).

B2. Statement of Columbia County Organization of Governments by M.E. McMichael, dated November 18, 1970 (1 page).

B3. Resolution No. 573 by St. Helens City Council, dated November 17, 1970 and signed by Mayor M.E. McMichael (1 page).

B4. Resolution (Docket No. 50-344) by Columbia County Board of Commissioners dated November 4, 1970 (1 page).

B5. Letter from St. Helens Chamber of Commerce signed by V.P. Phillips, President, and dated December 4, 1970 (3 pages).

B6. Letter from Milwaukie Rod and Gun Club, dated December 19, 1970 and signed by Jim Cassidy, Secretary (1 page).

B7. Letter from Fish Committee of Milwaukie Rod and Gun Club, dated December 17, 1970 and signed by Glendon G. Davenport, Chairman (1 page).

B8. Letter from Western Rod and Reel Club, Inc., dated December 14, 1970 and signed by Walt Vollertsen, President (1 page).

B9. Letter from State of Washington Department of Ecology dated December 18, 1970 and signed by John A. Biggs, Director (2 pages).

B10. Statement by Portland General Electric Company dated December 15, 1970 and entitled "Effect of Trojan Nuclear Plant upon the Environment" (11 pages).

B11. Letter dated December 7, 1970 from Betty J. Marshall of 4265 S.W. Chesapeake Ave., Portland (1 page).

B12. Letter from Mrs. Jerry Donovan of Route 1, Box 642, Scappoose, Oregon, dated December 10, 1970 (1 page).

B13. Letter from Ted L. Swensen of 5785 S.W. Carman Drive, Lake Oswego, Oregon, received December 17, 1970 (3 pages).

B14. Letter dated December 9, 1970, from Lindley D. Carson of 210 S.E. 87th Avenue, Portland (2 pages).

B15. Letter dated December 5, 1970 from David H. Corkran and additional statement by Columbia Group of the Sierra Club (3 pages).

B16. Letter dated December 7, 1970 and statement from Harry B. Nehls, President, Portland Audubon Society (4 pages).

B17. Letter dated December 16, 1970 from Daniel Lester of 7508 S.E. 29th Ave., Portland (2 pages).

B18. KPOK Radio Editorial by R.M. Brown, dated November 27, 1970 (1 page).

B19. Letter dated December 16, 1970 from Beulah Hand and Stephen Sellery and attached statements "Failure of Emergency Controls of Trojan Nuclear Reactor to Meet Safety Standards Requirements of AEC at the Present Time" and "Available Alternatives to the Trojan Nuclear Reactor for Present Development for the Pacific Northwest" submitted for the Citizens for Safe Power (11 pages).

B20. Statement from Port of St. Helens signed by Lew Winkler, Commission Secretary.

This completes the record of the hearing before the Environmental Quality Commission regarding the proposed Trojan Nuclear Power Plant.

Respectfully submitted,

Kenneth H. Spies

Kenneth H. Spies
Director

A1.


# OREGON AFL-CIO

EDWARD J. WHELAN, PRESIDENT
GLENN E. RANDALL, SECRETARY-TREASURER
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SECRETARY-TREASURER AND RESEARCH AND EDUCATION DEPARTMENT, SALEM MAIN OFFICE.




TO: ENVIRONMENTAL QUALITY COMMISSION

FROM: Mr. Edward J. Whelan, President, OREGON AFL-CIO

The Oregon AFL-CIO, in convention on September 17, 1970, adopted a resolution unanimously supporting the immediate construction of the Trojan Nuclear Generating Facility in Columbia County.

Having been deeply involved with the project since its inception, the opportunity was available to the officers of the organization to weigh the pros and cons of this type of generating facility. The Executive Board and the convention committee heard detailed testimony giving both sides the opprtunity to be heard. This background information is given to you as an indication that the convention's position on the resolution was taken only after great effort was made to bring out all the facts.

Too often labor takes an affirmative position simply because of the immediate work potential of a project. In the instance of Trojan this was not an issue. It is our considered opinion that the company, in consultation with recognized experts, has designed a facility that will produce the desired electrical energy and will, at the same time, minimize the dangers to mankind and the ecology. Alternatives just are not available. Unless this construction is started the people of Oregon by 1977 will suffer a complete breakdown in their economy because of the inability of distributors to provide the necessary electrical energy.

In addition to the organization that I head I have been requested to speak for the International Brotherhood of Electrical Workers, the Oregon Building and Construction Trades Council, the Building Trades of Portland and vicinity, and the various County Labor Councils.

There will undoubtedly be experts testifying on Fisheries, pollution and other considerations here today so I will confine my comments to the safety of the men who will operate this facility.

Oregon AFL-CIO

First all personnel connected with the actual operation of the generating facility will first have to be licensed by the A.E.C. This assures that only the most competent and well trained men will be responsible for actual operation.

As an indication of the effectiveness of this type of thoroughness I would like to illustrate by excerpting from "The Electrical Workers' Journal - October 1970" that portion of the International Brotherhood of Electrical Workers' President, C. H. Pillard, address to the 1970 International Brotherhood of Electrical Workers Convention:

> "The radiation safety record, as reflected by results of AEC compliance inspections and the latest statistical reports on the industry through 1969, indicates that the 20 licensed nuclear power plants have operated without a radiation fatality or serious radiation exposure to operating personnel or the public. (The only fatal accident involving reactors in the U. S. occurred in 1961 at an Army experimental reactor. Three technicians died in a nuclear excursion of an early prototype reactor at the National Reactor Testing Station in Idaho.)
>
> The IBEW continues to work with the AFL-CIO Subcommittee on Atomic Energy and Natural Resources in seeking adequate safety provisions for all workers in the nuclear industry.
>
> We have continued to advise and assist our local unions and members concerning nuclear energy, including research material relating to safety for negotiations, the appropriate bargaining unit, wage rates, and other working conditions.
>
> The IBEW is continuing to participate in American National Standards Institute committees for nuclear standards."

This is a safety record no other part of the electrical industry or, for that matter, any industry can match.

I can only urge that an end be put to the delays and that you gentlemen move with dispatch by invoking your "go ahead" on this project.

EJW:t
opeu#11
December 4, 1970

A2.

STATEMENT OF ASSOCIATED OREGON INDUSTRIES BEFORE THE ENVIRONMENTAL QUALITY COMMISSION, FRIDAY, DECEMBER 4, 1970

BY
THOMAS C. DONACA
COUNSEL
ASSOCIATED OREGON INDUSTRIES, INC.
2187 S. W. MAIN STREET
PORTLAND, OREGON 97205

My name is Thomas C. Donaca and I am Counsel for Associated Oregon Industries. Associated Oregon Industries is a voluntary non-profit organization of businessmen and employers within the State of Oregon who employ about 50% of Oregon's non-public employees and represents about 50% of the total private payroll in the state. We have 1350 members. Currently our activities range from interests in education and environmental quality to taxes and consumer protection. We represent every segment of Oregon business and industry in relations with government at the local, state and national level.

I have been directed by our Board of Directors to appear before you today to speak for our membership endorsing activities of the Portland General Electric Company and its partners in the proposed construction of the Trojan Nuclear Plant in Columbia County.

As we understand it, the purpose of this meeting is primarily for the purpose of investigating the facts regarding the environmental effects of the proposed construction and operation of that plant.

Associated Oregon Industries, as you well know, participated fully in all hearings relating to the development of the water quality standards on all interstate streams required by the Federal Water Quality Act. As you also know, we were the third state in the U.S. to qualify under that Federal Act. Our technical committee, which is fully familiar with those standards, has reviewed information presented at your earlier hearing as well as other information which has generally been available with regard to effluence

from the plant and the applicant appears to have fully satisfied all water quality criteria required of them.

We know of no further factual reason for this Commission to delay further with regard to any water quality permit or on the certification of the facility under Section 21 (b) under the Federal Water Pollution Control Act. We urge your favorable consideration on all aspects of your jurisdiction on this proposed nuclear power plant.

(A3.)

# TESTIMONY PRESENTED TO THE ENVIRONMENTAL QUALITY COMMISSION ON PORTLAND GENERAL ELECTRIC'S PROPOSED TROJAN NUCLEAR POWER PLANT BY THE OREGON ENVIRONMENTAL COUNCIL DECEMBER 4, 1970

Mr. Chairman and members of the Environmental Quality Commission, I am Lawrence F. Williams, Executive Director of the Oregon Environmental Council. Our office is located at 1238 N. W. Glisan Street in Portland.

We are very pleased that the Commission has chosen to hold public hearings on the discharge permit for PGE's proposed nuclear power plant. We recognize that public hearings are not required by Federal law, but only suggested in matters of this importance.

While the Oregon Environmental Council has not taken a position against the production of electricity through nuclear power, we have some serious reservations, however, about the location of PGE's proposed Trojan Nuclear Power Plant. Our reservations are with regard to plant impact upon the Columbia River, the town of Rainier, the climate and the potential hazard this plant represents to the residents of Oregon and Washington.

We also have some questions concerning the responsibilities of Portland General Electric and the Environmental Quality Commission with regards to the National Environmental Policy Act (NEPA). Under NEPA, the potential polluter is required to specify "any adverse environmental effects which cannot be avoided should the proposal be implemented..." There is nothing in NEPA which says that the Oregon Environmental Council, or any other private organization, must prove that there will be environmental damage in order to forstall a planned action. It appears to us that the State's certification that this plant will not degrade the environment is based almost entirely on faith. For example, the Fish Commission's report to the Nuclear Development Coordinating Committee and the Nuclear Siting Task Force states that "while...(the radioisotope emissions) may be regarded as safe for man, sensitivity of aquatic organisms to radiation is poorly understood." This report also states that "there is evidence that increased water temperature can interact with chemicals and increase the toxicity to aquatic life, we believe this aspect also requires study." The report concludes by saying that "we readily admit that we do not have all the answers in the fish-nuclear plant relationship."

Further, we submit the following statement made by the U. S. Department of Health, Education and Welfare on the Trojan facility. "It, therefore, seems likely that the applicant's estimate of Trojan's liquid waste discharges significantly underestimates what the actual discharges will be. This conclusion is further supported by the fact that the power levels of the presently operating PWR's are significantly lower than Trojan's power level."

All of the above quotes lead us to believe that far too little is known about the environmental effects of the proposed plant for the State to give the green construction light. PGE should be required to do far more research into the possible environmental effects prior to proceeding with construction. It is not we that should have to prove that there are environmental hazards, but rather PGE must prove that there are none.

With EQC's issuance of the previous discharge permit, which is being reviewed for re-issuance here today, the Commission failed to take into consideration the health and safety of the residents of Rainier, Oregon. Approximately 650 families living in Rainier must depend upon Columbia River water for several months every summer. The residents of Rainier face a two-fold threat, from the proposed Trojan plant, to their health and safety:

1. There still appears to be considerable doubt as to the effect of the chemicals which will be dumped into the Columbia River from the plant.

2. In the event of a large radiation release into the Columbia River, the City of Rainier could well find their entire water supply contaminated before the shut-off valve could be actuated. Even though Rainier has an 8 day reserve of water in storage tanks, it will do them little good if the intake valve is not shut off in time to stop the radiation from entering and contaminating their entire system. We, therefore, urge that this Commission require that an emergency system be established by PGE which will automatically cut off Rainier's water intake in the event of an abnormal release of radioactivity due to a plant malfunction.

Tritium, to the amount of 4,770 curries per year, along with other radionuclides, will be released into the air and water. In order to understand what this release of 4,770 curries of tritium per year means, I would like to quote from a paper by Dr. Dean E. Abrahamson, College of Medical Sciences, University of Minnesota. The paper is entitled "Ecological Hazards from Nuclear Power Plants".

"The phenomena associated with radioactive materials and the units used to measure quantities of radioactivity are outside of our usual experience and it is difficult to convey a 'feeling for these quantities. Although it is not directly applicable in terms of biological effect, it is useful to compare the quantities of radioisotopes from weapons testing or nuclear reactors with the quantity of radium which would contain the same amount of activity. A Curie is equivalent to the activity in one gram of radium. We can all recall the excitement and intensive searches instituted when a capsule containing a few milligrams of radium had been lost or misplaced. Yet the quantity of radioactivity proposed for release from a single nuclear power plant each year, even under the most optimistic assumptions as to its operation, is several times the activity in the entire world supply of radium. We are being asked lightly to dismiss this discharge of radioactivity.

Tritium discharge can also be used to illustrate another point which has confused discussion for radioactive wastes and the quantities of radioisotopes already present in the environment. It has been suggested that the added tritium would not be greater than the quantity of tritium already present in, for example, the Mississippi River. However, this tritium is itself due to pollution via the fallout from weapons testing, and does not form a part of the so-called 'natural background of radiation present in the environment.'

Prior to the advent of weapons testing and nuclear reactors the surface waters of North America had an average tritium concentration of less than 10 picoCuries per liter. The present tritium concentration in the Upper Mississippi River is in the neighborhood of 2000 picoCuries per liter. It matters little to the environment or to the individuals exposed to this radiation whether it arose from weapons testing or from waste from nuclear power stations. The fact that weapons testing has increased our exposure to radiation seems a poor argument indeed for the creation of an even greater risk by discharging radioactive wastes from nuclear power stations.

In present practice, tritium is not the only radioactive isotope which is released to the environment without any significant control. The noble gasses are also so released, either at the reactor site or at the fuel reprocessing plant. It has been estimated that the exposure due only to one of these isotopes, krypton-85, will approximately equal the exposure from natural sources of ionizing radiation by the year 2000 if the releases of krypton-85 continue from new reactors as they have from existing reactors."

A study published in Science and Technology (page 24, June, 1969) indicates that we have every reason to be concerned about the releases of even small amounts of radioactivity into the Columbia River. This study showed that the radioactivity of the plankton in the Columbia River "was two thousand times greater than that of the water, while the radioactivity of the fish and ducks feeding on the plankton was fifteen thousand and forty thousand times greater, respectively. Moreover, the radioactivity of the egg yolks of water birds contained more than a million times the radioactivity of the water. Here then, are clear illustrations of the way in which traces of radioactivity in the air, water, or soil may progressively concentrate, so that by the time it ends up on man's plate, it can be a tiny package of poison."

Finally, Oregon's own State Board of Health, Radiation Section, stated in a report to the American Chemical Society at their Annual Meeting on September 13-18, 1970 "it is recommended that exposure of the population, especially the more susceptible younger segment, to ionizing radiation from all sources, including environmental should be reduced whenever possible, and kept as far below recommended standards as is practicable."

There is no question that if the amount of radiation being released into the air and water can be significantly reduced then Portland General Electric should be directed to do so. We note that several systems have been recently developed which are capable of reducing the radioactive emissions to "essentially zero". Westinghouse, which is building the reactor for PGE, has developed a system called the "zero release" reactor. We feel that if this system is not immediately available for incorporation into the Trojan plant that the reactor design should be modified in such a way as to accept this environmental control equipment when it is available. In addition to the "zero release" development by Westinghouse, the engineering firm of Babcock and Wilcox has incorporated the new Oak Ridge Environmental System (which is similar to the "zero release") in three recent bids for the construction of nuclear reactors. The Oak Ridge system is reported to cost only $175,000, including installation. It is also reported that this system is available immediately. Because this Commission has the obligation to require the lowest practicable radiation emissions from Trojan, we, therefore, implore you to require that one of these two systems be made part of the Trojan reactor.

The U. S. Department of Health, Education & Welfare concurs with our position. In their report to the State, they say that "Some of the systems such as additional treatment of gaseous and liquid wastes may be feasible and should be encouraged where practicable." There is no need to bow to the AEC on this point. You have the responsibility to protect the people of Oregon from radiation pollution in the air and water. We see no need to equivocate on this matter.

The Oregon Environmental Council has been critical on the siting of this plant at the Trojan location because of the possibility of geologic faults in close proximity to the reactor and the reactor's proximity to Portland. While this Commission has little authority over the geologic suitability of the site, it most certainly must concern itself about the possible consequences of high level radiation exposure to the public in the event of a reactor core melt-down or a steam break.

It has been shown that Portland's prevailing wind comes directly through the Trojan site approximately 40% of the time. Our evidence shows that this is a stable wind which would hold large amounts of radiation, in case of a reactor failure, rather than diluting it before it reaches Portland. The consequences of such an "ill wind" blowing into a population center such as Portland is unthinkable.

With regards to the thermal effects of the cooling tower discharge on the Columbia River, we would like to take this opportunity to thank Portland General Electric Company for taking the necessary steps to reduce the maximum discharge temperature of the cooling water from 101°F to 89.6°F. We wonder, however, why this Commission

accepted the 101°F temperature as their maximum allowable discharge temperature from the Trojan facility without investigating whether or not a lower discharge temperature could be obtained? In fact, we wonder how such a permit can be issued when the Department's own administrative rule (41-050) states that "no waste shall be discharged and no activity shall be which either alone or in combination with other wastes or activities will cause in the waters of the Columbia River:" (sub-section 5): "Any measurable increase when river temperatures are 68°F or above, or more than 2°F increase when river temperatures are 66°F or less." What will happen to this hot water, during plant shut-down for refueling, when the river temperature is above 68°F? We should hope that the Department of Environmental Quality will insist that PGE comply with its own administrative rule.

In conclusion, we strongly urge the Oregon Environmental Quality Commission to carefully reconsider the advisability of reissuing this discharge permit. You must remember that the standards you insist upon for the operation of this plant will very likely set the criteria for all of the other nuclear power plants to be built in Oregon. Therefore, the environmental standards for the operation of the Trojan nuclear power plant must be as high as technically possible.

Based upon the lack of basic knowledge about the environmental effects of this plant and the failure of PGE to respond in an appropriate manner to the National Environmental Policy Act, we urge that the Environmental Quality Commission not issue the discharge permit at this time.

Thank you Mr. Chairman.

A4.

RAINIER CHAMBER OF COMMERCE

December 4, 1970

TO WHOM IT MAY CONCERN:

IT IS NOT WITHOUT CONSIDERABLE THOUGHT OR CONCERN FOR THE COMMUNITY OR ITS RESIDENTS THAT THE CHAMBER OF COMMERCE OF THE CITY OF RAINIER, OREGON ENDORSES THE TROJAN NUCLEAR PLANT LOCATED NEAR THE TOWN OF PRESCOTT.

THE INDIVIDUAL MEMBERS OF THE ORGANIZATION, LACKING IN EXPERTISE ON THE SUBJECT OF ECOLOGY, ARE DEPENDENT IN THIS FIELD ON THOSE WHO ARE KNOWLEDGEABLE AND HAVE IN REGULAR SESSION EXPRESSED THEIR WILLINGNESS TO ACCEPT PORTLAND GENERAL ELECTRIC'S TROJAN PLANT AS A COMPATIBLE RESIDENT OF THE AREA.

A RESOLUTION ADOPTED APRIL 13, 1970, READS AS FOLLOWS:

BE IT RESOLVED BY THE CHAMBER OF COMMERCE OF RAINIER, OREGON:

THAT THIS CHAMBER OF COMMERCE AND ITS MEMBERS, COLLECTIVELY AND INDIVIDUALLY, DO WHOLEHEARTEDLY ENDORSE, WELCOME AND ANTICIPATE THE LICENSING, CONSTRUCTION AND OPERATION OF THE TROJAN NUCLEAR PLANT.

A COPY OF THE FOREGOING TEXT IS SUBMITTED TO THE COMMITTEE FOR THE RECORD.

THANK YOU.

Robert F. Abbey

ROBERT F. ABBEY, PRESIDENT
CHAMBER OF COMMERCE
RAINIER, OREGON

RFA/ola

# Rainier Chamber of Commerce

April 13, 1970

TO WHOM IT MAY CONCERN:

WHEREAS a nation's and a community's economy has to grow in order to stay strong and respected; and

WHEREAS the Trojan Nuclear Power Plant will represent an investment upwards of $230 million; and

WHEREAS the Trojan Nuclear Power Plant will be a prime tourist attraction during construction and after completion; and

WHEREAS investment of multi-millions of dollars will beneficially increase tax valuations in Columbia county; and

WHEREAS assurance of an ample supply of clean electricity near our community may well bring new industry and additional jobs with the strong possibility that more of our young people can stay in or return to our community to live and work; and

WHEREAS recreational facilities planned in conjunction with construction of the Trojan Nuclear Plant will add to the enjoyment of local residents as well as visitors; and

WHEREAS safe nuclear generated electricity is most likely the best source of power for environmental improvements; present and future, now therefore,

BE IT RESOLVED BY THE CHAMBER OF COMMERCE OF RAINIER, OREGON:

That this chamber of commerce and its members, collectively and individually, do wholeheartedly endorse, welcome and anticipate the licensing, construction and operation of the Trojan Nuclear Plant.

Robert F. Abbey

ROBERT F. ABBEY, President

Dr. Alan G. Beardall
Chiropractic Physician
15800 S. W. Boones Ferry Road
Lake Oswego, Oregon 97034

636-0186

AS.

Testimony given December 4, 1970.

As a physician and a father, I am concerned about the environment for tomorrow. The Santa Barbarians after their war with the oil companies, made a declaration of Environmental Rights. It reads, "All men have the right to an environment capable of sustaining life. If the accumulative actions of the past becomes destructive of this right, men now living have the further right to repudiate the past for the benefit of the future."

As a physician, I share the opinion of Dr. Robert L. Bacon of Oregon Medical School, that we must be concerned about the total background radiation to which we are being exposed. If you build this Trojan Plant, you will build others as there is already talk of another plant to follow the Trojan. This is the beginning of the nuclear era; 102 plants by 1975 and 700 to 1,000 by the turn of the century.

What is the radiation-tolerance level of each man? Obviously, this varies with each individual. How then can you set allowable standards? Don't even your most trained scientific men disagree over these standards? I believe as Dr. Carnow, M.D. of Chicago, believes, that there is no safe level of radioactivity pollution. With every level there is risk and danger.

You consider the individual output radioactive effulent of each plant and ask them to meet your standards, but nowhere, at no time, do you take into consideration total radiation exposure to mankind, due to accumulation and build-up of radioactive substances in our environment.

Your literature indicates that sure, there are some side effects by radioactive pollution, but what about the general benefits of mankind? I ask you, at what point does the damage done to the population out weigh the general benefits and who among you will decide this? When does the measurable damage occur and on whom and how can this damage be stopped and/or reversed when it is measured? This is impossible! Why? Because the damaging effects of radioactive metals are irreversible. There is No antidote. No cell fully recovers from exposure to radioactivity. The A.E.C. and P.G.E. would have us to believe that your Trojan Plant is safe, clean, free from defect, both human and structural, and that it will withstand all floods, hurricanes, tornadoes, earthquakes, explosions, aircraft collisions, sabotage, title waves, hostile acts by foreign countries, riots and changing revolutioning America for the next 1,000 years. And what is more important, they must be right, or who will suffer? We, the Portland Metropolitan area; we will live with their radiation and pollution.

This Trojan Plant is still in the experimental stage. You are experimenting with us, the people of Oregon. In other words, you plan to learn more at our personal expense. We are your guinea pigs. Nuclear reactors are run by humans. Humans are subject to human error. Someone, someday will push the wrong button; someone will be undecided, someone will be incompetent, someone will have a profit motive behind them, someone could be blackmailed. Nuclear reactors are subject to the effect of war and confrontations. Why aren't they underground?

After your nuclear reactor is built, you are not subject to full-proof inspection policy. How could you possibly, no

one could enter the structure to see if there is any inherit damage; detection is then inadequate. We cannot risk even with the minutest chance of failure. Even with normal function you are dangerous. Your stacks in one year could admit and be within your A.E.C. standards one and one-half tons of radioactive metals.

A major accident could be fatal to this whole area. Some of you, now easily say that nuclear reactors do not produce the problem of more pollution as the air-like fossile type plants. This is only true because we have not faced up to the long-term effects of radioactivity. Radioactivity cannot be seen and thus, the air looks clean, even though it may be loaded with pollution.

You play with the most deadly pollutants known to mankind; and if by chance some person arrises to speak against you, he is called emotional and uniformed. I and the groups which I represent must stand in protest of your plant, because we are concerned about total background radiation, which can accumulate and build to reach dangerous levels due to the inherent qualities of radioactive waste. I repudiate the present for the future. In conclusion, I must ask you how peaceful can an atom be that has and is destroying LIFE???

Respectfully submitted,

Alan G. Beardall D.C.

Alan G. Beardall, D.C.

(A6.)

Statement on the Waste Discharge Permit for the Trojan Atomic Power Plant

by

The Columbia Group of the Sierra Club

Dec. 4, 1970

The Columbia Group of the Sierra Club is opposed to the issuance of a waste discharge permit for the Trojan Atomic Plant at this time. We believe that the discharge of more than five tons of chemical wastes per day into the Columbia River, even if "neutralized with additives", is a violation of ORS 449.105 which forbids release of "any deleterious or offensive substance" which will "befoul, pollute, or impair the quality of any spring, brook, river," etc. We believe that radioactive tritium is a deleterious substance which may harm various forms of life. We think that neutralized chemicals might well be offensive substances which befoul the Columbia. We believe that ORS 449.105 would be contravened if Portland General Electric Company were allowed to dump these materials into the Columbia River.

5411 S.E. Morrison Street

December 4, 1970

(A7.)

Environmental Quality Commission

400 S.W. 5th Street State Office Building

RE Discharge permit for Trojan Nuclear Power Plant

Gentlemen:

The proposed Trojan Nuclear power plant, a short forty miles outside of Portland, is surely one of the most significant events in the last few years. Despite this fact the public has been left almost totally ignorant of the real reasons for this plant and of its actual effects. The news media is filled, through advertising, with a lovely picture of parks, scenic structures, cool water, and cheap electricity. Nothing, however, is said in the press or to the public about large amounts of toxic chemicals which are to be dumped into the Columbia River. Nothing is said about the twenty four million gallons of water a day that will be pumped into thealready foggy atmosphere about Portland. We hear very little about the radiation effects, even though reputable scientists have said that it may be a significant health hazard in the form of increased cases of cancer, leukemia, heart disease, and genetic defects in man. So, we have here a significant contributor to environmental pollution and a potentially serious hazard to the health of the people of Oregon, which is being given a license to do these things by the very agency chosen to protect the environment and the people of this State! Nuclear power plants are new to this country. We know that they are potentially very dangerous. No one knows what the long range effects will be from their continuous leaking of radioactive elements into the air and into the river. We do not want to be the quinea pigs for this radioactive experiment!

We are told that this nuclear power plant is absolutely necessary because of the increasing power needs of our area, yet despite this threat of power shortages, major industrial power users are being lured into the area and will be supplied with the power

for which we and the environment are paying the price. Aluminum plants and chlorine producing plants, both of which use tremendous amounts of electricity, are building along the Columbia River because of the cheap electrical power provided for them. Portland General Electric Company advertises heavily to induce us to change to electric heat and add air conditioners to our homes. If power shortages are indeed iminent we should discourage the use of electricity and we should discourage industrial plants which use large amounts of power from locating in this area.

We urge that you revoke the discharge permit that you have given to PGE and call a moratorium on all nuclear plants in Oregon until such times as we can be assured there is noradioactive leakage and the other effluents can be minimized.

Mrs Joe H Rand

Mrs. Joe H. Rand, Chairman

Better Environment Committee YWCA of Portland

A8.

TELEPHONE 556-2201

City of Rainier

RAINIER, OREGON

RAINIER—A GOOD PLACE TO LIVE . . . A GOOD PLACE TO INVEST

*Dairying Berries Mint Truck Farming River Bottom and Hill Lands*

*Lumbering Industrial Sites Rail, Water and Highway Transportation*

COUNCIL MEETS FIRST MONDAY OF EACH MONTH

OFFICE OF: To:
Department of Environmental Quality Commission
1400 S. W. 5th Avenue
~~Room 36, State Office Building~~
Portland, Oregon 97201

December 4, 1970

Mr. Chairman and Members of the Board:

We feel the numerous officials, the officers of the departments, commissions, and committees, a long list, who have had access to the requirements, the proposals and plans of construction, operation and maintenance of this tremendous nuclear project have given a pretty close scrutiny to every part and plan. We know that most of these departments and commissions are primarilary interested in one or more parts and have carefully studied as to how they would be affected. Therefore, it has been very right and proper that all have been involed in the testing and inspection of every part of this plant because this check and recheck is the public safeguard we need. The very careful step by step progress to insure that every aspect of this plant is'work-safe', because this new plant with its many new problems must be solved and understood thus the path will be smoothed and cleared for the plants to follow.

Smart, brave men have put their lives on the line to develop methods and safeguards. Attesting their success are operating nuclear plants at work now in just about the most closely confined quarters possible, nuclear powered ships and submariens, a real test of safeguards. Yet there are those who, in the present protest noisely, who would deny these great accomplishments, who discount the veracity of the developers, who would deny and withhold from the general public the benefits derived from almost limitless nuclear energy. Instead they council fear and talk fear and delaying tactics. Very much the opposite are the people of the Hanford area who have successfully sought and secured another nuclear plant when doubt was raised about the Roosevelt Beach Site.

Safeguards for the area are through pollution controls. River, air, wind and rain studies compiled the information for comparison before and after getting the plant into operation. We are indeed pleased this nuclear energy plant is planned for Trojan. The City of Rainier welcomes this great benefit to our community. The record to date of operating nuclear plants is very good and have proven that safeguards can and do work and we believe these safeguards will be continued and improved.

The A.E.C. Regulatory Staff and the Commission Advisory Committee on Reactor Safeguards both have concluded there is reasonable assurance the Trojan Plant can be safely constructed and operated. Therefore,

TELEPHONE 556-2201

**RAINIER—A GOOD PLACE TO LIVE . . . A GOOD PLACE TO INVEST**

*Dairying Berries Mint Truck Farming River Bottom and Hill Lands*
*Lumbering Industrial Sites Rail, Water and Highway Transportation*

# City of Rainier

RAINIER, OREGON

COUNCIL MEETS FIRST MONDAY OF EACH MONTH

OFFICE OF:

To:
State Environmental Quality Commission
Room 36, State Office Building
Portland, Oregon 97201

December 4, 1970
Re: Trojan Public
Hearing-Portland



we who are not knowledgeable scientists are depending upon those who have worked and studied the actual plans and we accept their assurance and state, we at Rainier, Oregon desire the approval be granted for the Trojan Nuclear Plant.

The members of Rainier City Council join with me in extending our good wishes and respectfully urge the members of this board to grant the permit requested for Trojan Nuclear Plant, that the excellent program to date may continue into full completion and operation.

Thank you,

Charles E Van Gorder

Charles Van Gorder, Mayor
City of Rainier, Oregon

CVG:rj

A9.

# PETITION FOR FURTHER STUDY OF THE TROJAN NUCLEAR POWER PLANT*

* A One Million Killowatt Generator with 96 Tons of Uranium in its Reactor Core. To Be Located 38 miles West of Portland.

BECAUSE the potential dangers to all forms of life living near the proposed plant cannot be assessed because adequate data on the effects of low level radiation on human tissue and the environment is not available;

BECAUSE sufficient studies have not been made by the applicants or any government agency regarding the geological formations and weather patterns of the area surrounding the site of the proposed Trojan Nuclear Power Plant at Goble (Rainier);

BECAUSE data is not available on the long term effects of all the different types of radioactive material produced within a reactor and because it appears that Atomic Energy Commission standards are set too high in some instances;

BECAUSE the State of Oregon has set no standards for the transportation and storage of nuclear wastes within the state of Oregon;

BECAUSE recent technological improvements such as the "essentially zero release reactor" are not being incorporated in the Trojan design;

We, the undersigned, hereby request that Tom McCall, Governor of Oregon, declare a four (4) year moratorium at least on issuance of any permit that would authorize construction and/or operation of the Trojan Nuclear Power Plant or any other nuclear power plant in Oregon.

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FORWARD PETITIONS TO CITIZENS FOR SAFE POWER 6284 S.E. JENNINGS AVENUE
PORTLAND, OREGON 97222

A10.

Statement of Mrs. Dolores Hurtado, Dec. 4, 1970, before the Oregon Environmental Quality Commission, 1835 Palisades Terrace, Lake Oswego 636-5049

As a citizen of Oregon and a parent concerned about the future liveability of our state, I would like to ask the Oregon Environmental Quality Commission in what ways it has exercised its responsibility to protect our environment and our citizens in relation to the following areas (pertaining to the proposed Trojan nuclear power plant at Rainier):

1. Have you looked carefully at the geologic evidence indicating that there is a probable seismic fault near the location proposed for the Trojan plant? Can you state your convicti n that it is not possible that an earthquake could occur at this site with resulting potential release of radioactivity? Have you examined the meterological evidence which indicates that 40% of the year the wind direction from the site is toward the Portland metropolitan area, which could mean rapid contamination of our mostly densely populated area in the event of an accident at the plant? In 1966 there were 42 accidents reported at nuclear plants around the world, 37 in the U.S. Human error and structual defects have caused unanticipated accidents in other plants. Is it unrealistic for citizens to suggest that more appropriate siting would be at locations much farther removed from population centers?
2. Can you assure us that a daily dumping of 1000 lbs. of polyphosphates, 9500 pounds of sulfates, 180 pounds of caustic soda, 170 pounds of sulfar, 4 pounds of orthophosphates, 38 pounds of chlorine, as well as other chemicals con stitutes compliance with ORS 449.105 which states that "no person... shall discard... any deleterious or offensive substance into or in any other manner befoul, pollute, or impair the quality of any spring, river, brook, creek, branch..."

Are you convinced that the Columbia River, already the most radioactive river in the country, can and should absorb additional radioactive wastes. In their Detailed statement on the environmental considerations of the Trojan Nuclear Plant boththe Dept. of Health, Education and Welfare and the Portland General Electric Company note the special problem in measuring radioactivity concentration in the water of the Columbia attributable to the operation of the Trojan Plant because of the radioactivity already present in the river because of the Hanford plant upstream in Washington. The plankton in the Columbia River now average 2000 times the radioactivity of the water, the fish 15,000 times, and ducks feeding in the river 40,000 times.

The proposed plant would introduce tritium and other nuclear wastes

to this water. Reputable AEC scientists have raised serious questions about the lack of adequate information about the effect of long-term low-level radiation doses in increasing risks of death from leukemia and cancer, or causing genetic mutations that could kill thousands of future children.

Dr, James F. Crow, professor of genetics at the Univ. of Wisconsin Medical School, and president of the Genetics Society of America has stated: "Geneticists are convinced that there is no thrhold for radiation-induced mutations; that is, there is no dose so low that it produced no mutations at all. Each dose, however small, that reaches the germ cells between conception and reproduction carries a risk to future generations proportional to the dose."

When the scientific community is currently debating this issue (see the report in the Nov. 23, 1970 National Observer of the recent debate between Dr. John W. Gofman, medical physicist at the Lawrence Radiation Laboratory at Livermore, California, and Dr. Victor Bond, associate director of AEC's Brookhaven National Laboratory,) are we, the public to accept without question the further development of nuclear power. We believe it is your responsibility to examine the data and assure us that increasing the radioactivity of the river does not and will not constitute a hazard to our environment and our citizens.

3. Have you examined in detail the proposals for handling, transporting, and storing the deadly high-level radioactive wastes which are the present by-product of nuclear reactor operation. The AEC itself recognizes this as "the most severe potential hazard" in developing nuclear power. It stored 100,000 gallons of these wastes this year. By 1980, commercial nuclear reactors will produce some 3.5 million gallons of this radioactive waste. At present there are 140 AEC storage tanks containing 55 million gallons at Hanford, Wash. left over from the operation of the now abandoned nuclear reactors. They rest on an area which only recently has been discovered to be one of considerable earthquake hazard. Eleven of the tanks have leaked "some liquid into the dry soil under the tanks." A commercial company is doing research to reduce the potential hazards of damage and/or rupture of the pipes and tanks. Since 1966 they have succeeded in processing less than 1% of the total wastes stored just at Hanford.

Can you assure us that the plans for transporting and storing these hot wastes are adequate are adequate to protect us and our children from the incredible effects if trucks or trains carrying these materials are involved in accidents. Should the development and operation of nuclear dumps be permitted before there is adequate knowledge in how to cope with these long-lived, extremely

active materials?

4. My final questions concerns the great haste to push forward this pfoject. It is based on assumptions of increased power needs which are said to be incontrovertible. But the RAND Corporation is now, under National Science Foundation funding, engaged in study to determine whether the ever-upward spiraling energy supply really is necessary orcan be even justified. In discussing alternatives to the Trojan plant the Federal Power Commissiong, states that "the construction of a fossil-fuel plant as a substitute for the Trojan plant does not appear to be an economically superior choice. The question which is relevant to your commission, I believe, is whether it is the "environmentally superior" choice. Nuclear power is hightly touted as the "clean" method of producing power, but with the increasing awareness of our lack of knowledge about some of the undetermined effects it may have on the environment, the public is not convinced and will not be convinced until you can answer all our questions.

If you state that some of the above considerations are not within your jurisdiction, I would like to ask what you are doing to develop state controls which will enable you, charged with the protection of our environment and our citizens, to ensure that these questions are explored in depth and answered clearly and completely. The burden of proof for ensuring that a project of such scope and with so many implications is not a potential danger to our environment, ~~rests with you, and upon the promoters of that project~~. We ask you to exercise that responsibility in our behalf.

A 11.

FRIDAY, DECEMBER 4, 1970 PORTLAND, OREGON

OREGON ENVIRONMENTAL QUALITY COMMISSION

PUBLIC HEARING RE : TROJAN ATOMIC POWER PLANT

TESTIMONY OF : RICHARD CHAMBERS / RT 3 - BX 754B / SALEM, OREGON

GENTLEMEN, IT HAS BEEN MANY YEARS SINCE MY STUDENT DAYS, BUT I AM BEGINNING TO FEEL A KINSHIP WITH THOSE PERFECTLY RATIONAL STUDENTS WHO SAY THAT THEY ARE TALKING BUT NO-ONE IS LISTENING. THE IMPRESSION I HAVE GOTTEN IN MY SEVERAL APPEARANCES ON THIS SUBJECT IS THAT THE TROJAN ATOMIC POWER PLANT WAS CONCEIVED IN HEAVEN AND THAT ANYONE WHO LIFTS A HAND AGAINST IT IS A COMMON SCOLD.

MY REASON FOR BEING HERE TODAY IS TO TESTIFY THAT THE GREAT NUMBER OF UNANSWERED QUESTIONS RELATED TO THE TROJAN PROJECT MORE THAN JUSTIFY A STUDY DELAY IN GRANTING OF A PERMIT BY YOUR COMMISSION, AND THAT THIS DELAY SHOULD BE NOT LESS THAN ONE YEAR.

THE ENVIRONMENTAL QUALITY ASPECTS ARE AND WILL BE COVERED HERE TODAY BY OTHERS, AND THEY ARE VERY SERIOUS, NOT TO SAY DEADLY SERIOUS. MY OWN TESTIMONY HAS TO DO WITH SOMETHING MORE PROSAIC : BRIEFLY, WHETHER THE ENGINEERING AND ECONOMIC OUTLOOK FOR TROJAN JUSTIFIES ANY POTENTIAL PERMANENT CHANGES IN THE LOWER COLUMBIA RIVER COUNTRY.

QUOTING DIRECTLY FROM THE ATOMIC ENERGY COMMISSION BOOKLET TID-8200, TITLED "NUCLEAR REACTORS BUILT IN THE UNITED STATES AS OF JUNE 30, 1970" ONE FINDS UNDER THE CATEGORY OF "POWER REACTORS, CENTRAL STATION ELECTRIC POWER" THAT 21 SUCH CENTRAL STATIONS HAD GONE ON STREAM PREVIOUS TO JUNE 30TH OF THIS YEAR. ACCORDING TO THE BOOKLET, SIX OF THESE 21 POWER STATIONS HAVE BEEN SHUT DOWN OR DISMANTLED. ACCORDING TO A SUPPLEMENT ONE OF THE REMAINING 15, ( BUILT AT A COST OF 123 MILLION DOLLARS ), HAS NOT PRODUCED A KILOWATT SINCE 1966, AND ANOTHER OF THE FIFTEEN, IN LA CROSSE, WISCONSIN, IS ABOUT TO

BE PERMANENTLY SHUT DOWN. USING THE FIGURE OF 6 OUT OF 21 DOWN AND OUT, HOWEVER, WE COME UP WITH A BATTING AVERAGE OF POINT SEVEN ONE FOUR. PORTLAND GENERAL ELECTRIC'S ECONOMIC JUDGEMENT CAN SURELY BE FAULTED AS THEY CONSIDER THEIR PROPOSED 230 MILLION DOLLAR INVESTMENT.

THE REBUTTAL TO THIS TESTIMONY AT THE RECENT ST. HELENS HEARING WAS THAT THE SHUT DOWN CENTRAL STATION ELECTRIC POWER PLANTS WERE SMALL, EXPERIMENTAL OPERATIONS. YET PLEASE NOTE THAT THEY WERE ORDERED IN GOOD FAITH BY FIRMS WHO THOUGHT THEY WERE TO OBTAIN AN ENDLESS SOURCE OF KILOWATTS AND NOT EXPERIMENTAL DATA. THIS SAME BOOKLET HAS A LISTING FOR "EXPERIMENTAL POWER SYSTEMS" AND HERE THE BATTING AVERAGE IS 3 UP, 21 DOWN, AVERAGE POINT ONE TWO FIVE. I HAVE RECENTLY TALKED WITH PEOPLE IN MINNESOTA WHO WERE ASSURED THAT THE EXPERIMENTS WERE DEFINITELY AT AN END WHEN THEIR ELK RIVER PLANT WAS TO BE BUILT. THE BUDGET EXPENDITURES DURING CALENDAR 1970 TO PERMANENTLY CLOSE DOWN THE ELK RIVER PLANT IN THAT STATE ARE BETWEEN TWO AND FOUR MILLION DOLLARS AND THEY WILL NOT FINISH THIS YEAR.

PGE AND THE AEC RATE TROJAN AS SLIGHTLY OVER 1.1 MILLION KILOWATT CAPACITY. PRESUMABLY THE PLANT MUST PRODUCE SOMEWHERE NEAR THIS AMOUNT OF POWER TO AMORTIZE THE 230 MILLION DOLLAR INVESTMENT. THE PROSPECTS FOR THIS ARE NOT GOOD IF THE TWO NEARBY NUCLEAR POWER PLANTS ARE ANY CRITERION. I REFER TO HUMBOLDT BAY UNIT #3 OF THE PACIFIC GAS AND ELECTRIC COMPANY AND THE HANFORD "N" REACTOR OF WASHINGTON PUBLIC POWER SYSTEM. BOTH WENT "ON STREAM" IN THE YEAR 1963. YET IN 1969, SIX YEARS AFTER THE FIRST REACTION, NEITHER OF THESE PLANTS WAS ABLE TO REACH 53% OF RATED, NAMEPLATE CAPACITY.

GENTLEMEN OF THE COMMISSION, MY POINT HERE IS THAT THE VERY GREAT ENGINEERING AND ECONOMIC DIFFICULTIES INHERENT IN THIS TROJAN PROJECT DO NOT - AT THIS TIME - JUSTIFY THE ENVIRONMENTAL RISKS INVOLVED. IN THE CASE OF LAST WEEK'S 100 MILLION DOLLAR WASHOUT IN SPACE, OR SUCH ITEMS AS THE TACOMA NARROWS BRIDGE OR THE JOHN DAY BRIDGE, THE KEY WORDS WERE "BACK TO THE DRAWING BOARDS". IN THE CASE OF A CLOSED DOWN OR IMPROPERLY BUILT NUCLEAR POWER PLANT, HOWEVER, THE SITUATION IS A GOOD DEAL DIFFERENT. THE IMMEDIATE AREA IS CONTAMINATED FOR WELL OVER A THOUSAND YEARS AND SERIOUS LEAKAGE - NOT UNKNOWN IN THE SIX PLANTS MENTIONED EARLIER - IS A MAJOR AND CONTINUING CALAMITY.

I RESPECTFULLY REQUEST THAT THIS COMMISSION, WHICH QUITE LITERALLY HAS THE FATE OF NORTHWEST OREGON IN ITS HANDS, DELAY APPROVAL OF THE TROJAN PROJECT FOR AT LEAST ONE YEAR.

THANK YOU FOR YOUR ATTENTION.

#

June 28, 1970

B1.

Governor's Task Force
Nuclear Generating Plant - Trojan
Old Court House
St. Helen's Oregon

Gentlemen:

I have followed the nuclear generating plant controversy, reviewed PGE's Preliminary Safety Analysis Report to the AEC, read several articles concerning nuclear powered generating plants, and have discussed this issue with several people I consider informed, intelligent, and concerned people. I am not an "expert" in "Nukes" but just a concerned citizen that would like to submit the following based on what I know and what I don't know.

1. PGE is to be commended for their efforts to avoid the calefaction of the Columbia River. The additional expense of the cooling tower, in lieu of once through cooling, is justified to accomplish this. PGE has also done an excellent job in complying with the AEC regulations.
2. Some of the eventual effects of a nuclear plant on our environment and society are indeterminent and therefor the AEC minimum standards and regulations do not account for them.
   a.) The potential amount of fresh water needed nationwide to cool these plants raises the serious question whether this is a reasonable liability to assume for the total benefit received.
   b.) The amount of radioactive wastes that have to be stored and maintained by our great great grandchildren as a result of the electricity we use today may not be a reasonable liability for them to have to assume relative to the benefit we receive. Comparative costs of storing these wastes should be made with the costs of "cleaning" other sources of energy to produce electricity. (see no. 3 below)
   c.) Measure the effect on our local climate and the possible hazards to adjacent roads due to impaired visibility and surface icing due to the 16 to 24 million gallons of water evaporated through the cooling tower daily.
3. Consider synergetic uses of our reources as an alternate to nuclear generating plants for electrical generation. That is, solve more than one problem at a time.
   For example: what is the social cost-to-benefit analysis of burning our solid wastes ( using garbage as a regenerative source of fuel,) to produce heat to generate electricity, use the extra heat to heat buildings, irrigate crops, etc.
   ( The Department of the Interior has found they can extract enough oil out of a ton of garbage to incinerate that same ton of garbage!) Further synergetic efficiency might be realized in coastal areas by using this wasted heat for desalinization of sea water. These garbage burning electric

generating plants could be right in metropolitan areas and thus save the costs of lengthy transmission lines inherent in remote generating plants.

4. Consider the potential effect on our survival by the possible extinction of wildlife in and over our rivers and oceans through a pollution of the food chain from radioactive wastes in the air and water. While these emissions are low enough to be of no harm to man directly the food chain prinicple concentrates the radioactivity to cause death and sterilization of entire species of fish and birds that may someday be vital to our existence.

Since the effects of most of these wastes and inefficient use of resources will not be reaized in our lifetime it is easy to ignore or minimize them to justify raising the standard of living through increased per capita consumption of electricity. I suggest that we not succumb to this "static reflexing" rationalization and no approval be given to the Trojan plant until these kinds of questions have been answered. My questions only scratch the surface and I am sure many more will be raised which suggest a four year moratorium on nuclear plant construction , similar to that voted upon recently in Eugene Oregon, is in order. I recognize that EWEB is a municipal organization and subject to a vote of the people so I can only prevail on the conscienoe and integrity of the indiviuals in the PGE private corporation who ultimately make the decisions on this facility which will have immense and irreversible effect on our environment.

I make this moratorium recommendation with the knowledge that several knowledgable scientists and AEC personnel, including Dr. Teller of atom bomb fame, have expressed similar views. I feel it is unsafe, unfair, and unwise to make a decision approving this facility when there isn't agreement within the AEC on the irreversible effects of these plants.

The people who are to make these decisions regarding the use of our resources are in the enviable position of being able to demonstrate the forsight we wish we had before we decided to misuse other resources industrially only because we were ignorant of their accumulative effect on our environment.

We are at the threshold again and I respectfully submit this letter hoping that this time we have the forsight to research, understand, and predict accurately the effects of nuclear power generating plants on our environment and ultimately our survival.

Sincerely yours,

Nick Steffanoff

Nick Steffanoff
Architect and Planner
3439 N. E. Alameda Drive.
Portland Oregon 97212

WENDELL WYATT
FIRST DISTRICT
OREGON

HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515

APPROPRIATIONS
COMMITTEE

# Congress of the United States
## House of Representatives
### Washington, D.C. 20515

July 8, 1970

Mr. Nick Steffanoff
Architect and Planner
3439 N.E. Alameda Drive
Portland, Oregon 97212

Dear Mr. Steffanoff:

Many thanks for furnishing me with a copy of your letter dated June 28 to the Governor's Task Force with respect to the proposed Trojan nuclear generating plant.

I am very glad indeed to have the benefit of the views you expressed to the Governor's Task Force and you can be certain I shall continue to follow this matter with great care and interest.

With best wishes,

Sincerely yours,

WENDELL WYATT
Member of Congress

WW/t

EDITH GREEN
3D DISTRICT, OREGON

COMMITTEE:
EDUCATION AND LABOR

# Congress of the United States
## House of Representatives
### Washington, D.C. 20515

RICHARD E. FEENEY
ADMINISTRATIVE ASSISTANT
WASHINGTON OFFICE
PHONE: 225-4811

STAN SWAN
SPECIAL ASSISTANT
PORTLAND OFFICE
PHONE: 226-3361
EXT. 1028

July 13, 1970

Nick Steffanoff
Architect and Planner
3439 N.E. Alameda Drive
Portland, Oregon 97212

Dear Mr. Steffanoff:

Thank you for the courtesy of providing me a copy of your searching and knowledgeable letter of June 28 concerning nuclear generator plants directed primarily to the Governor's Task Force.

Like you, I have many reservations concerning the increase in the number of undertakings to establish new nuclear generating plants and appreciated having the benefit of your insights which, I might add, seem based on long and careful consideration -- and which evidence a technical grasp beyond what you have modestly disclaimed.

Sincerely,

Edith Green

EG:pvn

# United States Senate

COMMITTEE ON PUBLIC WORKS
WASHINGTON, D.C. 20510

July 20, 1970

Mr. Nick Steffanoff
Architect and Planner
3439 N. E. Alameda Drive
Portland, Oregon 97212

Dear Mr. Steffanoff:

Just a note to thank you for your thoughtfulness in sending me a copy of your well presented views to the Governor's Task Force regarding the Trojan Plant.

I think you've done well in making your views known to the Governor's working team.

Cordially,

Bob Packwood

BP/hjc

TOM McCALL
GOVERNOR

OFFICE OF THE GOVERNOR
STATE CAPITOL
SALEM 97310

July 24, 1970

Mr. Nick Steffanoff
3439 N. E. Alameda Drive
Portland, Oregon 97212

Dear Mr. Steffanoff:

I appreciate your concern about the development of nuclear power plants in Oregon. All interested citizens must balance the benefits of increased power against the risk of threatening our quality environment. Nuclear plants have great potential as major sources of clean energy, but we must have complete information on them before we embark on widespread development.

Two special teams are currently working to chart the best course for Oregon. The Nuclear Development Coordinating Committee deals with the broad range of nuclear questions. Its members represent all Oregonians. Simultaneously the heads of ten state agencies are working on the Nuclear Plant Siting Task Force under the direction of Mr. Larry Wilkinson. Together they will make certain that adequate standards are required to meet the special conditions of every potential site.

Hopefully these two groups, with the assistance of concerned citizens like you, will enable those of us in state government to strike an intelligent balance between our power needs and any environmental threats.

Thank you very much for writing.

Sincerely,

Tom McCall

Governor

TM:mcj

PARTICIPATING MEMBERS:
CLATSKANIE
COLUMBIA CITY
PRESCOTT
RAINIER
ST. HELENS
SCAPPOOSE
VERNONIA
PORT OF ST. HELENS
COLUMBIA COUNTY

# COLUMBIA COUNTY ORGANIZATION OF GOVERNMENTS

COLUMBIA COUNTY COURTHOUSE ROOM 308
ST. HELENS, OREGON 97051
PHONE 397-0466

B2.

November 18, 1970

The Columbia County Organization of Governments was created to provide the various local governments of Columbia County with a facility through which they could work cooperatively. The membership includes the cities of Clatskanie, Columbia City, Prescott, Rainier, St. Helens, Scappoose, and Vernonia, and the Port of St. Helens and the County of Columbia.

The planning coordinator for the organization contacted each representative and requested that the representative poll his respective council. This was done and the information returned to the coordinator. The last reports were received Wednesday, November 18, 1970. The city councils and governing bodies of the members of the Columbia County Organization of Governments indicated that these people were in favor of the proposed Nuclear Plant at Trojan.

At the June 18, 1970, Columbia County Organization of Governments meeting, the Trojan Plant site was discussed. The minutes of that meeting state that Mayor M. E. McMichael questioned whether anyone had any reason why the plant should not be constructed. No objections were stated.

During the Nuclear Plant Siting Task Force hearing held in St. Helens, July 2, 1970, I made a statement as a representative of not only the City of St. Helens, but also the Columbia County Organization of Governments. In this statement, I said that we covered the area under Section D land use, water use, air use, health and safety, and natural resources. This statement concluded with, and I quote from the record, "We represent Columbia County and I believe Columbia County is going to move forward more and faster after the Trojan project get the go ahead", unquote. Thank you for this opportunity.

M E McMichael

RESOLUTION NO. 573

B3.

WHEREAS, there is to be a public hearing on Thursday, November 19, 1970, at Columbia County Fair Grounds on the Application for Construction Permits In the Matter of PORTLAND GENERAL ELECTRIC COMPANY, THE CITY OF EUGENE, OREGON, OREGON PACIFIC POWER AND LIGHT COMPANY (Trojan Nuclear Plant) Docket No. 50-344, by the ATOMIC ENERGY COMMISSION OF THE UNITED STATES OF AMERICA; and

WHEREAS, it is to be determined at said public hearing whether or not the construction of said proposed plant and the operation thereof is in the best interests of the national defense and to the health and safety of the public; and

WHEREAS, the Common Council of the City of St. Helens has determined that the construction and operation of said plant is in the national interest and not inimical to the health and safety of the public; and

WHEREAS, the Common Council desires to express its approval and endorsement of said plant and to recommend that the permits therefor be granted; NOW, THEREFORE,

BE IT RESOLVED that the Common Council of the City of St. Helens make known its decision and desires to the Atomic Energy Commission and by this Resolution declares that said City petitions that said permits be granted and that the construction and operation of said nuclear plant be made in the interest of the national safety and defense and the interest and general welfare of the City of St. Helens; and be it further

RESOLVED that the Mayor be authorized and directed to appear and represent the City of St. Helens at said public hearing; and be it further

RESOLVED that copies of this Resolution be mailed by the Recorder to the ATOMIC ENERGY COMMISSION and that copies thereof be furnished to the press.

Passed and adopted by the Common Council on this 17th day of November, 1970, by the following vote:

Ayes Zaucker, Norwood, Shadley, Paulson, McMichael Nays None Absent None

M E McMichael
Mayor

Attest:

L N Mickelson
City Recorder

B4.

BEFORE THE BOARD OF COMMISSIONERS

FOR COLUMBIA COUNTY, OREGON

| | | |
|---|---|---|
| IN THE MATTER OF | ) | |
| | ) | |
| PORTLAND GENERAL ELECTRIC COMPANY | ) | Docket No. 50-344 |
| THE CITY OF EUGENE, OREGON | ) | |
| PACIFIC POWER AND LIGHT COMPANY | ) | |
| | ) | |
| (Trojan Nuclear Plant) | ) | |

RESOLUTION

WHEREAS, the Portland General Electric Company and others are seeking necessary permits to construct a nuclear electric generating plant within Columbia County, and

WHEREAS, the committee is concerned in determining, from testimony, whether or not such plant and the operation thereof will be inimical to the common defense and security or to the health and safety of the public, and

WHEREAS the Board of Commissioners for Columbia County have reviewed data pertaining to the planning and specifications for construction of the Trojan plant, now therefore it is hereby

RESOLVED that it is the opinion of the Board of Commissioners for Columbia County that the Trojan plant will not be inimical to the common defense and security or to the health and safety of the public.

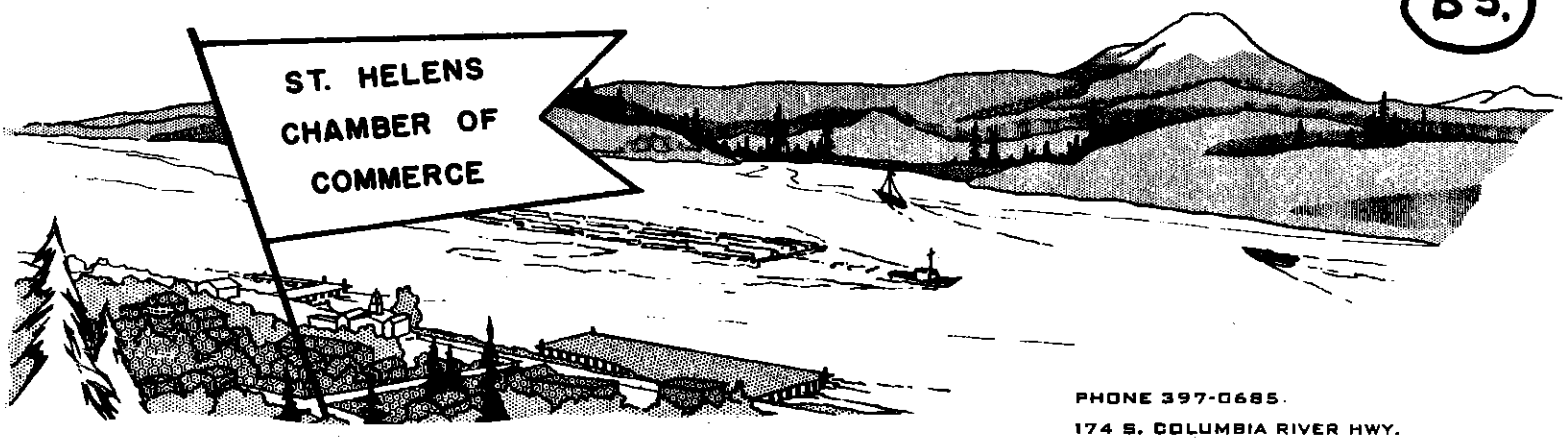
Dated at St. Helens, Oregon this 4th day of November, 1970.

BOARD OF COUNTY COMMISSIONERS
FOR COLUMBIA COUNTY, OREGON

J. W. Barnes
Chairman

Robert L. Gloeyer
Commissioner

Dale Dimbsoff
Commissioner




85.

PHONE 397-0685
174 S. COLUMBIA RIVER HWY.
ST. HELENS, OREGON

December 4, 1970

Chairman
State Department of Environmental Quality Control
Room 36
State Office Building
Portland, Oregon

Gentlemen:

The man who fishes in Columbia County on Sunday must have a place to work on Monday.

This is the basic premise of our endorsement of the plans to construct the Trojan nuclear power plant in Columbia County.

We, of the St. Helens Chamber of Commerce, have previously gone on record with the State of Oregon in support of the selection of the Prescott area of Columbia County as the site for Oregon's first nuclear power plant. We reaffirm this position today.

Our concerns as a Chamber of Commerce have gone far beyond the economic impact of the construction of such a plant.

We certainly realize and appreciate the fact that the dollar value of the Trojan plant equals the assessed valuation of all Columbia County.

We are well aware that 60 permanent employees will be a boon to our economy over the years.

We are cognizant of the fact that the tourist attraction of the nuclear plant will be great, and we will benefit from this.

But at the same time, we are not the type organization which would be willing to accept all these benefits if we felt a monster was being created within our county.

This is why our organization has studied plans for the Trojan nuclear plant. We have attended hearings, read reports, invited knowledgeable speakers to address us on the subject, asked questions, and compiled information before ever making a decision about Trojan.

With all this completed and our data carefully considered, we were satisfied that Portland General Electric, Pacific Power and Light and the Eugene Water and Electric Board had made provisions in their planning to protect the environment of our county.

We are satisfied that the construction of the Trojan nuclear power plant would not be a hindrance to the environment and ecology, but rather would be a benefit.

We will offer the fact that by 1976, five paper mills in the Willamette Valley alone will require 330,400,000 kilowatt hours of electricity for pollution abatement.

There are still cities without primary sewage treatment facilities. There are cities, like St. Helens, currently building secondary sewage treatment facilities. These pollution abatement systems require thousands of kilowatt hours of electricity for screening, filtering, and clarifying effluent. Electric incinerators, scrap metal and automobile shredders all require electricity in order to assist in the mammoth task of cleaning up and keeping clean our surroundings.

All these requirements come at a time when electricity is seriously deficient in supply, but when our demands on electricity for home and industrial use are increasing daily. And now we must add the requirements for environmental improvement to that existing demand.

For this reason we face a growing requirement for clean, non-polluting power sources. We are convinces that the Trojan nuclear plant is such a source.

We prefer to see plants such as Trojan constructed with serious consideration given to their location and construction requirements, than to come to a day when the lights go out and we find ourselves rushing helter-skelter in the darkness, indiscriminately building plants just to get the lights back on. It takes little imagination to realize that our fragile and life supporting environment could be trampled in such a stampede of panic constructions.

We are realists. We live here. We have heard the opposition to the Trojan plant from people who would not even be living in the same county with the plant.....many not even in the same state.

We want to continue to live here in an area blessed with abundant forests, clean rivers and streams, fishing and boating, and all the pleasures of life as Columbia County's Oregonians have come to know them. We would not take foolish risks with the county which we call our home.

We want to be able to fish on Sunday, and go back to work on Monday.

It is for these reasons that we offer our wholehearted support for the construction of the Trojan nuclear power plant in our county.

Sincerely,

V. P. Phillips, President
St. Helens Chamber of Commerce

VPP:bc

86.

# *Milwaukie Rod and Gun Club*

4224 S.E. View Acres Rd.

Milwaukie, Oregon 97222

December 19, 1970

Dept of Environmental Quality

1400 S.W. 5th Ave.

Portland, Oregon 97201

Dear Sirs:

The Milwaukie Rod & Gun Club is opposed to any further nuclear pollution being poured into the Columbia River as a result of the proposed Trojan Plant.

Yours truly,

Jim Cassidy

Jim Cassidy, Secretary

9833 S.E. 17th Ave
Milwaukie, Oregon
Dec 17, 1970

Dept of Environmental Quality
1400 S.W. Fifth Ave.
Portland Oregon

Dear Sirs,

As Fish Committee Chairman of the Milwaukie Rod and Gun Club I urge you to see that the water used by Troyan Power Plant be returned to the river in as good a quality as when it is taken from the river.

The fish commission has spent over $3,000,000.00 on a new fish ladder at Oregon City falls as well as the money spent on hatcheries on both rivers and we would hate to see one plant jipardize this outlay of fish.

What would Oregon be if our salmon runs were eliminated.

I'm sure you will agree with me that Oregon wouldn't be Oregon as we know it without salmon.

I further urge you and your staff to check the paper mills and other industries to see that they don't return hot water to the river, especially in the summer time when we have normal high temperatures.

Sincerely yours
Gordon L. Davenport
9833 S.E. 17th Ave Milwaukie, Ore.

B8.

*Affiliated with*
COLUMBIA RIVER COUNCIL
OREGON WILDLIFE FEDERATION


P.O. BOX 14371
PORTLAND, OREGON 97214

MEETS 2ND TUESDAY OF EACH MONTH
8:00 P.M. AT THE
PGE SERVICE CENTER- 3700 S.E.17th

December 14, 1970

Dept. of Environmental Quality
State Office Bldg.
1400 S.W. 5th
Portland, Oregon

Re: Trojan Project

Gentlemen:

Western Rod and Reel Club, Inc., a club of over twenty years standing wishes to express that it is against the Trojan Project for the following reasons:

1. Any increase of temperature in surrounding waters would have adverse effects on the natural ecological movement of fish and associated life.
2. If towers are built for cooling the moisture content of the atmosphere would, also, have an unnatural effect.
3. Although, the radiation effect is very minute, it has been shown that any increase in radio active substances can be adverse.
4. Whereas, one such project might not cause any gross effects, future needs show that this would only be one of many, compounding the elements of the first three objections.

Of course, if the above remifications could be eliminated we, as futuristic minded sportsmen, would consider it our duty to back this project and future projects.

With sincere and hopeful consideration,

Western Rod and Reel Club, Inc.

Walt Vollertsen

Walt Vollertsen, President

djc/WV

89.

STATE OF WASHINGTON

# DEPARTMENT OF ECOLOGY

DANIEL J. EVANS
GOVERNOR

JOHN A. BIGGS
DIRECTOR

15345 N. E. 36th Street
Redmond, Washington 98052

December 18, 1970

Mr. Kenneth H. Spies, Director
Oregon Department of Environmental Quality
State Office Building
1400 S. W. 5th Avenue
Portland, Oregon 97201

Dear Mr. Spies:

Further review and consideration of the Portland General Electric Company's proposal for a nuclear power plant on the Lower Columbia River has been undertaken by the State of Washington Department of Ecology, having in mind its integrated responsibilities for the environmental protection of air, water and land resources.

On June 25, 1969, Mr. James P. Behlke, Director of the former Water Pollution Control Commission, transmitted to you his statement of general agreement with the proposed permit conditions with respect to water pollution aspects.

At the hearing of December 4, by the Oregon Environmental Quality Commission Mr. George Hansen, on behalf of the Department of Ecology, referenced for the record the Water Pollution Control Commission endorsement of June 25, 1969, made note of further improvements offered by the company and in particular expressed appreciation that the record would be held open for a subsequent restatement of the position of the Department of Ecology.

At this time the Department of Ecology reaffirms the position of the former Water Pollution Control Commission with respect to the proposed permit conditions as they effect the waters of the Columbia River.

The Department does, however, have a considerable concern about the effects on atmospheric quality as may be influenced by the proposed wet cooling tower. The State of Washington, in developing its guidelines for certification of thermal power plant sites, specifically included the following requirement: "Demonstrate by acceptable research and study the extent to which fogging, misting, icing, obscuration of visibility or plumes would occur as the result of the operation of any proposed off stream cooling facilities." Noting that this will be the first installation of this type in either state we urge that the greatest of care be taken in decisions on cooling facilities to provide positive assurance that these adverse effects will not occur. Both states would be equally affected along the boundary area.

The Department of Ecology is aware of the studies by the NUS Corporation as consultants to the Portland General Electric Company and that your staff has taken their findings into account.

It is the position of the Department of Ecology, however, that the study findings lack the positive assurance desired and that unless more conclusive evidence can be compiled, the most serious consideration should be given to the utilization of dry cooling towers for off stream cooling purposes.

In general we have anticipated the coming of nuclear power as providing clean power from the standpoint of pollution. We believe that the optimum future beneficial use of nuclear power requires the use of the highest and best technology especially at the outset of a new program of this scope and permanency.

I thank you for the opportunity to enter this statement in the public record.

Sincerely,

John A. Biggs
Director

JAB:lf

B10.

December 15, 1970

PORTLAND GENERAL ELECTRIC COMPANY
EFFECT OF TROJAN NUCLEAR PLANT UPON THE ENVIRONMENT

## APPROVAL OF DETAILED PLANS & SPECIFICATIONS

Paragraph 1 of the Waste Discharge Permit issued to PGE for the Trojan Nuclear Plant requires the approval by the Sanitary Authority (now the Department of Environmental Quality) of detailed plans and specifications for air and water quality control facilities before actual construction of the facilities is begun.

PGE has complied strictly with this requirement and will continue to do so.

The plans for a sewage treatment plant were submitted last spring. Comments were received on June 30, 1970, and the necessary changes were made to comply with them.

The detailed plans for the intake structure and the outfall structure were submitted on October 26, 1970, and approval was obtained on November 6, 1970. The design of the intake structure during its development was discussed a number of times with the Federal Fish and Wildlife Service, the Oregon Fish Commission and the Oregon Game Commission. The outfall structure design was prepared with the cooperation of the Federal Water Quality Administration (FWQA) and details were discussed with them at a meeting on September 24, 1970. A preliminary Outfall Study was prepared by PGE and it was reviewed by the FWQA and DEQ. After making changes suggested by these agencies, the final version of the Outfall Study was submitted to DEQ on November 13, 1970.

Cooling tower performance curves were submitted to DEQ on October 26, 1970, and they acknowledged receipt on November 6, 1970. We have just received the detailed design of the tower from the Contractor who will build it and we will furnish a copy of all of the data we have received to DEQ at once.

Design concepts of all other air and water quality control facilities are contained in the Preliminary Safety Analysis Report (PSAR), a copy of which has been furnished to DEQ. Detailed plans and specifications are being prepared and they will be submitted to DEQ when completed.

In our endeavor to comply with the requirement of the Waste Discharge Permit that we keep heat, radioisotope and residual chemical discharge to the river at the lowest practicable level, we have adopted several improved design concepts which have reduced the effects upon the river substantially below those stated in our application for a Permit, submitted over a year and a half ago. A discussion of these improvements and the thermal, radiological,chemical and meteorological effects of the Trojan Plant upon the river and air environment follows.

## DISCHARGE WATER TEMPERATURE

The cooling tower we have selected will be the largest and strongest ever built. The contractor bid two alternative towers, the smaller of which would have handled the cooling job satisfactorily. Under maximum air and river temperature conditions, with the air at 104° F and the river water at 75° F, the blowdown from the larger tower will be about 3.5° F less than that from the smaller tower. The conservative nature of the air and river temperatures should be noted - they probably would occur only once in several decades, if ever. Because of its better performance and capability of reducing the temperature of the blowdown, we elected to buy the larger tower at an additional cost of $750,000. This is part of the $17,000,000 penalty PGE accepted when it changed its plans for condenser cooling from a once-through system to the use of a cooling tower.

We also designed the blowdown system so that we discharge from the cool side of the cooling tower-condenser circulating water system. The common practice is to take this blowdown from the warm side, which is better from the operational viewpoint but less desirable because of its greater environmental effect.

Another change made to reduce the temperature of the water in the discharge pipe was to dilute the blowdown with water pumped directly from the river. Thus under the hottest summer conditions mentioned earlier, 3,650 gpm of blowdown would be diluted with 850 gpm of river water. At other times of the year much more dilution would be effected.

As a result of these beneficial but costly changes, we have been able to reduce the maximum temperature of the water at the point of discharge from the 101° F given in our application for a Waste Discharge Permit to 89.6° F. Under average annual conditions the reduction is from 80° F to 60.1° F. Remember that these temperatures are before diffusion in the river.

The third measure we have taken to reduce the impact of warmed water discharges into the river is to provide a more effective diffusion pipe. We will use one 30-inch diameter pipe, which will have perforations along each side for the last 137 feet of its 300 foot length from shore. This will effect a dilution of 98 to 1 by the time the discharge reaches the surface at slack tide under maximum summer temperature conditions as compared with 9 to 1 in the original design. At slack tide the increase in temperature of the water at the surface of the river immediately above the plume will be not over 0.15° F. The outfall structure has been approved by the FWQA and DEQ.

By making these design improvements we have insured that the effect of the Trojan Nuclear Plant upon the temperature of the river will be negligible.

## RADIOACTIVE DISCHARGES

Revisions to the radioactive waste disposal system design as presented in our Waste Discharge Permit application and estimated amounts of radioactive waste to be discharged by specific radioisotope have been recorded in revisions to the Trojan PSAR, a copy of which has been filed with the DEQ, including all revisions as they were issued.

In our endeavor to provide a radioactive waste management system that will maintain discharges to the environment at the lowest levels practicable, we have made a number of modifications to the system design as presented in our Waste Discharge Permit application. These modifications consist primarily of additional demineralizers, filters, tanks and cross-connections of drains to improve our ability to maintain the cleanliness of auxiliary systems and to be able to drain them to the radioactive waste processing system in the event they become contaminated. These modifications have been recorded in our PSAR and our detailed plans will be submitted to the DEQ for approval as they are completed.

We have not only complied with the regulations with regard to radioisotope discharges, but are designing systems that will keep these discharges to the lowest practicable levels. We have taken extreme care and expended great effort to maximize reusability of material and minimize the release of effluents. However, in designing the systems and assessing both the amounts of effluents and their effects, we do not believe it prudent to take only the most favorable data into account or to attempt to use unproven techniques for handling materials. This we believe would not be a responsible attitude nor in the public interest.

Our radioactive waste management system is currently designed to accomplish the same or greater degree of control over emissions than any nuclear plant at or beyond the same point in its design. We have, however, deliberately chosen to be conservative in our evaluation of the effectiveness of our systems and emissions. Using these ultraconservative assumptions on releases (overestimations of up to a thousand or million times depending on the specific isotope), our discharges are only a fraction of permissible limits and are expected to have no measurable effect on the environment.

Using more optimistic assumptions which we expect will be realized in the operation of the plant, our liquid waste discharge, omitting tritium, will be about 2 millicuries (mci) per year instead of the 4.5 mci estimated in the PSAR. We anticipate that our gaseous discharge will be between one-tenth and one-hundredth of our PSAR estimate of 30,000 ci/year. Also, we expect that our tritium production may be low enough that we will be able to retain substantially all of it in our reactor coolant and refueling water storage systems and allow it to decay there without releasing it to the environment, exactly as is done in a "zero" release system, described below.

## "ZERO" RELEASE

There has been much discussion recently concerning radioactive waste treatment systems called "zero-release" or "mini-release" systems. We have been following these developments and looking into the technical details of what is being proposed. Many of these systems do appear promising to further reduce radioactive emissions. They do not, however, reduce emissions to zero and they are not technically proven systems at this time. No nuclear power plant is now being constructed that will incorporate all of the features that are commonly associated with these new systems. This is not because of cost, but because some of these features are not technically proven. Several utilities are considering these features for plants to begin operation in 1976 to 1978, as this may provide the time to prove their technical practicability. We are also considering the application of some of these features to the Trojan Plant at a later time when they are proven. Thus, we would emphasize that, as the U. S. Public Health Service said in its report on Trojan, ". . . the facility contains the best safety and waste control equipment available at the time the design was selected for control of radioactivity discharges during routine operation as well as for accidents". We are not standing on that basis, however, but as further features become proven, our policy is to incorporate these features where practicable and licensable by the AEC as we have done in our current design.

Even though we expect to hold radioactive emissions to the lowest practicable levels, we will have an extensive Environmental Radiation Monitoring Program to insure that plant radiation releases are being controlled and to provide data on any environmental effects attributable to the Trojan Nuclear Plant.

Information on our radioactive waste management systems and environmental monitoring program has been provided to the DEQ and State Board of Health and discussed with their representatives as it has been developed.

## EFFECT OF RADIOACTIVE LIQUID RELEASES

The PSAR lists 23 radioisotopes of 13 different elements that will be in the liquid discharge from the Trojan Plant. Of these, all but one (tritium) may undergo some degree of reconcentration by various organisms in the river. Thirteen of the radioisotopes will have estimated annual releases of less than two microcuries ($\mu$Ci)*. Expected maximum river concentrations of these are calculated to be so minute ($10^{-17}$ to $10^{-19}$ $\mu$Ci/ml)** that even the most extreme reconcentration known could not conceivably result in detectable hazard to man or the river biota. Four additional radioisotopes have half-lives*** measured in hours. Radiological decay alone will rapidly reduce their concentrations to negligible levels.

* Microcurie - one-millionth of a curie, a measure of radiation.
** Milliliter - one-thousandths of a liter or essentially one cubic centimeter.
*** A half-life is the time during which one-half of a substance's radioactivity is released.

The remaining five radionuclides are subject to reconcentration and they are released in higher concentrations and have half-lives of days to years. These are isotopes of cobalt, iodine, and cesium. Using the highest concentration factors for these elements reported in the literature and the calculated maximum downstream river concentrations of the respective radionuclides, the highest likely radioactive tissue levels in edible aquatic organisms can be determined. Furthermore, one can then easily calculate the human consumption of such organisms required to reach the maximum permissible body burdens or daily intake values set by Federal radioactivity standards. The results of these calculations are instructive in revealing just how insignificant the estimated Trojan releases will be. These are as follows for the isotope of each of these elements which has the greatest radiological effect:

(1) For $Co^{58}$, a person would have to eat 200 million pounds per day of such shellfish or crustacea to equal maximum permissible daily intake.

(2) For $I^{131}$, one would need to consume 2,400 pounds per day of such shellfish continually to reach the maximum permissible level.

(3) For $Cs^{137}$, a total consumption of 950,000 pounds of fish over a period of a few days would be required to reach the maximum permissible body burden.

Estimated tritium releases into the Columbia (4,770 Ci/yr) exceed the total of all other radionuclides. The environmental impact of tritium, however, is greatly reduced due to several factors. It has a very low radioactive decay energy; it is a $\beta$ emitter (a relatively nonpenetrating type of radiation) and it will be released entirely in the form of tritiated water, whose specific activity will be immediately reduced to exceedingly low levels in the river. Most importantly, tritium is not reconcentrated in any aquatic organism. Thus, the tissue tritium concentrations of even chronically exposed aquatic organisms will not exceed those of the water in which they are immersed. Following a similar pattern of calculations as used above it can be shown that a man would need to eat 79 million pounds of fish at predicted river concentrations of tritium to attain a maximum permissible body burden. The impossibility of such an intake should emphasize the low degree of hazard posed by the estimated tritium releases from the Trojan Plant.

Attached hereto as Attachment 1 is a study by Dr. David L. Willis, Ph. D., Oregon State University, on the subject: "An Ecological Evaluation of the Effects of Estimated Radioactive Liquid Effluents from the Trojan Nuclear Reactor."

Based on this study, it is our considered judgment and that of our expert consultants that the estimated liquid effluents from the proposed Trojan reactor will pose no demonstrable hazard to the aquatic organisms of the lower Columbia River or the human population using them commercially or for sport.

## CHEMICAL RELEASES

The major problem encountered in using water from the Columbia in the Trojan Plant stems from the fact that it is not chemically pure when received. The impurities may be grouped as follows: dissolved mineral matter; dissolved gases; turbidity and sediment; organic material, and micro-organisms. Of the dissolved mineral matter, the most abundant are bicarbonates, sulfates and chlorides of calcium, magnesium and sodium. There also are smaller quantities of other chemicals, including chromates and zinc. With respect to dissolved gases, there are carbon dioxide, oxygen, nitrogen, hydrogen sulfide and organic gases such as methane. The balance of materials found in the Columbia are insoluble impurities such as clay, silt, calcium salts, silica, sulfur and iron hydroxides, with trace amounts of organic substances from decaying vegetation.

The principal use of river water in the Trojan Plant is in cooling systems. If no form of chemical treatment were employed whastoever, these cooling systems would become clogged with scale, corrosion deposits, sediment and organic growths due to the previously mentioned natural impurities in the river. The only practicable means of preventing these deposits is to render innocuous their clogging effect by the addition of neutralizing and inhibiting chemicals in sufficient quantities to offset their effect.

Two criteria were used in the selection of chemical additives:

1. The small amounts of materials discharged from the circulating water system as blowdown must not impair the 14 beneficial uses of the river defined by the Standards of Quality for Public Waters of Oregon.

2. The materials must be effective in maintaining the integrity and safe operation of the plant systems and equipment in contact with the circulating water.

The Trojan Plant design incorporates to as great an extent as is practicable the closed system approach. This ensures that the water in the system is reused continuously and, therefore, requires the addition of much smaller quantities of chemical additives. Several other significant design features also reduce the requirements for chemical treatment, namely:

a. Wherever possible, protective coatings are applied to protect against corrosion and erosion.

b. Materials of construction are specifically chosen which resist corrosive attack. Examples of these are (i) the employment of inhibited Admiralty brass for the condenser tubes; (ii) the use of cement-asbestos cooling tower packing material, and (iii) the use of copper alloys for heat exchanger tubes.

c. Duplication of equipment permits maintenance of one set while the plant is in operation on the duplicate set. This permits cleaning of heat exchangers by manual methods instead of by chemicals.

d. Equipment is designed to ensure no contamination of the pumped fluids. For example, pump bearings in contact with the cooling water are water-lubricated to avoid contaminants such as oil and grease.

Evaporation in the cooling tower causes concentration in the cooling tower basin of undissolved contaminants derived from the river makeup water. Therefore it is necessary to periodically clean out the sludge in the cooling tower basin and dispose of it in solid form. This reduces by a small amount the quantity of contaminants in the river.

We are currently engaged in a detailed sampling program of the Columbia River water in order to establish the most appropriate and least harmful method of water quality control in our plant systems. This program, with the assistance of our expert consultants, should enable us to achieve the most acceptable forms of control compatible with the desire to minimize its effect on the environs.

For preliminary design purposes, however, and in order to provide a basis for obtaining our Waste Discharge Permit, estimates were made of the maximum amounts of chemicals we would discharge utilizing a chemical treatment program designed to ensure satisfactory operation of the plant in keeping with limitations established by the State of Oregon.

The several chemical additives that are required for treatment of the circulating water system include: corrosion inhibitors composed principally of blends of zinc, chromium or polyphosphates; chlorine to eliminate biological fouling and sulfuric acid to overcome the scaling properties of the Columbia River water. The quantity of corrosion inhibitors required is so small that they will result in negligible changes in the natural concentrations in the river. Only trace concentrations of chlorine will be discharged. The sulfuric acid injected into the circulating water is used to neutralize alkalinity in the incoming river water, a process which changes the acid to a salt. No sulfuric acid is discharged to the river. When released, the chemical will be in the same form as the naturally occurring sodium-calcium-magnesium sulfates in the river which, in the quantities we are speaking of, are completely harmless. The discharge will be neutral.

Attached is a table listing the chemical residuals which appear in our Waste Discharge Permit with the maximum amounts permitted by the Permit in the discharge to the river. Also listed are the average amounts we actually expect to discharge and the percentage of drinking water standards that the Columbia River will have for each chemical listed above and below Trojan when it is in operation. The last column gives the function performed by each chemical additive.

The amounts in the tabulation are quoted in ppm (parts per million by weight). This means, for instance, the concentration of polyphosphate in our discharge pipe must not exceed 21 pounds for every one million pounds of water released. At this rate, we will be adding

not more than one part of polyphosphate for every 1,500 parts already in the river under average flow conditions - truly insignificant.

The chemicals contained in the blowdown stream as given in the column in the table headed "Maximum" will be further diluted 104 times by the time they reach the surface of the river under the worst conditions of slack tide combined with average atmospheric conditions. It is apparent that the effect of chemicals on the river will be negligible.

Most of the chemicals added to the river by the Trojan Plant are of little or no importance to aquatic life, particularly in the amounts discharged. The phosphates are of some importance in the field of water fertility, although some disagreement exists among experts with respect to their role. In this case the amounts in the river are relatively small, and eutrophication of a receiving water is not involved.

Zinc may play an important role in that it is necessary to aquatic life in small quantities, but may be toxic to salmonids under continuous exposure to concentrations of 0.2 ppm or higher in relatively unbuffered waters. The amounts here are too small to be of any importance even if they were discharged into distilled water. On the contrary, Columbia River water is well buffered, and it is doubtful that even concentrations above 0.5 ppm would be hazardous.

Trace amounts of boron have been shown to be beneficial to many fishes, including salmonids, although it is doubtful that the quantities involved here are sufficient to improve growth conditions if growing fish were present in any numbers in the area, which is also unlikely.

Authorities agree that the concentrations of chromium to be discharged by Trojan are too small to matter. Dr. Donald Buhler, of Oregon State University, who has done a great deal of the research performed to this time involving this element in the Columbia River, has calculated that the discharge expected from Trojan will not be significant with respect to aquatic life.

The other substances are of no significance. All of the discharged chemicals have been used for this purpose in cooling towers and other devices discharging into aquatic environments for a number of years in this country and particularly in England. It is significant that no deleterious effects have been noted.

The Discharge Permit requires that the Trojan Plant discharge should in no way adversely affect the quality of the Columbia River water. Our choice of chemical additives is specifically linked to this requirement, as is the approach employed in the design of the plant systems. We intend to use as small a quantity of chemicals as we can.

If in the future more attractive methods of water treatment applicable to the plant become practicable, we intend to use them. It is our stated policy to include in the plant design those technological advances which are practicable and which would cause the least overall environmental effect of the Trojan Plant.

## COOLING TOWER PLUME

PGE engaged NUS Corporation in 1968 to study: a) the natural occurrence of fog at the Trojan site and the fog potential of the cooling tower, and b) the existing air quality in the vicinity of Trojan and potential interaction of the cooling tower plume with local emissions. Their report covering these subjects, published in January, 1969, has been furnished to all appropriate Federal and State Agencies, as well as numerous educational and research institutions and individuals. It was immediately furnished to DEQ for its use. For a complete understanding of the extent and objectivity of the report, the report itself should be reviewed. Its conclusions, however, can be summarized as follows:

a) There will be no calculable increase of ground level fog or icing from the cooling tower operation. The plume is released 585 feet above the river, and because of its buoyancy and momentum, it will continue to rise and will penetrate the local inversion which normally prevents dissipation of ground fog.

b) Water vapor exists in large quantities in the area under consideration and the minute percentage addition from the cooling tower will not interact to any significant degree with contaminants in the area to cause increased precipitation.

c) The cooling tower plume will consist essentially of pure water vapor and, because of the scrubbing action of the tower, may contain less contaminants that the local atmosphere. It will create a visible vapor plume which will disperse as it is transported downwind. Under no condition can a region-wide semi-permanent cloud cover resulting from the cooling tower operation be anticipated.

Because of the wide-spread interest in this subject, a committee representing the Pollution Control Council of the Pacific Northwest Area independently investigated the matter further. This committee was composed of representatives of the Oregon State Sanitary Authority, the Washington Water Pollution Control Commission, the Washington Office of Air Quality Control and the Federal Water Pollution Control Administration. Representatives of these agencies visited four power plants using cooling towers throughout the country in December, 1968. Their report was published in April, 1969, by the Pollution Control Council of the Pacific Northwest Area. Its conclusions are summarized below:

a) Cooling towers do not contribute to local fogging or icing conditions. No area problems were observed to result from cooling tower operation. In every case this is reported not to be a problem despite heavy natural fogging conditions.

b) Cooling towers do not add significantly to low overcast conditions. Thickening of the overcast is of local extent. No problems or complaints were reported.

c) Direct carryover of entrained water droplets from the towers is effectively controlled by drift eliminators in the towers. Misting from the carryover was not reported to be a problem.

d) The cooling tower plumes will always rise and dissipate. The distance required for dissipation under the worst conditions is reported to be on the order of miles. They will seldom, if ever, touch the ground except, perhaps, when influenced by strong winds.

Note that there was no significant disagreement with the NUS conclusions.

At both the Atomic Safety and Licensing Board hearing in St. Helens and the Environmental Quality Control Commission hearing in Portland, a member of the public referred to a paper titled "Cloud Condensation Nuclei from Industrial Sources and Their Apparent Influence on Precipitation in Washington State" by Hobbs and Radke as an authority for their statements that precipitation would be increased in the vicinity of Trojan. This paper, however, does not relate increased precipitation to water vapor. All references are to cloud condensation nuclei in the form of particulate matter emitted by smokestacks. One of the authors was contacted personally and he confirms that nuclei are the problem, not water vapor. The atmosphere west of the Cascades generally contains large quantities of water vapor and the amount contributed by the cooling tower is relatively very small. The Trojan plume will be singularly free of condensation nuclei because it is evaporated water.

There have been numerous other studies of existing cooling towers conducted by various organizations. In no case that we know of have there been any significant problems reported as resulting from cooling tower operation either in the United States or in Europe, where there are large numbers in use. We conclude that the fears expressed by a few members of the public regarding the cooling tower plume effects are a result of their lack of understanding of research that has been done.

## IMPACT OF TROJAN NUCLEAR PLANT ON COLUMBIA RIVER WATER

| | Permit Limitation** (ppm) | Maximum Expected Concentration*** (ppm) | Percentage of Drinking Water Standards | | Reason For Use |
|---|---|---|---|---|---|
| | | | Above Trojan | Below Trojan | |
| Polyphosphate as $PO_4$ | 21 | 6.7 | 5.998% | 6.000% | Corrosion protection |
| Chlorine | 1.5 | negligible | None | None | Prevention of biological growths (algae and fungii) |
| Sulfate | 824 | 271 | 9.155% | 9.161% | Prevention of scaling |
| Chromate | 14 | 4.6 | 20.000% | 20.369% | Corrosion protection |
| Zinc | 2 | 0.66 | 0.599% | 0.600% | Corrosion protection |
| Orthophosphate as $PO_4$ | 3.9 | 1.28 | negligible | negligible* | pH adjustment and corrosion protection |
| Volatile amines | 0.1 | 0.033 | negligible | negligible* | pH adjustment and corrosion protection |
| Boron | 0.48 | 0.16 | negligible | negligible* | Neutron absorber |
| Sodium | 170 | 56 | negligible | negligible* | Waste neutralization |

* Less than 0.1%

** Oregon State Sanitary Authority Waste Discharge Permit limit at point of discharge to the river.

ppm - parts per million by weight

pH - measure of the acidity-alkalinity of water

*** Resulting from dilution of blowdown with water pumped directly from the river prior to entering the discharge pipe, under average atmospheric temperature and relative humidity conditions.

B 11.

4265 S. W. Chesapeake Avenue
Portland, Oregon 97201
December 7, 1970

Oregon Environmental Quality Commission
Air Quality Control Division
State Office Building
1400 S. W. 5th Avenue
Portland, Oregon

Gentlemen,

Please add this letter to the Trojan Atomic Plant hearing record which was held December 4 in the State Office Building.

The Trojan nulcear power plant should not be allowed to release any radiological emissions either to the water or the air.

Thank you.

Sincerely,

Betty J. Marshall

Betty J. Marshall

B12.

Route #1, Box 642
Scappoose, Oregon

December 10, 1970

Department of Environmental Quality
1400 S. W. 5th Avenue
Portland, Oregon 97201

Gentlemen:

I am the mother of four children and my husband is a member of the International Longshoremen's and Wharehousemen's Union Local 92. We live in Columbia County, approximately 20 miles from Portland General Electric's proposed Trojan Nuclear Power Plant site.

I have been a 4-H Horticulture Leader for nine years and a member of the Scappoose Garden Club (our theme this year is ecology).

I am very concerned about the radiation and environmental effects from this proposed plant. Our natural resources are limited; there is no new frontier. Gentlemen, this is it. After mankind looks at what he has done to his environment, he must take steps of restitution. Is progress really progress when man knowingly degrades his environment?

I feel that the Atomic Energy Commission's safety standards are not strict enough to protect society and the environment from harmful radiation. The State of Oregon should demand stricter regulations on radioactive discharges from nuclear plants than those required by the AEC. Other states are demanding this protection. Why not Oregon?

In addition, more studies are needed on the long-term effects of continual low level emissions of radioactive materials into the environment. We do not need anything further being dumped into the already "hot" Columbia River. "The air, the water and the ground are free gifts to man and no one has the power to portion them out in parcels. Man must drink and breathe and walk and therefore each man has a right to his share of each. " Quote James Fenimore Cooper - 1827.

Gentlemen, of the Environmental Quality Commission, do not let the Almighty $$$ sign get in your way when you are considering issuing a permit to Portland General Electric. We, as concerned citizens, are demanding that further studies be made and that absolutely NO discharge permit be issued now.

Sincerely,

Jerry Donovan

Mrs. Jerry Donovan

B 13.

Ted L. Swensen
5785 S. W. Carman Drive
Lake Oswego, Oregon 97034

Department of Environmental Quality
1400 S. W. Fifth Avenue
Portland, Oregon 97201

Dear Sirs:

The following statement pertains to the Trojan nuclear power plant. I attended the public hearing held December 4, 1970. From this hearing I assume that the Trojan power plant will be constructed. If this assumption is valid, then I propose the consideration of the following, concerning air and water quality.

1. Air Quality

According to your publication, the 1969 Legislative Assembly redefined air pollution to mean "the presence in the outdoor atmosphere of one or more air contaminants, or any combination thereof, in sufficient quantities and of such characteristics and of a duration as are or likely to be injurious to public welfare, to the health of human, plant or animal life or to property or which unreasonably interfere with enjoyment of life and property throughout the state or throughout such area of the state as shall be affected thereby."

I propose this question: How is the DEQ to ascertain the effects of atmospheric emmissions from the Trojan nuclear power plant and their results on human health (which I feel is the least important) and to plant and other animal life?

I would propose an answer: That Portland General Electric (PGE) carry out long range studies (10 years or more) on the flora and fauna of the immediate and surrounding area plus a control area. Data can still be collected to determine the number of different species and population densities.before atmospheric emissions begin. If this is done, then before and after data could be compaired to determine what effect, if any, the Trojan nuclear power plant had on the flora and fauna. This evidence could then be evaluated to support or modify present emission standards.

The public is aroused against power plants because of unknown effects. Since the air is common property is seems PGE would welcome a chance to contribute knowledge to dispell the public fears.

2. Water Quality

I propose the same question: How is the DEQ to ascertain the effects of water emissions from the Trojan nuclear power plant and their results on human health and more important to plant and other animal life?

In resent years there has been much concern that the waste heat being produced and dicharged into rivers, lakes and seas by industrial activities is having a catastrophic effect on the populations of fishes and other organisms. This concern, I feel, is justified; clearly there is an upper limit to the amount of heat that can be introduced into such waters without harmful results.

The Honorable Russel E. Train, Under Secretary of the Interior, made the following statements about heated water: (1)

. . . fish use water temperature as a signal for migration and spawning.

. . . population distribution is related to water temperature.

. . . entire life cycles may be upset by changes in water temperature.

. . . resistance to disease decreases as water temperature is raise.

. . . oxygen content decreases as water temperature is higher.

. . . sensitivity of all aquatic life to toxic substances increases as the water temperature goes up.

. . . value of warm water lowers for drinking, recreational and industrial usage.

What happens to the Columbia river effluent as it enters the Pacific Ocean? Evidence indicates that the Columbia river effluent is superimposed on the oceanic water mass off the Oregon Coast and has been detected as a distict water mass as far south as Brookings, Oregon. The major influence of the Columbia River water on phytoplankton (algae) production appears to be the timing of events rather than gross production (2). Algae are the base of food webs, therefore, a whole shift in invertebrate and vertebrate populations is possible.

The study of the movement of Columbia River water and its nutrients and their mobility through food webs has been made possible by the pollution of the Columbia effluent with zinc 65 ($Zn^{65}$) (3). Let it suffice to say that $Zn^{65}$ reaches the benthic (bottom) community in a short period of time (3,4,5,6)

Because of the above evidence I propse that PGE initiate a long range study of water quality and its effects on aquatic and marine organisms above and below the power site and the Columbia effluent discharge into the Pacific.

The study could entail the continous recording of such data as rate of flow, temperature of surface and subsurface waters, variation in electrical conductivity, oxygen content of water and so forth. Also a study as "practicable" as possible to determine the aquatic flora and fauna of the Columbia.and coastal waters. If and when this is done comparitive data will be available and rational suggestions could be made regarding future development of the Columbia basin and the Oregon Coast.

I am possitive the academic community of the Metropolitan area could carry out such studies. The marine environment could be monitored by the Oregon State Marine Science Center at Newport.

I am convinced that the data collected from such long range studies will be relevant and useful data to support and/or modify present air and water quality controls.

Thank you for your time and consideration of this statement.

Ted L. Iverson

Bibliography: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4. Cross, F. A. 1968 Behavior of certain radionuceotides of a marine benthic amphipod. Unpublished PhD. Thesis, Oregon State University, Corvallis, Oregon.

5. Hebard, J. F. 1966 Distribution of euphausiacea and copepoda off Oregon in relation to oceanographic conditions. Unpublished PhD. Thesis. Oregon State University, Corvallis, Oregon.

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B14.

12-9-70

Mr. Barney McPhillips

Dear Sir,

Let this be a strong NO vote on TROJAN!

Let it be deferred for about 20 years while others find out the grave problems associated with atom power.

We must fight to keep industry ~~off~~ the Columbia River - not let them on and then try to make them clean up after they are firmly established.

Could you please let me know who to write to in Washington (State of)

about the proposed action to get the AEC to clean up their mess at Hanford.

Sincerely,

Lindley D. Carson

210 SE 87

Portland OR 97216

B 15.

SIERRA CLUB
Pacific Northwest Chapter

Columbia Group · 2775 S.W. SHERWOOD DRIVE · PORTLAND, ORE. 97201

8039 N.W. Skyline Blvd.
Portland, Ore. 97229
Dec. 5, 1970

Environmental Quality Commission
1400 S.W. 5th St.
Portland, Oregon

Dear Sirs:

Yesterday our organization testified at your hearing to determine if PGE should be granted a waste discharge permit for the Trojan Atomic Power Plant. We thank you for the opportunity to present our views.

The enclosed statement represents an additional item which we would like to submit for your consideration. While its subject might appear to be out of your jurisdiction, we believe it is of great concern to any body charged with responsibility for the quality of Oregon's environment.

Please include the enclosed as an addition to our testimony of December 4th.

Sincerely Yours,

David H. Corkran

David H. Corkran
Chairman

State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECEIVED
DEC 8 - 1970
OFFICE OF THE DIRECTOR

Addition to the Columbia Group, Sierra Club Statement on the Waste Discharge Permit for the TROJAN ATOMIC POWER PLANT made on December 1, 1970

An additional threat to air and water quality posed by PGE's planned reactor is that of massive lethal radioactive contamination as a result of earthquake damage to the reactor.

Adequate preliminary geologic investigation at the Trojan site might have assured the citizens of this state that such a catastrophe would not occur.

But in fact an adequate geologic investigation was not conducted. We believe this point was established by Professors Benson and Palmer of the Portland State University Geology Department during the recent hearing at St. Helens.

By "adequate investigation" we mean compliance at least with the AEC's own statement on tentative regulatory criteria for nuclear power plants.

We emphasize "at least" since we are aware that a number of states have challenged the adequacy of AEC safety standards. The point is that no geologic investigation which fails to meet at least these standards could be considered adequate.

Thus the following two items are of interest:

(1.) At the recent AEC hearing in St. Helens, during the cross examination of witnesses on Friday Nov. 18, a geologist with the PGE study team said that the team did not consider itself obligated to comply with the AEC criteria.

(2.) And as a matter of fact, the investigation conducted by geologists for PGE did not meet these criteria. To be specific:

On pages 10 and 11 of the Atomic Energy Commission's statement of tentative regulatory criteria (dated March 19, 1969), under the heading "Required Investigations", we read the following:

> The investigation shall include the following:... (3) For faults, fault zones, fault associated monoclinal flexures or similiar geologic structures greater than 1000 feet long, any part of which is within 10 miles of the site, determination of whether these geologic structures are capable of causing surface faulting;....

Now this requirement clearly was not satisfied by the geologic study commissioned by PGE. The PGE study team did geologic mapping only of an area roughly one mile wide along each side of the river at the Trojan site. It did no studies of the bedrock under the river itself.

One glaring omission of this study was lack of careful investigatigation of the obvious fault at the Kelso Interchange on Interstate 5 only 4.7 miles from the Trojan site.

The Columbia Group of the Sierra Club believes that the citizens of this state have the right to reasonable assurance that there will not be earthquake damage to and subsequent massive radioactive contamination from the Trojan plant.

We therefore urge the Environmental Quality Commission to suspend consideration of a discharge permit for the Trojan Plant until careful and responsible geologic investigations have been made.

B16.

# PORTLAND AUDUBON SOCIETY

*A Branch of National Audubon Society*

PHONE 292-6855 5151 NORTHWEST CORNELL ROAD • PORTLAND, OREGON 97210



December 7, 1970

Oregon Environmental Quality Commission
Air Quality Control Division
1400 S. W. 5th Avenue
Portland, Oregon

Gentlemen:

The Portland Audubon Society wishes to enter the enclosed statement in the hearing record regarding the Trojan Atomic Plant held by the Oregon Environmental Quality Commission at the State Office Building on December 4, 1970. This statement was given before the Atomic Energy Commission on November 19, 1970 at St. Helens.

We wish to add a point in the hearing record. The statment on page 2 and 3 of Roland C. Clement, Vice President and Staff Biologist of the 142,000 member National Audubon Society is the position of the National Audubon Society and not just a personal statement.

Thank you.

Sincerely,

Harry B. Nehls by BJM

Harry B. Nehls
President

TESTIMONY PRESENTED BEFORE THE ATOMIC ENERGY COMMISSION AT ST. HELENS, OREGON ON NOVEMBER 19, 1970 ON PORTLAND GENERAL ELECTRIC'S PROPOSED TROJAN NUCLEAR POWER PLANT BY THE PORTLAND AUDUBON SOCIETY.

I am Harry B. Nehls. I am appearing as the official representative of the Portland Audubon Society, 5151 N. W. Cornell Road, Portland.

We want to commend Portland General Electric for their long record of protecting our Oregon environment, their care for our wildlife, our fisheries, and our recreation needs, for their extensive and careful preparation for Oregon's first nuclear power plant, and for their willingness to modify their plans in response to criticisms and suggestions. However, some serious questions remain unanswered.

The Portland Audubon Society recognizes that radiation — solar, medical or atomic — is evidently harmful to living creatures, including Man, and that science has not yet verified any safe level of radiation.

Until generation of electric power from atomic fuel can be accomplished with complete certainty that there will be no leakage of radioactive materials, and no emission into the atmosphere of radioactive gases, which would progressively increase the background radiation for all Oregonians, we respectfully urge that issuance of any construction license be deferred pending definitive research to answer these questions.

In the meantime, we urge that intensive research be applied to determining the long-range effect, on Man and on all biological systems, of increased levels of background radiation, in order to determine if a safe level can be identified, on which future planning for the use of nuclear reactors can be based.

Thank you for the privilege of presenting this statement.

In seeking information regarding nuclear power, the Portland Audubon Society sought the advice of Mr. Roland C. Clement, Vice President and Staff Biologist of the 142,000 member National Audubon Society.

Mr. Clement had just completed an extensive nationwide study of nuclear power plants. We wish to enter Mr. Clement's statement in this hearing records, as follows:

It should be an axiom of wise political policy that when the experts disagree, the citizen, and his representatives in the legislature and the agencies, should defer action. Unfortunately, in the pell-mell rush to develop nuclear power, this bit of wisdom seems to have been forgotten. Instead, all sorts of equivocations are trotted out to justify "action now". The citizen is not only made into an experimental guinea pig for the benefit of the industry, but will of course also pick up the tab when it falls due.

Oregon's projected Trojan Nuclear Power Plant on the Columbia River, near Rainier, illustrates this dilemma in all its complexity and short-sightedness. The safety factor, both from the plant operation side and the long-run effects of low-level radiation on humans and the total environment, is completely unresolved. This uncertainty and outright disagreement has created a furious controversy within the scientific community, as all regular readers of Science know. The observations of British medical science on the radioactivity of various sorts, and the expert testimony of Dr. John Gofman of the Lawrence Radiation Laboratory at Berkeley, California, are being downgraded or discounted by proponents of the Trojan project even though, as the largest plant yet built in the United States, this plant is by its very nature "experimental", and unproven. Our position is not one of opposition to the development of atomic power plants, but a plea for the rule of reason which seems to us to dictate withholding permits to build such plants until several serious unresolved questions are answered to the satisfaction of the community, not merely to the satisfaction of an Atomic Energy Commission which is both advocate and judge, or the satisfaction of industry leaders who have traditionally put profits ahead of environmental quality in deciding for development.

The weak link in current decision making processes, whether in industry or in governmental agencies, is the piecemeal approach to the hazards posed by radiation pollution. Each agency looks at the problem from its own special point of view, and each new plant is considered separately; no one adds up the many present and projected effects to arrive at a rounded determination.

We are told that the Columbia River is already one of the world's radioactive hot spots, "so a little more radioactive or thermal pollution is insignificant." A study of official statements and newspaper reports will reveal this serious shortcoming. For ten years we have been assured that "everything is all right", but now Westinghouse announced (Wall Street Journal, May 6, 1970) that a new nuclear reactor system has been designed to "eliminate the regular discharges of radioactive wastes into the air and water that now accompany nuclear power generating stations." Krypton 85 and tritium, two radioactive gases emitted by these power plants, it is now admitted, must be contained. Will the Trojan plant include this new refinement? And is the new containment technique safe? Unfortunately, the Portland General Electric Company's brochure on the Trojan project, An Oregon First, tells us all about its landscape engineering consultants, but nothing about its geological, seismological or radiological justifications. Geologist Gilbert T. Benson of Lake Oswego has posed several pertinent questions about the structural geology of the Trojan site which the public should be given answers to before construction is allowed to continue. Indeed, the company's current construction schedule, in the absence of an AEC permit, is both arrogant and irresponsible, and compromises review by State officials.

The final, guiding pressure in reaching premature decisions in this area is of course "public demand for power". Almost everyone who has analyzed demand projections considers them unfounded, yet they continue to be made and used. Recently the Joint Committee on Atomic Power of the U. S. Congress circulated a study of nuclear power economics made at their request by Philip Sporn. This report states that the atomic power industry has already placed excessively high orders for generating facilities, and that this overcapacity may be expected to result in inefficiency. Rather than giving the public 4-mill electricity as was promised less than a decade ago, it is expected that electricity will cost 7.4 mills or more in 1975. In 1968, also, the Joint Committee warned that both the nation and the industry were placing undue reliance on atomic power generation, in disregard of the many unresolved technical problems that could be expected to lead to difficulties and production failures. So concerned was the Joint Committee about this problem that in late August it invited the comment of the general public on the question of rationing power rather than allowing pell-mell development. In a letter to the Joint Committee in September, the National Audubon Society urged the Joint Committee to recommend to Congress that, as a first step in bringing hasty development under control, the lower "bloc rate" charges to heavy consumers of electricity be abolished. The aluminum industry, for example, is currently a wasteful consumer of electricity and this leads to the creation of artificial shortages and false projections of demand.

We urge a review of this problem in the broader perspective suggested here so that Oregon's environmental quality shall not be sacrificed to hasty development.

End

Roland C. Clement/23 September 1970/ prepared in cooperation with the Portland Audubon Society.

Daniel Lester
7508 SE 29th Ave.
Portland, Ore. 97202
Dec. 16, 1970

B17.

Environmental Quality Commission
c/o Barney McPhillips
1400 SW 5th Ave.
Portland, Oregon 97201



Dear Sirs,

I write to you as a member of the concerned, informed public, to advise against the issuance of a waste discharge permit to Portland General Electric for their Trojan nuclear power plant.

Within the raging controversy over the effects of low-level radiation on life; submerged under evidence to this effect and evidence to that effect, one fact is clear. The effects of low-level radiation on the ecology of this planet have not yet been sufficiently assessed for the Department of Environmental Quality to allow the construction of a nuclear power plant on the Columbia. The DEQ must make a judgement based on experimental fact. It must be able to assert the validity of that experiment, and the applicability of that fact. Can we realistically weigh the benefits of nuclear power against its risks, when we know little of either? It is clear that the DEQ cannot, with the bulk of information compiled supporting and opposing the Trojan plan, favor either side at this time.

If the DEQ as conceived, is concerned only about the direct, immidiate effects of the Trojan plant on our environment, there is little that can be said that would stop you from issuing a permit. Granted, a week or a year after its construction we will not be indundated in radioactive waste. We will not see electro-process industry spring up the next day. The lower Columbia will not disappear in a mess of high-tension wires, concrete and chimneys overnight. But it will be a beginning-- perhaps the beginning of an end. As if we can turn our heads from the mistakes of other states-- the death of the Hudson in New York, the eternal envelope of smog over Los Angeles, the desecration of once beautiful areas of our nation.

The DEQ should, if it has not already, motivate itself against pollution that affects our mental health and well-being as well as our physical health. The inundation of the Lower Columbia with industry would hardly give us something to be proud of. Our society has already changed its philosophies of beauty. A slab of concrete, with towering walls and unmarred symmetry has begun to replace the grass and trees-- from an economic and aesthetic standpoint. The plant will be "architecturally pleasing," as well as the industry that will grow around it. Truly, I could get this pleasure from a downtown high-rise parking facility.

As the Department of Environmental Quality in our state, representing the environmental interests of the people of Oregon, assuring the people of Oregon that its their region will not succomb to pollution and environmental degradation, can you assure us that the long range plans for, and effects of this plant have been established, and reviewed? I do not believe that you can. I urge you to reject the Trojan proposal, pending further study of the plant's long-range effects.

Sincerely,

Daniel Lester

Daniel Lester

B18.

kpOk RADIO

am fm 1019 S.W. 10TH AVENUE PORTLAND, OREGON 97205 503/227-3484

November 27, 1970
70/71

The following is an editorial representing the opinion of KPOK.

About 400 persons were on hand for the public hearings on the proposed Trojan Nuclear Power Plant to be built at Ranier. Those opposed to the plant cited safety factors and harm to the environment as the reason for their opposition. However, there really hasn't been anything tangible offered that would show the Trojan Plant would be un-safe and harmful to the environment. On the contrary, officials point out that the water to be discharged into the Columbia River would be less than one one-hundredth degrees Fahrenheit...an amount too small to be measured. It's also interesting to note that a leading British Nuclear Official in Portland last week pointed out that fish in waters near nuclear plants in England, appear to be thriving... getting bigger and healthier. But mainly, the argument against the plant is based on fear...fear that something might happen.

This fear would be worth serious re-consideration of the plant if this were to be the first. But there are already numerous nuclear plants in the nation and the world...eight in England... one in Penna., 20 years old. Have there been any accidents? No! The plant is urgently needed to supply the power needs of the Northwest. The hearings are proper and the people opposing the plant are to be commended for their efforts which insures there will be no shortcuts taken which could jeopardize the environment. On the other hand, the public should not be swayed into thinking that some vast gamble is being taken. There is no alternate source of power to meet the needs of this region. Let's not waste too much time in getting the Trojan Plant into operation.

Your contrary opinions are invited. Address your comments to:

R. M. Brown
Editorials
1019 S. W. 10th Avenue
Portland, Oregon 97205

B 19.



Citizens for Safe Power
6284 S.E. Jennings Avenue
Portland, Oregon 97222

December 16, 1970

Chairman
Oregon State Environmental Quality Commission
1400 S.W. 5th Avenue
Portland, Oregon

Dear Sir:

Please include this letter and the enclosed two statements entitled "Failure of Emergency Controls of Trojan Nuclear Reactor To Meet Safety Standards Requirements of Atomic Energy Commission at the Present Time," and "Available Alternatives to the Trojan Nuclear Reactor For Present Development For the Pacific Northwest," with the testimony of Beulah Hand and of Stephen Sellery for Citizens for Safe Power on December 4, 1970 before the Oregon State Environmental Quality Commission.

The "Failure of Emergency Controls" article outlines the fact that the ability of the Emergency Core Cooling System for the proposed Trojan nuclear power plant to control the temperature of the core to acceptable levels in case of an accident has not been proven, and that there is inadequate meterological data to evaluate the radiological consequences from postulated accidents; and that these two conditions do not meet A.E.C. safety requirements at present. Therefore, under ORS-449.765, ORS-449.105, ORS-449.077, and under the conditions of the Waste Discharge Permit issued by the E.Q.C., requiring that emission be at the lowest practicable levels and within A.E.C. standards, The Oregon Environmental Quality Commission has no choice but to refuse the waste discharge permit for the Trojan, or to delay the issuance of the permit until the data required by the A.E.C., providing proof that A.E.C. standards can and will be met, is submitted and approved.

On top of that the "Available Alternatives" article indicates that when existing and authorized water projects on the Columbia and Snake Rivers are completed, electrical power from water will triple in the Northwest, that estimates of future power needs indicate a double to triple of power needs from the present to 1990, and that electrical power from coal in Montana and Idaho is economically practicable. Therefore, practicable alternatives to nuclear power exist and should be utilized. Nuclear power should be kept out of the Northwest until it has proven itself to be safe beyond all reasonable doubt.

For these reasons and for reasons presented at the Oregon State Environmental Quality Commission hearings on December 4, 1970 by ourselves and others, we believe that there should be a four year moratorium on issuance of waste discharge permits to the Trojan Nuclear Power Plant.

Respectfully submitted,

Beulah Hand, by SS

Beulah Hand

Stephen Sellery

Stephen Sellery

for Citizens for Safe Power

# FAILURE OF EMERGENCY CONTROLS OF TROJAN NUCLEAR REACTOR TO MEET SAFETY STANDARDS REQUIREMENTS OFATOMIC ENERGY COMMISSION AT THE PRESENT TIME.

from

Citizens for Safe Power

6223 S.E. Jennings Avenue

Portland, Oregon 97222

Tel. 654-9962

EMERGENCY CONTROLS OF THE TROJAN NUCLEAR REACTOR NOT AT PRESENT MEETING ATOMIC ENERGY COMMISSION SAFETY STANDARD REQUIREMENTS.

Two critically important controls in the design of the Trojan reactor have not yet met AEC's own safety specifications, as defined in the Safety Evaluation of the Atomic Energy Commission (1).

These controls are concerned with:

(a) Ability of the Emergency Core Cooling System (ECCS) to control the temperature of the core to acceptable levels in case of an accident.

(b) Inadequate meteorological data used in evaluating radiological consequences from postulated accidents.

Emergency Core Cooling System. Safety during possible accident requiring use of the Emergency Core Cooling System.

In case of certain accidents the Emergency Core Cooling System (ECCS) will be brought into use.

In the "Safety Evaluation by the Division of Reactor Licensing, U. S. Atomic Energy Commission", Docket No. 50-344, Oct. 19, 1970, it is stated that "Recent results of analyses of Emergency Core Cooling System performance, using a multinode computer code, have raised several questions regarding the thermal hydraulic response of the core during ECCS operation. These concern the ability to predect reliably the thermal response of of a reactor core during blowdown following a large cold-leg break. In view of the questions we will require the applicant to provide additional evidence ---- to verify that the ECCS is

capable of limiting fuel clad temperatures to acceptable levels, and to provide this information as soon as practical -------. In addition to these analyses, research and development programs are being and have been conducted to promote further information on core performance following a loss-of-cooling accident". (1, section 7.1, p. 34)

It is clear, therefor, that it is not yet known how much heat will be produces in the reactor core during ECCS operation, and that the AEC is warning that more preliminary work must be done.

Inadequate Meteorological Data.

In the "Safety Evaluation by the Division of Reactor Licensing, U. S. Atomic Energy Commission", section 3.2, Meteorology, October 19, 1970, it is stated that "It appears that less favorable meteorological conditions may prevail for a significant period of time at the Trojan site" than those assumed by the applicants, Portland General Co., etc., in evaluating the potential short term (less than 2 hours) radiological consequences from postulated accidents, and "for this reason the applicant is now collecting onsite meteorological data".

The Safety Evaluation of AEC further states:

"Sufficient onsite metereological data will be available for the selection of an appropriate atmospheric diffusion model by early 1971. Using these new meteorological data, doses

which might result at the site boundary from postulated accidents will be recalculated. If any of these doses exceed 150 Rem to the thyroid the applicant has agreed to provide additional iodine removal equipment so that calculated thyroid doses would be limited to 150 Rem at the site boundary. The potential offsite doses are discussed further in Section 11 (1).

We have reviewed the applicant's presently operating meteorological measurements program, and have concluded that the proposed program is adequate to provide the meteorological data for establishing operating release limits and the diffusion rates for the postulated accidents"(1, pps. 6-7).

The AEC itself concludes, therefor that at present meteorological data needed for establishing operating release limits and diffusion rates of radiolactive material for postulated accidents to the Trojan is not adequate.

Conclusion.

In at least two important respects, (a) core temperatures under operation of the Emergency Core Cooling System, and (b) meteorological control data, the calculated Trojan conditions do not meet AEC safety requirements at present. Therefor under ORS-449.765, ORS-449.077, ORS-449.105 and under the conditions of the Waste Discharge Permit issued by EQC, requiring that emission be at the lowest practicable levels and within AEC standards, The Oregon Environmental Quality Commission has no choice but to refuse the waste discharge permit

for the Trojan, or to delay the issuance of the permit until the data required by AEC, providing proof that AEC standards can and will be met, is submitted and approved.

(1) Safety Evaluation by the Division Licensing, U. S. Atomic Energy Commission in the Matter of Portland General Electric Company, City of Eugene, Oregon Pacific Power and Light Company, Trojan Nuclear Plant, Dockett no. 50-344, Oct. 19, 1970.

# AVAILABLE ALTERNATIVES TO THE TROJAN NUCLEAR REACTOR FOR PRESENT DEVELOPMENT FOR THE PACIFIC NORTHWEST.

From

Citizens for Safe Power

6284 S. E. Jennings Avenue

Portland, Oregon 97222

Tel. 654-9962

## Alternatives - continued

### Water Power

Comparison of energy requirements and hydro power generation capacity in the Pacific Northwest.

At the Northwest Conference on the Role of Nuclear Energy (Portland, Oregon, Dec. 45, 1969), H.R.Richmond, Administrator of the Bonneville Power Administration, presented data which projects the total estimated power needs in the Pacific Northwest, and the planned capacity of the Federal Columbia River power system up to the year 1990. Under this projection, although residential demand shows a greater than 100% increase, it still is only about 25% of the total requirement, the bulk of which is for industrial expansion.(1) Admittedly, if our philosophy of unbridled expansion, with no regard for our environment continues our prospects are bleak. However, with intelligent planning, using expanded hydro capabilities and coal and resources, we should be able to meet the needs of the Pacific Northwest, without using nuclear energy until and unless the problems concerned with its safe use are solved.

For example, Mr. Richmond points out that when the existing and authorized projects on the Columbia and Snake Rivers are completed, the existing capacity of 8,074 megawatts of power will be expanded to 26,811 megawatts.(1,a) This means that our water power will be tripled. Here in the Northwest dams currently provide 96 % of the electrical power capacity (1, p 14).

Further data by Richmond estimates that by 1990 slightly less than half the total needed power will be water power from the Columbia River system, and half will be thermal power. Peaking

power (increased production at maximum demand hours), however, will consist of 63% water power and 37% thermal power (1,b).

Richmond shows power requirements in 1970 to be just under 100,000 millions of kilowatt hours (KWH) and an increase in total to about 290,000 millions of KWH by 1990. Our projected needs by 1990 are also tripled (1).

We can conclude, therefor, that steady expansion of our water power should be undertaken, together with the use of coal resources within the Northwest, and the importation of coal or the transmission of electric power generated by fossil fuels from the vast low-cost coal deposits in Montana and Idaho.(2) Transmission lines are already available over much of this distance. In this way we can avoid the development of nuclear power in Oregon until it is made safe or until other methods of power production are developed.

The immense monies and effort being directed toward nuclear power research and development should now be diverted to study of how to completely inactivate and render harmless the enormous quantities of lethal radioactive waste material which we have already accumulated in the United States. These man-made materials, which man does not know how to destroy, are more dangerous today to the people of the United States than the threat of atomic war, which with the use of reason man can avert.

Refernances.

(1) Energy Requirements and Hydropower Generation in the Northwest, Richmond, H. R., Administrator Bonneville Power Administration. In Northwest Conference on the Nuclear Role of Energy, Report on the Second Annual Governor's Conference on Conservation, Portland, Oregon, Dec. 4 and 5, 1969. Chart between pps. 17-18, "Electric Power Requirements by Major Consumer Categories."

(1,a) Ibid. Table following p.17, "Federal Columbia River System". General Specifications, Projects Existing, Under Construction and Authorized".

(1.b) Ibid. Figures, pps. 17-18. "Average Firm Energy Resources", "Peak Generating Capacity".

(2) Fossil Fuel as a Source of Energy in the Pacific Northwest. de Luccia, E. R., President Oregon Graduate Research, P. 18. In Northwest Conference on the Nuclear Role of Energy, op. cit.

B20.

# PORT OF ST. HELENS

TO WHOM IT MAY CONCERN:

The Port of St. Helens is a municipal body governed by state statutes. One of the duties with which we are charged is that of industrial development within our port district. The Port of St. Helens boundaries encompass the entire Columbia River waterfront area of Columbia County and approximately six miles inland. This, of course, takes in the Trojan Site owned by Portland General Electric Company.

The Port was pleased to be afforded the opportunity of working with P.G.E. and to assist them in site selection with the hopes that our area would be the one ultimately selected for the construction of the nuclear power plant. As time passed, we were indeed gratified to reach the point where only two sites were continuing under consideration and both of these were within our port district. The Port was responsible for getting the Trojan Powder Company and the Portland General Electric Company officials together and subsequently, the Trojan Site was acquired. The Port owned the other site that was considered and an option was granted to P.G.E. and studies were conducted on both sites but ultimately the Trojan Site was selected.

This is called to your attention to indicate to you that we were actively and earnestly soliciting Portland General Electric Company to establish their nuclear plant within our district. At no time in all of the negotiations did P.G.E. ask us for a single special incentive if they were to establish in our area.

P.G.E. has been doing business within our state since before the turn of the century and they have been the electrical serving agency for the St. Helens area of our Port District since 1925. They are not newcomers

and we know that they have been good citizens in our area and state for many years. It is not surprising to think that P.G.E. would be the first to build a nuclear plant in the Northwest; alter all, they were the first to pioneer the long distance transmission of electricity in the United States. This was done from the Willamette Falls at Oregon City to Portland and took place about 1892.

In addition to the enviable record they have earned in the business community of our state, they have also been a leader in creating things for the enjoyment of citizens from all over the West. There are public facilities throughout the state in the form of picnicing and/or camping areas which they have built for public use and to be enjoyed by all. They have nine parks and camp grounds plus an observatory and picnic area with a viewing gallery at their fish ladder. The Trojan Site will also have public facilities which will include picnic areas, viewpoints, nature trails, boat launching, warm water swimming and a fish rearing pond. The existing lagoon will be preserved and a reflecting lake constructed. The visitors education-information center will attract many to our area and we hope it will become one of the state's largest man-made tourist attractions for people coming to view the plant. The entire plant is designed to be aesthetically pleasing and compatible to the natural river and forest setting. It is not surprising to us that P.G.E. is going to such lengths to provide these extra features for the public--it is merely a continuation of their corporate policy but designed to fit a new location.

We are not knowledgeable in the field of nuclear plant safety but we have investigated enough to know that the history of such plants is excellent and that all necessary precautions will be taken in the design, construction and operation of the plant.

Compared to our geographical area, 676 square miles, our population is small, 28,385 in the county. This does not mean that community services can be lacking throughout the area. Roads, schools, fire protection and other services need to be provided. The investment that P.G.E. is making in the nuclear plant will almost double the assessed valuation of our entire county. P.G.E. will become a full taxpaying partner in our economy and the valuation they add and the taxes they pay will go far toward providing the area with better services at less per capita cost. The permanent employment that the plant will add is relatively small compared to the investment but their people will be well trained and an asset to our area. They will help our business climate.

In the field of industrial development we have realized for some time that we are no longer in an electrical power surplus area. In fact, the opposite is true; we are rapidly becoming a power deficient area. This was more strikingly brought to our attention when we read the annual 1969 report of the United States Department of Interior, Bonneville Power Administration. The power deficit increases yearly until 1974 when the P.G.E. nuclear plant comes on the line and then it drops considerably but still leaves a decided deficit. If we expect to hold our own or grow in the Northwest, we must have more power.

The Port of St. Helens has encouraged P.G.E. to establish this nuclear plant in our district and we welcome them to our area.

PORT OF ST. HELENS

By Lew Winkler

Lew Winkler, Commission Secretary

## PROJECT PLANS

During the month of October, 1970, the following project plans and specifications and/or reports were reviewed by the staff. The disposition of each project is shown, pending ratification by the Environmental Quality Commission.

| Date | Location | Project | Action |
|---|---|---|---|
| Municipal Projects (35) | | | |
| 10-5-70 | Pendleton | Change Order #1 (STP) | Approval |
| 10-6-70 | Cottage Grove | East Main Renewal Project | Prov. approval |
| 10-7-70 | Arlington | Preliminary report | Comments |
| 10-9-70 | Canby | Predesign study | Approved |
| 10-9-70 | Hillsboro | Edwards Meadows Subdivision | Prov. approval |
| 10-9-70 | Sherwood | Lincoln Street district | Prov. approval |
| 10-12-70 | Winston | Park Street sewer | Prov. approval |
| 10-12-70 | Unified Sew. Agency | Hamlin Subd. (Aloha) | Prov. approval |
| 10-13-70 | Lake Oswego | Patton St. interceptor & Latter Day Saints extension | Prov. approval |
| 10-13-70 | Gresham | SE 242nd Dr. & SE Chase Rd. | Prov. approval |
| 10-13-70 | Newberg | Change Order No. 1 to STP | Prov. approval |
| 10-13-70 | Valsetz | System and treatment | Prov. approval |
| 10-15-70 | Riddle | Football field pump station | Prov. approval |
| 10-16-70 | Curry County | Comprehensive report | Approval with comments |
| 10-19-70 | USA (Tigard) | Lang Hill Subdivision | Prov. approval |
| 10-19-70 | Portland | Change Order #1, plant site preparation contract | Approval |
| 10-19-70 | Gresham | Rowe Road san. sewer | Prov. approval |
| 10-19-70 | McMinnville | Change Order #2 to treatment plant | Approval |

PROJECT PLANS (Cont.)

| Date | Location | Project | Action |
|---|---|---|---|
| 10-19-70 | Nyssa | Change Order #1 & #2 to plant contract | Approval |
| 10-19-70 | USA (Aloha) | Jersey Park Subdivision | Prov. approval |
| 10-21-70 | McMinnville | South McMinnville sewerage study | Approved |
| 10-22-70 | Eugene | 5 sewer projects | Prov. approval |
| 10-22-70 | Myrtle Point | Report on sewage treatment requirements | Approved with comments |
| 10-22-70 | USA | Valley Hills Subdivision | Prov. approval |
| 10-22-70 | Lake Oswego | Condo-Lea Subdivision | Prov. approval |
| 10-22-70 | West Linn | Iron Tree Subdivision | Prov. approval |
| 10-23-70 | North Powder | Change Orders #1, 2, & 3 | Approved |
| 10-23-70 | Cedar Hills | Forest Village Patio Develop. | Prov. approval |
| 10-26-70 | Gresham | U.P. Rockwood Industrial Area | Prov. approval |
| 10-26-70 | West Linn | Change Orders 1, 2 & 3, Schedule I. Change Orders 1 & 2, Schedule S | Approved |
| 10-26-70 | Jefferson | Union Street extension | Prov. approval |
| 10-26-70 | Multnomah County | Inverness sewer, Unit #3 | Prov. approval |
| 10-27-70 | Hood River | Indian Creek interceptor, Phase II | Prov. approval |
| 10-28-70 | USA | SW Southview Street extension | Prov. approval |
| 10-29-70 | USA | Four Seasons #7 & Monterey Pk. | Prov. approval |

| Date | Location | Project | Action |
|---|---|---|---|
| Industrial Projects (14) | | | |
| 9-3-70 | Milton-Freewater | Harris Feedlot | Disapproved |
| 9-15-70 | Eugene | J. H. Baxter | Approved |
| 9-23-70 | Sumner | Fred Messerle & Sons Dairy | Approved |
| 9-23-70 | Coos County | Frank Rood Dairy | Approved |
| 9-24-70 | Tillamook | Wayne Barker Dairy | Approved |
| 9-25-70 | Tillamook | Ed Myers Dairy | Approved |
| 10-2-70 | Lane County | Johnson Ranch Co. | Approved |
| 10-13-70 | Tillamook County | MacDonald Dairy | Comments submitted |
| 10-14-70 | Nehalem | Hibbs Dairy | Approved |
| 10-15-70 | Cottage Grove | Weyerhaeuser Co. san. sewer | Prov. approval |
| 10-16-70 | Blachly | Griffith Dairy | Approved |
| 10-19-70 | Yamhill County | Northwest Premium Pork | Approved |
| 10-21-70 | Myrtle Point | Reynolds Feedlot | Approved |
| 10-21-70 | Junction City | Pilney Dairy | Approved |
| Solid Waste Projects (2) | | | |
| 10-16-70 | Klamath County (near Merrill) | Tire disposal site | Prov. approval |
| 10-23-70 | Portland | Black & Veatch engineering report | Comments submitted |

PROJECT PLANS, REPORTS, PROPOSALS

The following project plans or reports were received and processed by the Air Quality Control Division for the month of October 1970:

| Date | Location | Project | Action |
|---|---|---|---|
| 2 | Douglas County | Winston Paving Company<br>Control System | Not approved<br>Modification requested |
| 9 | John Day | G. L. Pine Company<br>Waste Burner | Not approved<br>Insufficient information |
| 9 | Prineville | Coin Millwork<br>Waste Burner | Not approved<br>Modification requested |
| 16 | Brookings | Brookings Plywood<br>Waste Burner & System<br>Schedule | Approved |
| 27 | Sutherlin | L & H Lumber Company<br>Residue Disposal | Conditional approval |

## PROJECT PLANS

During the month of November, 1970, the following project plans and specifications and/or reports were reviewed by the staff. The disposition of each project is shown, pending ratification by the Environmental Quality Commission.

| Date | Location | Project | Action |
|---|---|---|---|
| Municipal Projects (35) | | | |
| 11-2-70 | Roseburg | Fairgrounds system | Prov. approval |
| 11-2-70 | Multnomah Co. (E) | Mt. States Airport Park sewage treatment plant | Prov. approval |
| 11-4-70 | Philomath | Sewage treatment plant modifications | Prov. approval |
| 11-4-70 | East Salem S&D #1 | Satter Drive, N.E. sewer extension | Prov. approval |
| 11-9-70 | Aumsville | Change Order No. 1 | Approved |
| 11-9-70 | Newberg | Oakwood Subdivision | Prov. approval |
| 11-9-70 | Inverness | Hollyview No. 1 | Prov. approval |
| 11-9-70 | Salem | Three sewer project extensions | Prov. approval |
| 11-9-70 | West Linn | Linn's Third Addn. sewer | Prov. approval |
| 11-9-70 | Cannon Beach | Change Order No. 1 | Approved |
| 11-9-70 | Tualatin | Apache Bluff No. 4 | Prov. approval |
| 11-9-70 | Ashland | Sunset Avenue extension | Prov. approval |
| 11-9-70 | Lake Oswego | Shannon View Subdivision | Prov. approval |
| 11-9-70 | Oak Lodge S.D. 2 | Holly Hills No. 2 | Prov. approval |
| 11-9-70 | Portland | Change Order No. 90 | Approved |
| 11-9-70 | Hillsboro | Change Orders #6, 7, 8 & 9 (sewage treatment plant) | Approved |

PROJECT PLANS (Cont.)

| Date | Location | Project | Action |
|---|---|---|---|
| 11-9-70 | Hillsboro | Change Order #1 (Westside interceptor) | Approved |
| 11-9-70 | Parkdale San. Dist. | Change Order No. 3 | Approved |
| 11-9-70 | Medford | Change Orders #6 through 12 (sewage treatment plant) | Approved |
| 11-9-70 | St. Helens | Change Orders #1 and 2 | Approved |
| 11-10-70 | Columbia County | Westport School sewage treatment plant | Prov. approval |
| 11-13-70 | Parkdale San. Dist. | Change Order No. 5 | Approved |
| 11-13-70 | Clackamas County | River Bend Mobile Ranch sewage treatment plant | Prov. approval |
| 11-16-70 | Eugene | River Road-Beltline Area | Prov. approval |
| 11-17-70 | Gresham | Rembold Ridge Subdivision | Prov. approval |
| 11-18-70 | Forest Grove | "B" Street Schedule II and "A" Street Schedule I | Prov. approval |
| 11-19-70 | Beaverton | S.W. Hargis Road | Prov. approval |
| 11-20-70 | Lake Oswego | Berwick Road sewer (L.I.D. #128) | Prov. approval |
| 11-20-70 | Salem | Cannon Street sewer | Prov. approval |
| 11-20-70 | Ka-Nee-Ta | Ka-Nee-Ta No. 2 | Prov. approval |
| 11-20-70 | Vernonia | Louisiana Avenue | Prov. approval |
| 11-20-70 | Tualatin | Tualatin Trailer Park | Prov. approval |
| 11-23-70 | Unified Sew. Agency | Park Knoll Local Improvement District | Prov. approval |
| 11-24-70 | Unified Sew. Agency | Metzger plant modification | Prov. approval |
| 11-27-70 | North Bend | Simpson Heights pump station and interceptor | Prov. approval |

PROJECT PLANS (Cont.)

| Date | Location | Project | Action |
|---|---|---|---|
| **Industrial Projects (2)** | | | |
| 11-2-70 | Milton-Freewater | Harris Feedlot | Approval |
| 11-18-70 | St. Helens | City of St. Helens outfall to Columbia River | Approval |
| **Solid Waste Projects (2)** | | | |
| 11-16-70 | Lake County | Chemical-Waste, Inc. Alkali Lake Disposal Site for metallic chloride wastes | Prov. approval |
| 11-30-70 | Deschutes County | Knott Pit Sanitary Landfill | Prov. approval |

PROJECT PLANS, REPORTS, PROPOSALS

The following project plans or reports were received and processed by the Air Quality Control Division for the month of November 1970:

| Date | Location | Project | Action |
|---|---|---|---|
| 6 | Douglas County | Winston Paving Company Installation of Control Equipment | Conditional Approval |
| 6 | Jackson County | Review of Lausmann Process for Wigwam Waste Burner | Comments Submitted |
| 6 | Klamath County | Control Equipment Compliance Schedule and Plans | Accepted |
| 30 | Deschutes County | Brooks-Willamette Corp. Plans for Baghouse Installation | Approved |
| 30 | Crook County | Hudspeth Pine, Inc. Wigwam Waste Burner | Approved |

BEFORE THE ENVIRONMENTAL QUALITY COMMISSION

OF THE STATE OF OREGON

In the Matter of the Application of the
NORTHWEST ENVIRONMENTAL DEFENSE CENTER

PETITION

TO THE ENVIRONMENTAL QUALITY COMMISSION:

The petitioner seeks the promulgation of rules instituting a program of control over automobile emissions in the Portland metropolitan area in order to preserve and protect the health and safety of our citizens, in order to prevent interference with the reasonable enjoyment of life by persons in the Portland metropolitan area, and in order to preserve, protect and improve the quality of the environment of the State of Oregon and Pacific Northwest.

I

Petitioner, the Northwest Environmental Defense Center, is an interested and affected party and a non-profit corporation formed under the laws of the State of Oregon with the corporate purpose of preserving, protecting and improving the environmental quality of the Pacific Northwest.

II

The Environmental Quality Commission is a commission formed under the laws of the State of Oregon with the responsibility of effectuating the public policy of the State of Oregon

(A) To restore and maintain the quality of the air resources of the state in a condition as free from air pollution as is practicable, consistent with the overall public welfare of the state,

(B) To provide for a coordinated statewide program of air quality control and to allocate between the state and the units of local government responsibility for such control,

(C) To facilitate cooperation among units of local government in establishing and supporting air quality control programs, ORS 449.765, and

(D) To safeguard the air resources of the state by controlling or abating air pollution and preventing new air pollution. ORS 449.770.

III

The Environmental Quality Commission maintains continuous air monitoring equipment at 718 Southwest Burnside Street, Portland, Oregon, but does not maintain any similar equipment elsewhere in the metropolitan Portland area. In air samples taken in 1969, the air sampled at the Southwest Burnside Street location, when averaged over an eight-hour period, was found to contain the below-indicated parts per million of carbon monoxide on the dates indicated:

| | | | |
|---|---|---|---|
| 25 September: | 6.1 | 27 September: | 6.2 |
| 6 October: | 15.37 | 7 October: | 14.87 |
| 9 October: | 11.62 | 10 October: | 9.12 |
| 16 October: | 14.37 | 21 October: | 15.62 |

On each of the above-indicated dates, the Columbia Willamette Air Pollution Authority operated a mobile measuring device within the Portland metropolitan area, principally at the intersection of Southwest Sixth and Alder Streets, Portland, Oregon, and on each of the above-indicated dates, the air sampled, when averaged over an eight-hour period, was found to contain more than 20 parts per million of carbon monoxide.

IV

On 10 November 1969, a letter signed by Mrs. Betty Merten, Bill Luch, and ten other citizens was written to Richard Hatchard, director of the Columbia Willamette Air Pollution Authority, asking for an air pollution alert or other emergency procedure. On 12 November 1969, Hatchard wrote a letter to Mrs. Merten stating that the Columbia Willamette Air Pollution Authority /hereafter CWAPA/ could not establish such a procedure without permission and cooperation from the Department of Environmental Quality and the other two regional authorities. Hatchard stated that efforts in that direction would be initiated. Between that date and 19 June 1970, Mrs. Merten talked with Hatchard on a number of occasions regarding the progress of those efforts; he has indicated to her that the Department of Environmental Quality was slow to take the matter up and that defining an air pollution emergency was difficult.

V

On 20 November 1969, Mrs. Merten testified before the Environmental Quality Commission on behalf of herself, her children, and the citizens of Portland in support of the then-proposed visible emission and carbon monoxide standards. Her testimony, in addition, emphasized the necessity of enforcement procedures if the standards were to be effective. She asked the Commission what it proposed to do to reduce the amount of carbon monoxide on those days when, averaged over an eight-hour period, more than 20 parts per million of carbon monoxide were present in the ambient air. To reduce emissions at their source, Mrs. Merten urged the establishment of an annual automobile inspection program as a pre-requisite to license tag renewal, that the Department of Envoronmental Quality restrict traffic in the City of

Portland as a means of reducing the concentration of carbon monoxide in the ambient air. Mrs. Merten stated to the Commission that under ORS chapter 449 it had the authority to designate existing auto repair shops as state licensing agents to administer an emissions check or specified tune-up, or it had the authority to administer its own emission check. The District Attorney of Multnomah County, George Van Hoomissen, who was also present at the hearing and who also testified, stated that it was clearly the responsibility of the Environmental Quality Commission to control the automobile as a pollution source in the state.

VI

On 23 November 1969, Mrs. Merten wrote a letter to B. A. McPhillips, Chairman of the Environmental Quality Commission, putting in writing the specific recommendations made at the 20 November 1969 hearing. A copy of that letter is attached to this Petition as Exhibit A and incorporated by reference herein.

VII

On 19 December 1969, Mrs. Joe Rand testified on behalf of herself, her children and the citizens of Portland before the Environmental Quality Commission. In her testimony, she stressed the inadequacy of the carbon monoxide standards then being considered for adoption.

VIII

In December 1969, Mrs. Merten wrote another letter to B. A. McPhillips asking why he had not answered her letter of 23 November 1969.

IX

On 4 January 1970, B. A. McPhillips wrote Mrs. Merten that he did not have the time to answer his mail, that the Department of Environmental Quality had not provided him with a staff, and suggested she write Kenneth H. Spies, the Director of the Department of Environmental Quality. A copy of that letter is attached to this Petition as Exhibit B and incorporated by reference herein.

X

Responding to the suggestion of McPhillips, Mrs. Merten wrote more than once to Kenneth H. Spies, the Director of the Department of Environmental Quality. On 12 January 1970, Spies responded in a letter indicating he appreciated her interest and support in the area of air pollution control. A copy of that letter is attached to this Petition as Exhibit C and incorporated by reference herein.

XI

On 23 January 1970, Attorney Keith Tichenor spoke before the Environmental Quality Commission on behalf of a group of approximately 30 citizens present, calling for specific enforcement procedures, such as an automobile inspection program and restriction of traffic, to reduce automobile air pollution, specifically carbon monoxide. Attorney Arnold Silver responded for the Commission, stating that it was not in the power of the Commission to do so; Commission Chairman McPhillips told the citizens to go to the Legislature.

XII

After the 23 January 1970 meeting, Keith Tichenor wrote a letter to the Solicitor General of the State of Oregon, Jacob B. Tanzer, discussing

the powers of the Environmental Quality Commission under ORS chapter 449. On 11 March 1970, Tanzer wrote that he had referred Tichenor's letter to John Osborn in the Portland branch of the Attorney General's Office.

XIII

On 9 February 1970, a delegation of citizens went to Salem, Oregon, to discuss the lack of action by the Department of Environmental Quality and by the Environmental Quality Commission regarding automobile air pollution. They spoke with Kessler Cannon, an assistant to the Governor, who listened to their concerns.

XIV

At a meeting of the Environmental Quality Commission in March 1970, citizens appeared and sought to raise the matter of an air pollution alert procedure, but were unable to have the matter placed on the agenda.

XV

On 31 March 1970, the Department of Environmental Quality adopted sections 24-005 through 24-045 of the Oregon Administrative Rules Compilation, dealing with visible emissions from motor vehicles. A copy of those sections is attached to this petition as Exhibit F and incorporated by reference herein.

XVI

On 24 April 1970, Mrs. Merten telephoned and talked to Mr. Patterson of the Department of Environmental Quality and asked what progress had been made by the Department with the regional authorities to establish an air pollution alert procedure. Mr. Patterson said that the Department and the regional authorities were discussing the matter.

XVII

On 16 July 1970, petitioner, as a result of several months of investigation by its Task Force on Automobile Emissions, wrote a letter to Chairman McPhillips of the Environmental Quality Commission regarding automobile emissions, requesting four specific actions deemed feasible and essential, and offering the petitioner's scientific and legal expertise in drafting and implementing these steps. A copy of that letter is attached to this Petition as Exhibit D and incorporated by reference herein.

XVIII

On 10 August 1970, Director Kenneth H. Spies of the Department of Environmental Quality, having had the 16 July 1970 letter referred to him by Chairman McPhillips, wrote a letter to the petitioner's president, informing him that the Department was concerned about the problems of field burning and that the Commission had adopted standards for controlling visible emissions from motor vehicles. A copy of that letter is attached to this petition as Exhibit E and incorporated by reference herein.

XIX

On 28 September 1970, a delegation of petitioner consisting of its president, Chairman Elizabeth Wieting of petitioner's Task Force on Automobile Emissions, Mrs. Betty Merten, and Dr. Joe Rand went to Salem, Oregon, and discussed with Governor Tom McCall and his assistant, Kessler Cannon, the lack of action by the Department and Commission concerning their responsibility to effectuate the

public policy of this State noted in Paragraph II, above, by establishing effective testing procedures, enforcing visible emission regulations applicable to all motor vehicles, instituting a program of automobile inspection, developing a thorough emission survey system in metropolitan Portland, and establishing an air pollution warning system. The petitioner again offered to make its resources available to assist in any way the fulfillment of these requests. The Governor promised to explore the recommendations with the Department of Environmental Quality and with his assistant, Kessler Cannon. He advised the delegation to call upon him or his assistant, Cannon, at any time for assistance, and promised he would inform Petitioner's president by Friday, 2 October 1970, of action taken.

XX

On 30 September 1970, Dr. John Donnelly, Multnomah County Health Officer, declared a health emergency in the Portland metropolitan area and urged that only necessary automobile driving be undertaken and that those citizens with cardiac or respiratory ailments should avoid the core area of metropolitan Portland.

XXI

On Thursday, 1 October 1970, Petitioner's president telephoned Kessler Cannon and asked what action was being taken. Cannon stated that the matter was under study by the Department of Environmental Quality. At the time of the conversation and during that week, the metropolitan Portland area was again experiencing severe air pollution.

XXII

Earlier, on 23 July 1970, Dr. Joe H. Rand, a member of the Board of Trustees of Petitioner, had issued a Statement of Public Health Hazard Arising from Urban Air Pollution, a copy of which is attached to this Petition as Exhibit G and incorporated by reference herein.

XXIII

On 14 September 1970 in the Senate of the United States of America, Senator Gaylord Nelson spoke on the economics of air pollution and caused to be printed with his remarks an article from the 17 August 1970 issue of U.S. News & World Report which pointed out that automobiles and trucks are the single biggest source of contaminated air, that over 100 million tons of "lethal" carbon monoxide contaminated the nation's air annually and that "/e/ven in small doses it affects reflexes and judgment." Senator Nelson also included as part of his remarks an article from the 21 August 1970 issue of Science magazine by Dr. Lester B. Lave and Eugene P. Seskin of Carnegie-Mellon University of Pittsburgh in which the two scientists directly linked morbidity and mortality from bronchitis to air pollution, established that the incidence of lung cancer in urban dwellers was significantly higher than its incidence in rural dwellers, determined that the incidence rate of nonrespiratory-tract cancers (such as cancer of the stomach, esophagus or bladder) for urban dwellers was also significantly higher, found that there was a similar correlation in the higher incidence of cardiovascular disease because of air pollution, discovered

higher incidence of respiratory disease among people subjected to heavier air pollution, and learned that air pollution was also a major factor in infant mortality and total mortality rates. The remarks of Senator Nelson and the two articles he caused to be printed are attached to this Petition as Exhibit H and incorporated by reference herein. Similar alarm was recently expressed in Congress by Representative Joshua Eilberg on 16 September 1970 (appearing on pages E 8274-8275 of the 17 September 1970 Congressional Record).

XXIV

In Volume 11 Number 3 of Clinical Pharmacology and Therapeutics, Dr. Stephen M. Ayres and Meta E. Buehler of the Department of Medicine, St. Vincent's Hospital and Medical Center of New York, New York, emphasized the variation in average carbon monoxide levels taken from probes in areas remote from traffic and from those in traffic-congested areas. They also noted that even low concentrations of carboxyhemoglobin (resulting from intake of carbon monoxide) can interfere with the higher integrative functions of the central nervous system and can produce significant neural and cardiovascular effects. A copy of their study is attached to this Petition as Exhibit I and incorporated by reference herein.

XXV

In June 1966, Robert M. Brice and Joseph F. Roesler of the Special Projects Unit, Air Quality Section, Laboratory of Engineering and Physical Sciences, Division of Air Pollution, Robert A.

Taft Sanitary Engineering Center, Cincinnati, Ohio, for the Public Health Service of the U. S. Department of Health, Education and Welfare, presented a paper at the Annual Meeting of the Air Pollution Control Association, San Francisco, California, entitled "The Exposure to Carbon Monoxide of Occupants of Vehicles Moving in Heavy Traffic" discussed the result of their research in six cities that demonstrated that carbon monoxide concentrations inside moving vehicles on high-density traffic routes were 1.3 to 6.8 times the corresponding concurrent concentrations measured by instruments at the Continuous Air Monitoring Program station in each city. The study also concluded that hydrocarbon concentrations were similarly significantly higher in traffic than at the CAMP site. A copy of their paper is attached to this Petition as Exhibit J and incorporated by reference herein.

XXVI

In Volume 10, Number 3, of Scientist and Citizen (April, 1968), Dr. Henry A. Schroeder, Professor of Physiology, Dartmouth Medical School and Director of Research, Brattleboro Memorial Hospital, stated in an article entitled "Airborne Metals" that the principal source of airborne lead is tetra-ethyl lead, an anti-knock agent added to gasoline since 1924, and that lead accumulated in lungs and other tissues of human beings has injurious effects. A copy of his article is attached to the Petition as Exhibit K and incorporated by reference herein.

XXVII

As a result of discussions with the Federal Air Quality Control Region 10 officials, the Columbia-Willamette Air Pollution Authority on 16 October 1970 promulgated an emergency alert plan based on the concentration of carbon monoxide in the air over metropolitan Portland. A copy of that emergency alert plan is attached to this Petition as Exhibit L and incorporated by reference herein.

XXVIII

On 9 November 1970, Commissioner Donald E. Clark of Multnomah County, Oregon, wrote a letter to Chairman M. James Gleason of the Multnomah County Board of Commissioners and to Mayor Terry D. Schrunk of the City of Portland, in which he asked that the two governments update their emergency plans to include a contingency plan for the curtailment of all internal combustion vehicular traffic in the metropolitan area at such times as the air quality diminishes to a point of being an immediate health hazard. A copy of that letter is attached to the Petition as Exhibit M and incorporated by reference herein.

XXIX

The Oregon State Legislature has determined the air contaminants emitting from automobiles are a threat to the maintenance and restoration of the quality of air resources of this state, ORS 449.765, 449.770, and likely to be injurious to the public welfare, to the health of human, plant or animal life or to property

or which unreasonably interfere with enjoyment of life and property throughout the state or throughout such area as is affected thereby, ORS 449.760, and the Legislature has vested the Environmental Quality Commission with the responsibility of safeguarding the air resources of this state and preventing new air pollution. ORS 449.770, 449.785.

XXX

To the date of the filing of this petition, no person and/or no state agency, board, commission, department or official have sustained the heavy burden placed upon them by the Legislature of establishing that the present quality of the air in the Portland metropolitan area is not injurious to the public welfare, to the health of human, plant or animal life or to property or which unreasonably interferes with enjoyment of life and property throughout that area.

XXI

WHEREFORE, pursuant to the provisions of ORS 183.390, petitioner prays that the Commission immediately promulgate rules to do each of the following:

A. Adopt rules providing procedure for the consideration, acceptance, modification, or denial of petitions. ORS 183.390.

B. Establish comprehensive testing procedures in the Portland metropolitan area by taking measurements of contaminants at various locations at street levels during peak traffic periods, including the measurement of concentrations inside automobiles

traveling in the core area and on heavily traveled streets and highways. ORS 449.702(1), 449.760(3), 449.781(6), 449.785.

C. Develop forthwith in cooperation with the Columbia-Willamette Air Pollution Authority, the Multnomah County Board of Commissioners, the City of Portland and any other interested governmental body or agency a plan to reroute or exclude traffic from any congested or core area within the Portland metropolitan area when a public health hazard is threatened. Such plan should include the emergency system designed to alert the public promptly of weather conditions that may lead to heavy concentrations of automobile emissions in the atmosphere adopted by the Columbia-Willamette Air Pollution Authority on 16 October 1970. ORS 449.760(3), 449.765, 449.770, 449.781(2), 449.781(5), 449.782, 449.785(1), 483.532(1)(a).

D. Encourage (1) the use of buses and bicycles by the public, (2) the provision for bus express lanes and bicycle lanes on the highways and streets of the Portland metropolitan area, and (3) the requirement that only mass transit or bicycles be used as vehicles in any congested or core area. ORS 449.781(1), 449.781(2).

E. Institute forthwith a program of statewide motor vehicle inspection, establishing standards for minimum allowable air contamination by such vehicles, and abating or preventing the use of such vehicles found to exceed such air purity standards. ORS 449.702, 449.782, 449.785(1).

F. Conduct or cause to be conducted studies and research with respect to the concentrations of lead in the air, and in the

plant and animal life of the State of Oregon, with special emphasis on the concentration of contaminants in roadside life forms and agricultural products, ORS 449.702, 449.781(4), 449.781(6).

G. Institute forthwith a cooperative program for the formulation and execution of plans in conjunction with air pollution control agencies or associations of counties, cities, industries and other persons who severally or jointly are or may be the source of automobile air pollution, for the prevention and abatement of such pollution. ORS 449.765, 449.781(2)

FOR THE NORTHWEST ENVIRONMENTAL DEFENSE CENTER:

Dated this 23rd day of November, 1970.

Respectfully submitted,

Billy L. Williamson
President
Northwest Environmental Defense Center

6028 Reed College Place
Portland, Oregon
November 23, 1969

B. A. McPhillips, Chairman
Herman P. Meierjurgen
George A. McMath
Arnold B. Silver
Kenneth H. Spies
Storrs S. Waterman

Gentlemen:

In my testimony before you November 20 I indicated that Portland's air pollution problem, like that of Los Angeles, results from the unique combination of automotive exhaust and frequent temperature inversions which box the pollutants into an unmoving air mass. These temperature inversions occur in Portland on 83% of our days, and they become dangerous when they come in periods of 2 or more consecutive days. Since we cannot change these meteorological conditions, it is only reasonable that we change the other factor--our cars, trucks, and buses. Between 65-70% of our air pollution comes from these vehicles. We must act now to avoid the fate of L. A., where much plant life no longer grows within its 400 square mile area, where people have died in excess of the normal death rate during extended temperature inversions, and where the problem has become too big to be solved. Must we wait until our problem is too big to tackle, or until people die in Portland from bronchial ashma, emphysema, or pheumonia during a lengthy temperature inversion? We already know that respiratory illnesses are up in Oregon and that the death rate from respiratory illnesses, including lung cancer, is considerably higher in Portland than in the rural areas of our state.

As that appointed body impowered to protect the environment of Oregon, you gentlemen hold the public health and welfare in your hands. It seems clear under ORS 449.800 subdivision (7) that the board can designate auto repair shops, the Department of Motor Vehicles, the State Police, or anyone else as inspection agents. Or, under subdivision (9) the board could hire its own inspection people and under subdivision (10) set up its own inspection stations. An annual or semi-annual CO inspection (similar to New Jersey's) could be a precondition for license tag renewal; driving a vehicle without a certificate of compliance with exhaust standards could be made punishable by fine; failure to bring an auto up to standard within 30 days of violation could be cause for license-tag suspension or pick-up on that auto.

In addition to an effective inspection system, I submit that you gentlemen give careful consideration to the reduction of air pollution through a reduction in the number of automobiles entering our cities. As stated on page 5 of the D.E.Q.'s "Alternative Programs," this is "the only short term alternative that can give any degree of assurance that air quality standards will not be violated in the ear future." Such restrictions, made by your board for the protection

Exhibit A

of the public health and welfare, are valid under the police power of the states notwithstanding the commerce clause of the U. S. Constitution. Likewise, municipal governments can prohibit motor vehicles from public streets: ORS 483.532(a) expressly states that a city or county may prohibit any or all vehicles of any or all types from streets or roads under its jurisdiction.

Not one person with whom I have talked has objected to these two methods of reducing air pollution. The citizens of this state--at least those who reside in Portland and the Willamette Valley--are wanting, pleading, demanding that pollution be eradicated. They are willing to make sacrifices in order to protect their environment, their health, and the health of their children. You need not hesitate to take strong, effective, and immediate steps to curb auto pollution for fear of public disfavor. We all recognize that driving is a privilege, not a right, and that sacrifices will have to be made until such time as the internal combustion engine is either improved on old and new cars alike or take off the market.

Sincerely,

Mrs. Chas. J. Merten

Mrs. Charles J. Merten

B. A. McPHILLIPS
P.O. Box 571
McMinnville, Ore. 97128

1/4/70

Dear Mr. Meeter

Sorry that you have not received a response to your letter of November 20. The state does not provide me with secretarial help unless I make a trip to Portland and avail myself of one of the staff. I receive several letters a day and I am simply not in a position to answer them. Many of them I forward to our office and I thought that I had done this with you. I would suggest that you send a copy of your recommendation to Ken Spies, Director of the E.B.C., and I assume that you will receive a reply.

For your information the members of

Exhibit B

the Commissioners are paid only on a per diem basis, which is $10 a day, we must all of us have other interests, so the time we can spend with the State is somewhat limited.

Very truly yours,

# DEPARTMENT OF ENVIRONMENTAL QUALITY

STATE OFFICE BUILDING • 1400 S.W. 5th AVENUE • PORTLAND, OREGON • 97201



January 12, 1970

Mrs. Charles J. Merten
6028 Reed College Place
Portland, Oregon

Dear Mrs. Merten:

I am sorry to say that your letter of November 23, 1969, was not received in this office until January 7, 1970. However, we appreciate your concern with the problems of automotive air pollution and wish to thank you for taking the time to research several suggested methods.

Our staff is actively investigating various proposed automotive emission control programs to determine those most appropriate for use in Oregon. Currently the enforcement program in Oregon is similar to that used in California. A visual inspection to determine if the pollution control devices are installed and properly operating is made by the Oregon State Police as part of their roadside motor vehicle inspection program.

The inspection program proposed for New Jersey has received national interest. Currently an inspection machine has been installed in one of the 75 state-owned motor vehicle inspection stations. Various vehicles passing through this inspection station are tested for emission levels. As yet, it is not clear when emission testing will become part of New Jersey's vehicle inspection program, however our staff is closely watching the development of this program.

Both short term and long range traffic planning must be considered as a means of reducing air pollution. In adopting ambient air carbon monoxide standards, the board did address itself to this approach. I should also mention that the Environmental Quality Commission and the Department have gone on record in support of the Tri-Metropolitan Transportation District programs for developing a mass transportation network.

Again, thank you very much for your interest and support in this area of air pollution control.

Very truly yours,

Kenneth H. Spies

Kenneth H. Spies, Director
Department of Environmental Quality

Exhibit C

July 16, 1970

Mr. Barney McPhillips, Chairman
Environmental Quality Commission
P. O. Box 571
McMinnville, Oregon 97128

RE: Automobile Emissions

Dear Mr. McPhillips:

The NWEDC Board of Directors met on July 15, 1970, and considered the report of its Task Force on Automobile Emission. As a result, the Board asked that I communicate to you its intention to seek through consultation or litigation, if necessary, the implementation of feasible regulatory techniques designed to eliminate or curb the threat which automobile emission poses to the public health as the primary air pollutant in the state's "metropolitan areas."

The Center, as you may know, brings together lawyers, scientists, educators, and other professionals whose purpose is the assertion of citizen rights to a healthy, safe, ecologically balanced environment. In this regard, the Center seeks to mobilize those with special expertise to secure legislative reform, to embark upon or support litigation aimed at environmental protection, to offer educational activities and to assert the public interest in the environment through conciliation and consultation with governmental agencies. It is the intent of the center membership to embark upon litigation in behalf of the general public in those instances where statutory compliance on the one hand or enforcement on the other are not forthcoming.

Our more immediate attention has focused on automobile emission because of what we have learned

EXHIBIT D

of the magnitude of the threat posed by this pollutant to the public health.

In assessing this source of pollution we have become aware of the inherent technological barriers to its elimination. However, in the interest of diminishing its concentration in our atmosphere, we are persuaded that the immediate implementation of the following steps is both feasible and essential:

1. Establish effective testing procedures - the present assessment program must be expanded to include measurement in various locations at street level during peak traffic periods, to include measurement of concentrations inside automobiles traveling in the core area.

2. Implement visible emission regulations - the visible emission standards should be applied to all vehicles operating on public roads by appropriate state, county and municipal law enforcement agencies; this should include the requirement of fleet maintenance records and assessment of such records, as well as adoption of enforcement practices to be applied to automobile dealers.

3. Institute program of automobile inspection - this program should be implemented either through capital expenditure or by contracting with such agencies or corporations equipped to perform this service; establishment of such a program appears well within the environmental quality commission's statutory authority; such a program has the potential to eliminate 20 to 30 percent of noxious automobile emission.

4. Establish an air pollution warning system - regardless of federal standards which may be established in the future, the EQC should establish forthwith a program designed to alert the public to weather conditions which result in extreme concentrations of automobile emission in the atmosphere thereby causing an inordinant public health hazard; such a system should include arrangements for rerouting or excluding traffic from the core area.

The Northwest Environmental Defense Center Board of Directors stands ready to assist the Commission and its

department in attaining the aforementioned programs. That government and private sectors might combine resources of expertise and manpower in combatting this pollution problem seems highly desirable to us and we hope you will see fit to utilize the Center.

Very truly yours,

Bill L. Williamson
President

BLW/pn

cc: Betty Merten
Beth Wieting
Wm. Hutchison
Dr. Joe Rand

# DEPARTMENT OF ENVIRONMENTAL QUALITY

STATE OFFICE BUILDING • 1400 S.W. 5th AVENUE • PORTLAND, OREGON • 97201

TOM McCALL
GOVERNOR

KENNETH H. SPIES
Director

ENVIRONMENTAL QUALITY COMMISSION

B. A. McPHILLIPS
Chairman, McMinnville

EDWARD C. HARMS, JR.
Springfield

HERMAN P. MEIERJURGEN
Nehalem

STORRS S. WATERMAN
Portland

GEORGE A. McMATH
Portland


August 10, 1970

Mr. Bill L. Williamson, President
Northwest Environmental Defense Center
c/o Box 51, Northwestern School of Law
Lewis and Clark College
0615 Southwest Palatine Hill Road
Portland, Oregon 97219

Dear Mr. Williamson:

Mr. McPhillips has referred to me your letter of July 23, 1970 and the statement furnished by Dr. Joe H. Rand regarding the public health hazard arising from urban air pollution.

The programs and activities of the state and regional air pollution authorities in Oregon recognize and are based on the need to control pollution in our major centers of population. Two examples are the current smoke management programs associated with forest slash and agricultural grass seed field burning.

Because agricultural operations are exempt from the provisions of the state's general statutes pertaining to air quality control and the open burning of fields can therefore not be completely banned, their burning is being closely regulated under a special schedule adopted by the Commission so as to keep the smoke away from the centers of population as effectively as possible.

As the first step in attempting to reduce the pollution caused by automobiles the Environmental Quality Commission in January of this year adopted standards for controlling visible emissions from motor vehicles. This particular problem is under constant surveillance by our staff and thorough consideration is being given to the adoption of whatever additional controls may be needed.

Sincerely,

Kenneth H. Spies

Kenneth H. Spies, Director
Department of Environmental Quality

KHS:vt



Mailing Address: P.O. Box 231, Portland, Oregon 97207 – Telephone: (503) 226-2161

Subdivision 4

Motor Vehicles

VISIBLE EMISSIONS

[ED. NOTE: Unless otherwise specified, sections 24-005 through 24-045 of this chapter of the Oregon Administrative Rules Compilation were adopted by The Department of Environmental Quality March 31, 1970, and filed with the Secretary of State April 7, 1970 as Administrative Order DEQ 8].

24-005 DEFINITIONS. As used in these regulations unless otherwise required by context:

(1) Dealer means any person who is engaged wholly or in part in the business of buying, selling, or exchanging, either outright or on conditional sale, bailment lease, chattel mortgage or otherwise, motor vehicles.

(2) Department means Department of Environmental Quality.

(3) Motor Vehicle means any self-propelled vehicle designed and used for transporting persons or property on a public street or highway.

(4) Motor Vehicle Fleet Operation means ownership, control, or management or any combination thereof by any person of 5 or more motor vehicles.

(5) Opacity means the degree to which transmitted light is obscured, expressed in percent.

(6) Person means any individual, public or private corporation, political subdivision, agency, board, department or bureau of the state, municipality, partnership, association, firm, trust, estate or any other legal entity whatsoever which is recognized by law as the subject of rights and duties.

(7) Regional Authority means a regional air quality control authority established under the provisions of ORS 449.760 to 449.840 and 449.850 to 449.920.

(8) Visible Emissions means those gases or particulates, excluding uncombined water, which separately or in combination are visible upon release to the outdoor atmosphere.

24-010 VISIBLE EMISSIONS - GENERAL REQUIREMENTS, EXCLUSIONS. (1) No person shall operate, drive, or cause or permit to be driven or operated any motor vehicle upon a public street or highway which emits into the atmosphere any visible emission.

(2) Excluded from this section are those motor vehicles:

(a) Powered by compression ignition or diesel cycle engines.

(b) Excluded by written order of the Department by ORS 449.810.

24-015 VISIBLE EMISSION - SPECIAL REQUIREMENTS FOR EXCLUDED MOTOR VEHICLES. No person shall operate, drive, or cause or permit to be driven or operated upon a public street or highway, any motor vehicle excluded from Section 24-010 which:

(1) When operated at an elevation of 3,000 feet or less, emits visible emissions into the atmosphere;

(a) Of an opacity greater than 40%.

(b) Of an opacity of 10% or greater for a period exceeding 7 consecutive seconds.

(2) When operated at an elevation of over 3,000 feet, emits visible emissions into the atmosphere;

(a) Of an opacity greater than 60%.

(b) Of an opacity of 20% or greater for a period exceeding 7 consecutive seconds.

24-020 UNCOMBINED WATER-WATER VAPOR. Where the presence of uncombined water is the only reason for failure of an emission to meet the requirements of Section 24-010 or 24-015, such sections shall not apply.

24-025 MOTOR VEHICLE FLEET OPERATION. (1) The Department may, by written notice, require any motor vehicle fleet operation to certify annually that its motor vehicles are maintained in good working order, and if applicable, in accordance with the motor vehicle manufacturers' specifications and maintenance schedule as may or tend to affect visible emissions. Records pertaining to observations, tests, maintenance and repairs performed to control or reduce visible emissions from individual motor vehicles shall be available for review and inspec-

tion by the Department.

(2) The Department, by written notice, may require any motor vehicle of a motor vehicle fleet operation to be tested for compliance with Sections 24-010 and 24-015 of these regulations.

(3) A regional authority, within its territory, may perform the functions of the Department as set forth in Items 1 and 2, upon written directive of the Department permitting such action.

24-030 DEALER COMPLIANCE. No dealer shall sell, exchange or lease or offer for sale, exchange or lease, any motor vehicle which operates in violation of Sections 24-010 or 24-015 of these regulations, except as permitted by federal regulations.

24-035 METHOD OF MEASUREMENT. (1) The opacity observation for purposes of these regulations shall be made by a person trained as an observer; provided, however, that

(2) The Opacity Chart, marked "Exhibit A", with instructions for use, attached hereto and by reference incorporated into these regulations, may be used in measuring the opacity of emissions for purposes of these regulations.

24-040 ADOPTION OF ALTERNATIVE METHODS OF MEASURING VISIBLE EMISSIONS. (1) The Department may permit the use of alternative methods of measurement to determine compliance with the visible emissions standards in Sections 24-010 and 24-015 of these regulations, when such alternative methods are demonstrated to be reproducible, selective, sensitive, accurate and applicable to a specific program.

(2) Any person desiring to utilize alternative methods of measurement shall submit to the Department such specifications and test data as the Department may require, together with a detailed specific program for utilizing the alternative methods. The Department shall require demonstration of the effectiveness and suitability of the program.

(3) No person shall undertake a program using an alternative method of measurement without having obtained prior written approval of the Department.

24-045 ENFORCEMENT. Any person who drives, operates, or causes or permits to be driven or operated upon a public street or highway a motor vehicle which emits visible emissions into the atmosphere in violation of Section 24-010 or 24-015 of these regulations, shall be ordered to bring the vehicle into conformity with these regulations and to present the vehicle to a police office within 15 days for inspection and verification that the vehicle does conform to these regulations, unless within such time evidence is presented that such vehicle will no longer be operated on a public street or highway. Notice of nonconformity with these regulations may be given on Oregon State Police Form 53 (Inspection Check List), a copy of which is attached hereto, marked "Exhibit B", and by this reference incorporated into these regulations. Any person so ordered who wilfully fails to present the designated vehicle, or evidence that such vehicle shall no longer be operated on a public street or highway, to a police office within the time specified, shall be punished as provided in ORS 449.990 for violations of rules and regulations of the Department.

## EXHIBIT A

## INSTRUCTIONS

The miniature opacity chart available from the Department of Environmental Quality will enable the observer to conveniently grade the opacity of emissions observed.

Opacity means the degree to which transmitted light is obscured, expressed in percent. The opacity may be judged by the degree to which an observer's view is obscured.

The observer's line of observation should be at right angles to the direction of emission travel.

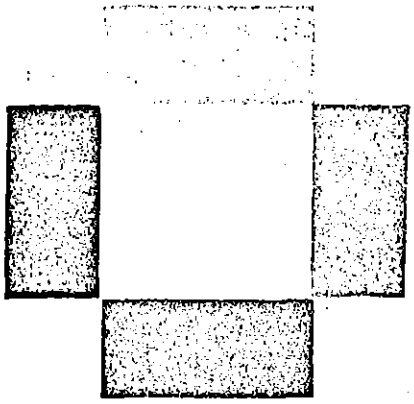
The reading should be made against the same type background for both the emission and the opacity chart.

Any sunlight should be directed from behind the observer. Care should be taken to prevent interfering reflections on the chart.

The emission under observation is sighted through the chart center, and the opacity is recorded using the film shades are standards of 10%, 20%, 40%, and 60% opacity.

Following is a reproduction of the Opacity Chart, Exhibit "A". As the opacity shades of the chart cannot be properly shown on paper, this reproduction is intended for informational purposes only. Due to the cost of the chart, irs distribution is restricted; however, a chart may be viewed at the Secretary of State's Office or at the Department of Environmental Quality Offices. The staff of the Department of Environmental Quality is available for explanation of the use of the chart.

## MOTOR VEHICLE VISIBLE EMISSION REGULATIONS



(From adopted regulations pertaining to visible emissions from motor vehicles)

VISIBLE EMISSIONS, General Requirements, Exclusions:

No person shall operate, drive, or cause or permit to be driven or operated any motor vehicle upon a public street or highway which emits into the atmosphere any visible emission.

Excluded from this section are those motor vehicles:
Powered by compression ignition or diesel cycle engines,
Excluded by written order of the Department by ORS 449.810.

VISIBLE EMISSIONS—Special Requirements for Excluded Motor Vehicles:

No person shall operate, drive, or cause or permit to be driven or operated upon a public street or highway, any motor vehicle excluded from Section II, which:

When operated at an elevation of 3,000 feet or less, emits visible emissions into the atmosphere:
Of an opacity greater than 40%,
Of an opacity of 10% or greater for a period exceeding 7 consecutive seconds.

When operated at an elevation of over 3,000 feet, emits visible emissions into the atmosphere:
Of an opacity greater than 60%,
Of an opacity of 20% or greater for a period exceeding 7 consecutive seconds.

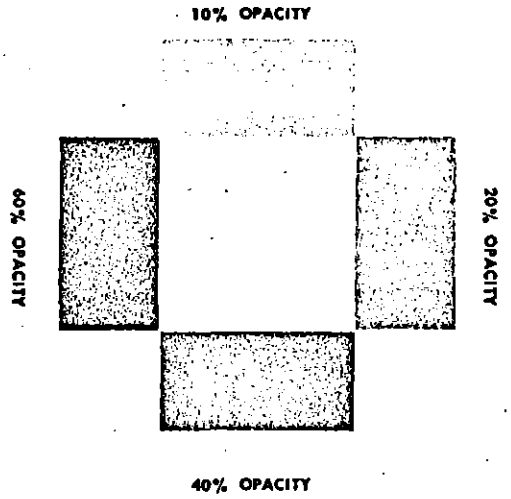
UNCOMBINED WATER—WATER VAPOR:

Where the presence of uncombined water is the only reason for failure of an emission to meet the above requirements, such sections shall not apply.

DEALER COMPLIANCE:

No dealer shall sell, exchange or lease or offer for sale, exchange or lease, any motor vehicle which operates in violation of the above requirements of hese regulations, except as permitted by Federal Regulations.

## EXHIBIT "A" OPACITY CHART




### INSTRUCTIONS

This miniature opacity chart will enable the observer to conveniently grade the opacity of emissions observed.

Opacity means the degree to which transmitted light is obscured, expressed in percent. The opacity may be judged by the degree to which an observer's view is obscured.

The observer's line of observation should be at right angles to the direction of emission travel.

The reading should be made against the same type background for both the emission and the opacity chart.

Any sunlight should be directed from behind the observer. Care should be taken to prevent interfering reflections on the chart.

The emission under observation is sighted through the chart center, and the opacity is recorded using the film shades as standards of 10%, 20%, 40%, and 60% opacity.

DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY CONTROL DIVISION

1400 S. W. 5th Ave.
Portland, Oregon 97201

(Over)

EXHIBIT B

INSPECTION CHECK LIST | LOCATION | DATE | OREGON STATE POLICE

YEAR MODEL | MAKE | VEH. TYPE | DRIVER'S LICENSE NO.

VEHICLE LICENSE NO. | STATE | MILEAGE | STATE | DATE OF BIRTH

REGISTERED OWNER | ADDRESS

NOTICE: Correct any violation checked immediately. Proof of compliance must be submitted to a State Police office within 15 days. I UNDERSTAND THAT FAILURE TO COMPLY MAY RESULT IN COURT ACTION.

DRIVER'S SIGNATURE

X

No. 228 COPY

ADDRESS: LAST, FIRST, MIDDLE; NO. STREET, CITY, STATE, ZIP CODE

Name _____

Res. Address _____

City _____ State _____ Zip Code _____

Officer _____ No. _____

Date Violation Corrected

CHECK LIST (A check below indicates a defect or violation)

| A. DRIVER'S LICENSE | B. REGISTRATION | | C. HORN |
|---|---|---|---|
| 1 NOT IN POSSESSION | 1 NOT IN POSSESSION | 6 DISPLAY PLATE | 1 DEFECTIVE |
| 2 EXPIRED | 2 TAB NOT ATTACHED | 7 PLATE COVERED | 2 INAUDIBLE |
| 3 CHANGE OF ADDRESS | 3 PLATE NOT SECURED | 8 PLATE ILLEGIBLE | 3 NONE |
| 4 RESTRICTIONS | 4 CHANGE OF ADDRESS | 9 EXPIRED | |
| 5 OTHER | 5 PLATE ON WRONG VEHICLE | 10 TRANSFER DUE | |

| D. WIPERS | E. MIRRORS | F. GLASS | G. EXHAUST |
|---|---|---|---|
| 1 INOPERATIVE | 1 NONE | 1 DEFECTIVE | 1 EXCESS NOISE |
| 2 DEFECTIVE BLADES | 2 INADEQUATE | 2 VISION OBSCURED | 2 MODIFIED, ETC. |
| | | 3 UNAPPROVED | 3 EXCESS SMOKE |
| | | | 4 LEAKY |

| H. LIGHTS | | | I. TIRES/WHEELS |
|---|---|---|---|
| 1 HEAD LAMP DEFECTIVE | 5 BEAM-OUT | 10 REFLECTORS | 1 DEFECTIVE TIRE |
| 2 LOOSE/IMPROPERLY MOUNTED | 6 DEFECTIVE DIMMER SWITCH | 11 STOPLIGHT DEFECTIVE | 2 DEFECTIVE WHEEL |
| 3 HEADLAMP ADJUST. | 7 SIGNALS REQUIRED | 12 STOPLIGHTS | |
| 4 BEAM INDICATOR | 8 SIGNALS DEFECTIVE | 13 LICENSE LIGHT DEFECTIVE | |
| | 9 TAILLIGHT DEFECTIVE | 14 LICENSE LIGHT REQ. | |
| | | 15 CLEARANCE LIGHTS | |
| | | 16 UNAPPROVED LIGHTS | |

| J. POLLUTION DEVICES | | K. BRAKES | L. OTHER |
|---|---|---|---|
| 1 DEFECTIVE | TYPE (CHK. AS APPROP.) | 1 SERVICE BRAKE DEFECTIVE | 1 DEFECTIVE STEERING |
| 2 REQUIRED | ☐ CRANKCASE | 2 PARKING BRAKE REQ. | 2 LOWERED VEHICLE |
| 3 DISCONNECTED | ☐ EXHAUST | 3 PARKING BRAKE DEFECTIVE | 3 FENDER REQUIRED |
| | | | 4 FUEL CAP |
| | | | 5 UNSAFE LOADING |

☐ Your vehicle has been inspected and no defects found. This check list may be used as a guide to assist you in keeping your vehicle and its equipment in legal condition and proper repair. Should you encounter another inspection lane, this form may be shown to the officer; however, you must bear in mind that a defect may occur at any time.

☐ WARNING

☐ CITATION

DEFECT CORRECTED DATE OFFICER

No. 228

July 23, 1970

Statement of Public Health Hazard Arising From Urban Air Pollution

Full scale examination of the health hazard resulting from air pollutants is a relatively new field and years will pass before we know the full extent of the danger. However, evidence is already overwhelming that present levels of pollutants are detrimental to health. Major disasters attributed to air pollution occuring in Belgium, Pennsylvania, London and New York are generally well known and are only mentioned here.

Epidemiological surveys have shown a 17-fold increase in emphysema from 1950 to 1966. This disease which is a major cause of morbidity and mortality in this country, is twice as common in urban and heavily polluted areas as in rural areas. Other major diseases which are experimentally linked to air pollution and which are significantly more frequent in areas of heavy air pollution include asthma and asthma-like illnesses, chronic bronchitis, lung cancer, and coronary artery disease. Mortality rates from myocardial infarction have been shown to be increased in areas of heavy air pollution. Pulmonary function of children living in heavy pollution areas have been shown to be significantly impaired.

Physiologic studies involving healthy human volunteers have demonstrated visual and other sensory discrimination impairment with carbon monoxide (CO) exposure as low as 50 parts per million (PPM) for one hour. Exposure of nonsmokers to peak traffic in Dayton, Ohio, for one and one-half hours resulted in decreased blood oxygen and significantly shortened visual-motor reaction time. Dogs exposed to CO of 50 PPM six hours a day, five days a week, for six weeks had abnormal electrocardiograms and morphologic heart abnormalities at autopsy.

Hydrocarbons emitted in large amounts from automobiles contain known carcinogenic compounds such as benzpyrene. Nitrogen dioxide is an irritating and potentially dangerous gaseous emission from automobiles.

This summary only touches on a few highlights of health hazards from air pollution. They are documented and expanded in the documents listed in the attached bibliography. I think it is obvious from the above that we have a problem of major magnitude. Every effort should be made to fully define our local problem and take necessary steps to protect the health of the people of Portland and Oregon. The automobile contributes 60% to 85% of air pollution in urban areas and, therefore, seems the obvious place to start.

Exhibit G

Joe H. Rand, M. D.

glass bottles, to make fertilizer from garbage and trash.

The Nixon Administration is committed to provide leadership and "seed money" to help cope with the environmental crisis. One official notes, however, that the Government is limited in how far it can go. Says this authority:

"Industries that are releasing waste products into the air or water cannot escape the responsibility for cleaning up their own pollutants. State and local governments, too, must do their share, because most programs for curbing pollution are outside the jurisdiction of federal agencies."

All in all, the effort to provide a better environment is shaping up as a job of mammoth proportions. Latest developments point to costly programs involving individuals, business and Government alike.

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[From Science magazine, Aug. 21, 1970]

AIR POLLUTION AND HUMAN HEALTH

(Lester B. Lave and Eugene P. Seskin)

(NOTE.—The quantitative effect, with an estimate of the dollar benefit of pollution abatement, is considered.)

Air pollution is a problem of growing importance; public interest seems to have risen faster than the level of pollution in recent years. Presidential messages and news stories have reflected the opinion of scientists and civic leaders that pollution must be abated. This concern has manifested itself in tightened local ordinances (and, more importantly, in increased enforcement of existing ordinances), in federal legislation, and in extensive research to find ways of controlling the emission of pollutants from automobiles and smokestacks. Pollutants are natural constituents of the air. Even without man and his technology, plants, animals, and natural activity would cause some pollution. For example, animals vent carbon dioxide, volcanic action produces sulfur oxides, and wind movement insures that there will be suspended particulates; there is no possibility of removing all pollution from the air. Instead, the problem is one of balancing the need of polluters to vent residuals against the damage suffered by society as a result of the increased pollution.[1] To find an optimum level, we must know the marginal costs and marginal benefits associated with abatement. This article is focused on measuring one aspect of the benefit of pollution abatement.

Polluted air affects the health of human beings and of all animals and plants.[2] It soils and deteriorates property, impairs various production processes (for example, the widespread use of "clean rooms" is an attempt to reduce contamination from the air), raises the rate of automobile and airline accidents[3] and generally makes living things less comfortable and less happy. Some of these effects are quite definite and measurable, but most are ill-defined and difficult to measure, even conceptually. Thus, scientists still disagree on the quantitative effect of pollution on animals, plants, and materials. Some estimates of the cost of the soiling and deterioration of property have been made, but the estimates are only a step beyond guesses.[4] We conjecture that the major benefit of pollution abatement will be found in a general increase in human happiness or improvement in the "quality of life," rather than in one of the specific, more easily measurable categories. Nonetheless, the "hard" costs are real and at least theoretically measurable.

In this article we report an investigation of the effect of air pollution on human health; we characterize the problem of isolating health effects; we derive quantitative estimates of the effect of air pollution on various diseases and point out reasons for viewing some earlier estimates with caution; we discuss the economic costs of ill health; and we estimate the costs of effects attributed to air pollution.

THE EFFECT OF AIR POLLUTION ON HUMAN HEALTH

In no area of the world is the mean annual level of air pollution high enough to cause continuous acute health problems. Emitted pollutants are diluted in the atmosphere and swept away by winds, except during an inversion; then, for a period that varies from a few hours to a week or more, pollutants are trapped and the dilution process is impeded. When an inversion persists for a week or more, pollution increases substantially, and there is an accompanying increase in the death rate.

Much time has been spent in investigating short-term episodes of air pollution.[5] We are more concerned with the long-term effects of growing up in, and living in, a polluted atmosphere. Few scientists would be surprised to find that air pollution is associated with respiratory diseases of many sorts, including lung cancer and emphysema. A number of studies have established a qualitative link between air pollution and ill health.

A qualitative link, however, is of little use. To estimate the benefit of pollution abatement, we must know how the incidence of a disease varies with the level of pollution. The number of studies that allow one to infer a quantitative association is much smaller.

*Quantifying the relation.* Our objective is to determine the amount of morbidity and mortality for specific diseases that can be ascribed to air pollution. The state of one's health depends on factors (both present and past) such as inherited characteristics (that cause a predisposition to certain diseases), personal habits such as smoking and exercise, general physical condition, diet (including the amount of pollutants ingested with food), living conditions, urban and occupational air pollution, and water pollution.[6,7] Health is a complex matter, and it is exceedingly difficult to sort out the contributions of the various factors. In trying to determine the contribution of any single factor one must be careful neither to include spurious effects nor to conclude on the basis of a single insignificant correlation that there is no association. Laboratory experimentation is of little help in the sorting process.[8]

The model implicit in the studies we have examined is a simple linear equation wherein the mortality or morbidity rate is a linear function of the measured level of pollution and, possibly, of an additional socioeconomic variable. In only a few cases do the investigators go beyond calculating a simple or partial correlation.

A number of criticisms can be leveled at this simple model. No account is taken of possibly important factors such as occupational exposure to air pollution and personal habits. These and other factors influencing health must be uncorrelated with the level of pollution, if the estimated effect of pollution is to be an unbiased estimate. In addition, the linear form of the function is not very plausible, except insofar as one considers it a linear approximation over a small range.

Both because of the rather crude nature of the studies and because of the statistical estimation, there is a range of uncertainty concerning the quantitative effect of pollution on human health. This range is reflected in the estimate of the benefit of pollution abatement, discussed below.

*Epidemiological studies.* Epidemiological data are the kind of health data best adapted to the estimation of air pollution effects. These data are in the form of mortality (or morbidity) rates for a particular group, generally defined geographically.[9] For example, an analyst may try to account for variations in the mortality rate among the various census tracts in a city. While these vital statistics are tabulated by the government and so are easily available, there are problems with the accuracy of the classification of the cause of death (since few diagnoses are verified by autopsy and not all physicians take equal care in finding the cause of death). Other problems stem from unmeasured variables such as smoking habits, occupations, occupational exposure to air pollution, and genetic health factors. Whenever a variable is unmeasured, the analyst is implicitly assuming either that it is constant across groups or else that it varies randomly with respect to the level of air pollution. Since there are many unmeasured variables, one should not be surprised to discover that some studies fail to find a significant relationship or that others find a spurious one. For the same reason, one should not expect the quantitative effect to be identical across various groups, even when the relationship in each group is statistically significant.

Sample surveys are a means of gathering a more complete set of data. For example, a retrospective analysis might begin with a sample of people who died from a particular disease. Through questionnaires and interviews, the smoking habits and residence patterns of the deceased can be established. The analysis would then consist of an attempt to find the factors implicated in the death of these individuals. Two types of problems arising from such a study are the proper measurement of variables such as exposure to air pollution (there are many pollutants and many patterns of lifetime exposure) and the possible contributions of variables which still are unobserved, such as occupational hazards, socioeconomic characteristics, and personal habits.

Whatever the source of data, the investigators must rest their cases by concluding that the associations which they find are so strong that it is extremely unlikely that omitted variables could have given rise to the observed correlations; they cannot account for all possible variables.

*Episodic relationships.* Another method of investigating the effects of pollution involves an attempt to relate daily or weekly mortality (or morbidity) rates to indices of air pollution during the interval in question.[10] The conclusions of these studies are of limited interest, for two reasons. First, someone who is killed by an increase in air pollution is likely to be gravely ill. Air pollution is a rather subtle irritant, and it is unlikely that a healthy 25-year-old will succumb to a rise in pollution levels. Our interest should be focused on the initial cause of illness rather than on the factor that is the immediate determinant of death. Thus, morbidity data are more useful than mortality data. Second (and more important for the morbidity studies), there are many factors that affect the daily morbidity rate or daily rate of employee absences. Absence rates tend to be high on Mondays and Fridays for reasons that have nothing to do with air pollution or illness. One would expect little change in these absence rates if air pollution were reduced. Other factors, such as absence around holidays, give rise to suprious variations; this can be handled by ignoring the periods in question or by gathering enough data so that this spurious variation is averaged away. Some of these factors (such as high absence rates on Fridays and seasonal absence rates) may be correlated with variations in air pollution and no amount of data or of averaging will separate the effects. We have chosen to disregard the results of these episodic studies, with a few exceptions, cited below.

It is difficult to isolate the pollutants that have the most important effects on health on the basis of the studies we survey here.

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Footnotes at end of article.

Exhibit H

Measurement techniques have been crude, and there has been a tendency to base concentration figures on a single measurement for a large area. A more important problem is the fact that in most of these studies only a single pollutant was reported. Discovering which pollutants are most harmful is an important area, where further exploration is necessary. We have tried, nevertheless, to differentiate among pollutants in the survey that follows.[11] The problem is complicated, since pollution has increased over time, and since lifetime exposure might bear little relation to currently measured levels. These problems are discussed elsewhere.[12]

A REVIEW OF THE LITERATURE

We will proceed with a detailed review of studies made in an attempt to find an association between mortality or moridity and air pollution indices.

*Air pollution and bronchitis.* Studies link morbidity and mortality from bronchitis to air pollution in England [13], the United States [14], [15], Japan [16], and other countries.[17] Mortality rates by country boroughs in England and Wales have been correlated with pollution (as measured by the sulfation rate, total concentration of solids in the air, a deposit index, and the density of suspended particulates) and with socioeconomic variables (such as population density and social class). The smoking habits of the individuals studied have also been investigated. The conclusion of these studies is that air pollution accounts for a doubling of the bronchitis mortality rate for urban, as compared to rural, areas.

We took data reported by Stocks [18], [19], and by Ashley [20] and performed a multiple regression analysis, as shown in Table 1. We fit the following equation to the data

$$MR_i = +a_1P_i + a_2S_i + e_i \quad (1)$$

where $MR_i$ is the mortality rate for a particular disease in country borough $i$, $P_i$ is a measure of air pollution in that borough, $S_i$ is a measure of socioeconomic status in borough $i$, and $e_i$ is an error term with a mean of zero. (We also fit other functional forms, as discussed below.) Under general assumptions, the estimated coefficients ($a_0$, $a_1$, $a_2$) will be best linear, unbiased estimates.[21] Only if we want to perform significance tests must we make an assumption about the distribution of the error term (for example, the assumption that it is distributed normally).

The first regression in Table 1 relates the bronchitis mortality rate for men to a deposit index (see Table 1, footnote †), and the population density in each of 53 country boroughs. Thirty-nine percent of the variation in the mortality rate (across boroughs) is "explained" by the regression. It is estimated that a unit increase in the deposit index (1 gram per 100 square meters per month) leads to an increase of 0.18 percent in the bronchitis mortality rate (with population per acre held constant). An increase of 0.1 person per acre in the population density is estimated to lead to an increase of 0.02 person per acre in the population density is estimated to lead to an increased of 0.02 percent in the mortality rate (with air pollution held constant). As indicated in Table 1 by the $t$ statistics (the values in parentheses below the estimated coefficients), the air pollution variable is extremely important, whereas the socioeconomic variable contributes nothing to the explanatory power of the regression.

The first ten regressions in Table 1 are an attempt to explain the bronchitis death rate. Four different data sets are used, along with three measures of pollution and two socioeconomic variables. The coefficient of determination, $R^2$ (the proportion of the variation in the mortality rate explained by the regression), ranges from .3 to .8. Air pollution is a significant explanatory variable in all cases. In only three cases is the socioeconomic variable significant.

TABLE 1.—MULTIPLE REGRESSIONS BASED ON DATA FROM ENGLAND

| Category | $R^2$* | Index† Air pollution | Index† Socioeconomic |
|---|---|---|---|
| **Bronchitis mortality rate:** | | | |
| 1. Males, 53 county boroughs‡ (deposit index, persons/acre) | 0.386 | 0.182 | 0.016 |
| t statistic | | 4.80 | .22 |
| 2. Females | .332 | .182 | −.031 |
| t statistic | | 4.55 | −.42 |
| 3. Males, 28 county boroughs§ (smoke, persons/acre) | .433 | 1.891 | .180 |
| t statistic | | 3.79 | 1.86 |
| 4. Females | .412 | 1.756 | .252 |
| t statistic | | 3.23 | 2.40 |
| 5. Males, 26 areas (smoke, persons/acre) | .766 | .310 | .062 |
| t statistic | | 3.77 | .53 |
| 6. Females | .559 | .303 | −.038 |
| t statistic | | 2.85 | −.25 |
| 7. Males, 26 areas (smoke, social class) | .783 | .301 | .176 |
| t statistic | | 5.86 | 1.44 |
| 8. Females | .601 | .213 | .248 |
| t statistic | | 3.31 | 1.59 |
| 9. Both sexes, 53 urban areas§ (smoke, persons/acre) | .377 | .199 | .159 |
| t statistic | | 4.07 | 3.02 |
| 10. Both sexes, 53 urban areas ($SO_2$, persons/acre) | .300 | .161 | .151 |
| t statistic | | 3.05 | 2.64 |
| **Lung cancer mortality rate:** | | | |
| 11. 53 county boroughs (deposit index, persons/acre) | .445 | .041 | .154 |
| t statistic | | 2.09 | 4.23 |
| 12. 28 county boroughs (smoke, persons/acre) | .576 | .864 | .161 |
| t statistic | | 4.08 | 3.89 |
| 13. Male, 26 areas (smoke, persons/acre) | .781 | .137 | .115 |
| t statistic | | 2.86 | 1.70 |
| 14. Male, 26 areas (smoke, social class) | .805 | .161 | .172 |
| t statistic | | 5.62 | 2.47 |
| 15. 53 Urban areas (smoke, persons/acre) | .344 | −.086 | .184 |
| t statistic | | −2.42 | 4.83 |
| 16. 53 Urban areas ($SO_2$ persons/acre) | .378 | −.105 | .197 |
| t statistic | | −3.00 | 5.23 |
| **Other cancers:** | | | |
| 17. Stomach, male, 53 county boroughs (deposit index, persons/acre) | 0.167 | 0.070 | 0.005 |
| t statistic | | 3.08 | .12 |
| 18. Stomach, female | .175 | .070 | −.023 |
| t statistic | | 3.08 | −.56 |
| 19. Stomach, male, 28 county boroughs (smoke, persons/acre) | .257 | .714 | .065 |
| t statistic | | 2.57 | 1.21 |
| 20. Stomach, female | .454 | .883 | .066 |
| t statistic | | 4.13 | 1.60 |
| 21. Intestinal, 53 county boroughs (deposit index, persons/acre) | .041 | .018 | −.012 |
| t statistic | | 1.45 | −.52 |
| 22. Intestinal, 28 county boroughs (smoke, persons/acre) | .129 | .174 | .036 |
| t statistic | | 1.26 | 1.35 |
| 23. Other cancer, male 26 areas (smoke, persons/acre) | .454 | .019 | .073 |
| t statistic | | .59 | 1.60 |
| 24. Other cancer, female, 26 areas (smoke, persons/acre) | .044 | .039 | −.062 |
| t statistic | | .93 | −1.03 |
| 25. Other cancer, male, 26 areas (smoke, social class) | .396 | .060 | .017 |
| t statistic | | 2.75 | .33 |
| 26. Other cancer, female, 26 areas (smoke, social class) | .002 | .005 | −.013 |
| t statistic | | .17 | −.19 |
| **Pneumonia mortality rate:** | | | |
| 27. Male, 26 areas (smoke, persons/acre) | .477 | .118 | .121 |
| t statistic | | 1.34 | .97 |
| 28. Female | .253 | .068 | .137 |
| t statistic | | .58 | .83 |
| 29. Male, 26 areas (smoke, social class) | .475 | .158 | .126 |
| t statistic | | 2.82 | .93 |
| 30. Female | .242 | .124 | .106 |
| t statistic | | 1.65 | .58 |

*The coefficient of determination: a value of 0.386 indicates a multiple correlation coefficient of .0.62, and indicates that 39 percent of the variation in the death rate is "explained" by the regression.

†The t statistic: for a 1-tailed t-test with 23 degrees of freedom, a value of 1.71 indicates significance at the 0.05 level; for 25 or 50 degrees of freedom, the critical values are 1.71 and 1.68.

‡Data for 53 county boroughs in England and Wales as reported by Stocks (18). Air pollution is measured by a deposit index (in grams per 100 square meters per month) whose observed range is 96 to 731, with a mean of 375. The socioeconomic index is expressed in number of persons per acre (multiplied by 10); the range is 69 to 364, and the mean is 163. Death rates are measured as index numbers, with the mean for all boroughs in England and Wales equal to 100. Ranges within this sample are as follows: bronchitis (males), 73 to 259; bronchitis (females), 72 to 268; lung cancer, 70 to 159; stomach cancer (males), 67 to 168; stomach cancer (females), 84 to 161; intestinal cancer, 87 to 123.

§Data for 28 county boroughs in England and Wales as reported by Stocks (18). Air pollution is measured by a smoke index (suspended matter, in milligrams per 100 cubic meters); the range is 6 to 49. Again, the socioeconomic index is expressed in numbers of persons per acre (×10); the range is 83 to 342.

‖Data for 26 areas in northern England and Wales as reported in Stocks (19). Air pollution is measured by a smoke index, as for category 3; the range is 15 to 562 mg, 1000 m³ and the mean is 260. 1 socioeconomic variable is the number of persons per acre (×10); the range is 1 to 342 and the mean is 102. The other socioeconomic variable is social class; the range is 61 to 295. Death rates are measured as for category 1; within this sample, the range for lung cancer is 23 to 165; for other cancer, 6 to 122 (males) and 88 to 154 (females); for bronchitis, 18 to 259 (males) and 12 to 240 (females); for pneumonia, 61 to 227 (males) and 40 to 245 (females).

¶Data for 53 areas as reported by Ashley (20). Air pollution is measured (i) by a smoke index (as for category 3), with a range of 23 to 261 μg/m³ and a mean of 124, or (ii) by an $SO_2$ index (apparently in the same units), with a range of 33 to 277 and a mean of 124. Death rates are measured as for category 1; within this sample, the range for lung cancer is 70 to 146, and for bronchitis, 64 to 186.

The implication of the first regression is that a 10 percent decrease in the deposit rate (38 g 100 $m^{-2}$ $month^{-1}$) would lead to a 7 percent decrease in the bronchitis death rate. Another way of illustrating the effect of air pollution on health is to note that, if all the boroughs were to improve the quality of their air to that enjoyed by the borough having the best air of all those in sample (a standard deposit rate for all boroughs of 96 g 100 $m^{-2}$ $month^{-1}$), the average mortality rate (for this sample) would fall from 129 to 77. Thus, cleaning the air to the level of cleanliness enjoyed by the area with the best air would mean a 40 percent drop in the bronchitis death rate among males in the fifth regression the pollution index is a smoke index (Table 1, footnote §), and a different set of areas is considered. This is a more successful regression in terms of the percentage of variation explained. As before, the air pollution coefficient is extremely significant, and the implication is that cleaning the air to the level of cleanliness currently enjoyed by the area with the best air (15 mg/100 $m^3$) would lower the average bronchitis mortality rate

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from 106 to 30, a drop of 70 percent. Results of the other regression analyses based on bronchitis mortality data have similar implications. Note that the effect is almost the same for males and females. This indicates reliability and suggests that the effect is independent of occupational exposure.

Winkelstein *et al.*[14] collected data on 21 areas in and around Buffalo, New York. A cross tabulation of census tracts by income level and pollution level shows that the mortality rate for asthma, bronchitis, and emphysema (in white males 50 to 69 years old) increases by more than 100 percent as pollution rises from level 1 to level 4 (see [23]).

These studies indicate a strong relationship between bronchitis mortality and a number of indices of air pollution. We conclude that bronchitis mortality could be reduced by from 25 to 50 percent depending on the particular location and deposit index, by reducing pollution to the lowest level currently prevailing in these regions. For example, if the air in all of Buffalo were made as clean as the air in those parts of the area that have the best air, a reduction of approximately 50 percent in bronchitis mortality would probably result.

*Air pollution and lung cancer.* The rate of death from lung cancer has been correlated with several indices of pollution and socioeconomic variables in studies that provided controls for smoking habits and other factors. For English nonsmokers, Stocks and Campbell [22],[24] found a tenfold difference between the death rates for rural and urban areas. Daly [25], in comparing death rates in urban and rural areas of England and Wales, found the urban rate twice as high. Evidence for other parts of Europe also shows an association between lung cancer and air pollution

[illegible]essions 11 through 16 (Table 1) show our reworking of the data for lung cancer mortality for England and Wales (there is no control for smoking). Regressions 11 through 14 imply that, if the quality of air of all boroughs were improved to that of the borough with the best air, the rate of death from lung cancer would fall by between 11 and 44 percent. Regressions 15 and 16 show a relationship between air pollution and lung cancer which is either insignificant or inverse. The only contrary results come from Ashley's data. In the absence of more complete evidence, we must remain curious about these results. Use of such small samples and inadequate controls is certain to lead to some contrary results, but they are disconcerting when they appear.

In a study of 187,783 white American males (50 to 69 years old), Hammond and Horn [27] reported that the age-standardized rate of death due to lung cancer was 34 (per 100,000) in rural areas as compared to 56 in cities of population over 50,000. When standardized with respect both to smoking habits to age, the rate was 39 in rural areas and 52 in cities of over 50,000.

Haenszel *et al.*[28] analyzed 2191 lung cancer deaths among white American males, that had occurred in 40 states, and data for a control group consisting of males who died from other causes. They found the crude rate of death from lung cancer to have been 1.56 times as high in the urban areas of their study as in the rural areas in 1958 and 1.82 times as high in the period 1948–49 (in subjects 35 years and older, with adjustments made for age). When adjustments are made for both age and smoking history, the ratio is 1.43. Also the ratio increased with dur[illegible]n of residence in the urban or rural are[illegible]om 1.08 for residence of less than 1 year to 2.00 for lifetime residence. Haenszel and Taeuber [29] report similar results for white American females. In a number of additional studies the association between air pollution and lung cancer is examined.[30]

Buell and Dunn [31] review the evidence on lung cancer and air pollution; a summary of their findings is given in Table 2. For smokers, death rates (adjusted for age and smoking) ranged from 25 to 123 percent higher in urban areas than in rural areas. For nonsmokers, all differences exceeded 120 percent. "The etiological roles for lung cancer of urban living and cigarette smoking seem each to be complete," they say, "in that the urban factor is evident when viewing nonsmokers exclusively, and the smoking factor is evident when viewing rural dwellers exclusively." They argue that differences in the quality of diagnosis could not account for the observed differences for urban and rural areas.

*Nonrespiratory-tract cancers and air pollution.* Our reworking of data from England on rates of death from nonrespiratory-tract cancer is presented in Table 1 (regressions 17 through 26). In the regressions, stomach cancer is significantly related to a deposit index and a smoke index. The effects are nearly identical for males and females. Intestinal cancer appears to be only marginally related to indices of either deposit or smoke. For 26 areas in northern England and Wales, there appears to be little relationship between nonrespiratory-tract cancers and a smoke index. The single exception in the four regressions occurs for males when the socioeconomic variable is social class; here the smoke index explains a significant amount of the variation in the cancer mortality rate. (Apparently population density and smoke index are so highly related in these 26 areas that neither has significant power to explain such variation.)

Winkelstein and Kantor [33] investigated rates of mortality from stomach cancer in Buffalo, New York, and the immediate environs. Their measure of pollution is an index of suspended particulates averaged over a 2-year period. They found the rate of mortality due to stomach cancer to be more than twice as great in areas of high pollution as in areas of low pollution.[33]

Hagstrom *et al.*[34] tabulated rates of death from cancer among middle class residents of Nashville, Tennessee, between 1949 and 1960, using four measures of air pollution. They found the cancer mortality rate to be 25 percent higher in polluted areas than in areas of relatively clear air.[35] They also found significant mortality-rate increases associated with individual categories of cancer, such as stomach cancer, cancer of the esophagus, and cancer of the bladder. The individual mortality rates are more closely related to air pollution after the data are broken down by sex and race.

Levin *et al.*[36] report, for all types of cancer, these relationships: The age-adjusted cancer-incidence rates for urban males was 24 percent higher than that for rural males in New York State (exclusive of New York City) (1949–51), 36 percent higher in Connecticut (1947–51), and 40 percent higher in Iowa (1950); the incidence rate for urban females was 14 percent higher than that for rural females in New York State, 28 percent higher in Connecticut, and 34 percent higher in Iowa. For both males and females, the incidence rate for each of 16 categories of cancer was higher in urban that in rural areas.

*Cardiovascular disease and air pollution.* Enterline *et al.*[37] found that mortality from heart disease is higher in central-city counties than in suburban counties, and, in turn, higher in suburban counties than nonmetropolitan counties. Zeidberg *et al.*[38] found that both morbidity and mortality rates for heart disease are associated with air pollution levels in Nashville. The morbidity rate was about twice as high in areas of polluted air as in areas of clean air. The mortality rate was less closely associated; it was 10 to 20 percent higher in areas of polluted air than in areas of clean air.[39]

Friedman [40] correlated the rate of mortality from coronary heart disease in white males aged 45 to 64 with the proportion of this group living in urban areas. The simple correlation for 33 states is .79. When cigarette consumption is held constant, the partial correlation is .67.

On the basis of these studies we conclude that a substantial abatement of air pollution would lead to 10 to 15 percent reduction in the mortality and morbidity rates for heart disease. We caution the reader that the evidence relating cardiovascular disease to air pollution is less comprehensive than that linking bronchitis and lung cancer to air pollution.

*Total respiratory disease.*[41] Daly [25] found significant correlations between air polution and death rates for all respiratory dieases (and for nonrespiratory diseases as well) in England. Douglas and Waller [42] found significant relationships between air pollution and respiratory disease in 3866 British school children. Fairbairn and Reid [43] found significant correlations between air pollution and morbidity rates (for bronchitis, pneumonia, pulmonary tuberculosis, and lung cancer) in England. Regressions 27 through 30 in Table 1 shown pneumonia mortality to be related only marginally to a smoke index.

TABLE 2.—A SUMMARY OF LUNG CANCER MORTALITY STUDIES. NUMBER OF DEATHS FROM LUNG CANCER PER 100,000 POPULATION [FROM BUELL AND DUNN (31)]

| Study | Standardized for age and smoking | | | Nonsmokers | | |
|---|---|---|---|---|---|---|
| | Urban | Rural | Urban/rural | Urban | Rural | Urban/rural |
| Buell, Dunn, and Breslow (67)[1] | 101 | 80 | 1.26 | 36 | 11 | 3.27 |
| Hammond and Horn (68)[2] | 52 | 39 | 1.33 | 15 | 0 | 8 |
| Stocks (69)[3] | 189 | 85 | 2.23 | 50 | 22 | 2.27 |
| Dean (70)[4] | | | | 38 | 10 | 3.80 |
| Golledge and Wicken (71)[5] | 149 | 69 | 2.15 | 23 | 29 | .79 |
| Haenszel et al. (72)[6] | 100 | 50 | 2.00 | 16 | 5 | 3.20 |

[1] California men; death rates by counties.
[2] American men.
[3] England and Wales.
[4] Northern Ireland.
[5] England; no adjustment for smoking.
[6] American men.

Zeidberg *et al.*[44] questioned 9313 Nashville residents about recent illnesses. Among males aged 55 and older from white middle-class families, the numbers of illnesses per respondent during the past year were 1.92, 1.15, and 1.26 for areas of high, moderate, and low pollution, respectively. There are a number of other comparisons, based on other measures of air pollution and on data for females and nonwhites (some of these are given in 45). However, we should add a word of caution: although the sample size in this study was large and controls for many socioeconomic variable were included, many important factors were ignored—for example, smoking habits and length of residence. Nonetheless, the finding is extremely strong

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and seems unlikely to be an artifact of unmeasured variables.

Hammond [48] studied over 50,000 men to find the relationships between emphysema, age, occupational exposure to pollution, urban exposures, and smoking. His results indicated that the effect of air pollution is significant and that heavy smokers have a much higher morbidity rate in cities than in rural areas; the effect becomes more marked as age increases.

Ishikawa, *et al*, [47] estimated the incidence of emphysema in Winnipeg (Canada) and St. Louis. They examined the lungs of 300 corpses in each city (the samples were comparable). Findings for each age group (over 25 years old) indicated that the incidence and severity of emphysema is higher in St. Louis, the city with the more polluted air. (In the 45-year-old group 5 percent of those in Winnipeg and 46 percent of those in St. Louis showed evidence of emphysema.)

A number of studies have been made in England on homogeneous occupational groups, such as postmen. The results are relatively pure in that all members of the sample have comparable incomes, working conditions, and social status. Holland and Reid [49] found that the rates of occurence of severe respiratory symptoms were 25 to 50 percent higher for London postmen than for small-town postmen (sample size, 770). Reid [49] found that, in the postmen of his study, absences due to bronchitis rose from an index number of 100 for the area of least air pollution, to 120 for an area of moderate pollution, to 260 and 283 for the areas of highest pollution. Corresponding figures for absences due to other respiratory illness were 100, 100, 150, and 151, respectively, and for absences due to infections and parasitic diseases, 100, 115, 130, and 140. Cornwall and Raffle [50] made a similar study of bus drivers in London. They found that 20 to 35 percent of absences due to sickness of any kind could be ascribed to air pollution (they used a fog index as a measure of pollution). Fairbairn and Reid [46] tabulated absences due to sickness for postmen, for males working indoors, and for females working indoors. They found that the age-standardized morbidity rate for bronchitis and pneumonia in the postmen of their study rose from 40 man-years, per 1000 man-years, for the area of lowest air pollution (of the four acres studied) to 122 for the area of highest air pollution. Corresponding figures for morbidity from colds were 75 and 171 man-years, and for morbidity from influenza, 131 and 184 man-years. For males working indoors, the low and high morbidity rates were as follows: bronchitis and pneumonia, 32 and 89; colds, 53 and 64; influenza, 88 and 102.

Dohan [51] studied absences (of more than 7 days) of female employees in eight Radio Corporation of America plants. He found a correlation of .96 between atmospheric concentrations of $SO_4$ and absences due to respiratory disease in the five cities for which complete data were available. During Asian flu epidemics there was a 200 percent increase in illness in cities with polluted air and only a 20 percent increase in those with relatively unpolluted air.

*Infant mortality and total mortality rates.* Sprague and Hagstrom [52] compared air-pollution data for Nashville with fetal and infant mortality rates for Nashville as given in census tracts (for 1955 through 1960). Controls for socioeconomic factors were not included. For infant death rates (ages 28 days to 11 months), the highest correlation was with atmospheric concentrations of $SO_4$ (in milligrams per 100 square centimeters per day) and was .70. For the neonatal death rates (ages 1 day to 27 days), the highest correlation was with dustfall and was .49. For infants dying during their first day whose death certificate includes mention of immaturity, the highest correlation was with dustfall and was .45. The correlation of the fetal death rate with dustfall was .58.

In a study just being completed [53], we have collected data for 114 Standard Metropolitan Statistical Areas in the United States and have attempted to relate total death rates and infant mortality rates to air pollution and other factors. Socioeconomic data, death rates, and air-pollution data were taken from U.S. government publications [54]. Regression 1 (Table 3) shows how the total death rate in 1960 varies with air pollution levels and with socioeconomic factors. As the (biweekly) minimum level of suspended particulates increases, the death rate rises significantly. Moreover, the death rate increases with (i) the density of population of the area, (ii) the proportion of nonwhites, (iii) the proportion of people over age 65, and (iv) the proportion of poor families. Eighty percent of the variation in the death rate across these 114 statistical areas is explained by the regression.

TABLE 3.—REGRESSIONS RELATING INFANT AND TOTAL MORTALITY RATES FOR 114 STANDARD METROPOLITAN STATISTICAL AREAS IN THE UNITED STATES TO AIR POLLUTION AND OTHER FACTORS, FOR MEANS AND STANDARD DEVIATIONS (S.D.) OF THE VARIABLES, SEE †

| Category | $R^2$‡ | Air pollution (minimum) concentrations) | Socioeconomic P/mi²§ | Socioeconomic Nonwhite (percent) | Socioeconomic Over 65 (percent) | Socioeconomic Poor (percent) |
|---|---|---|---|---|---|---|
| **TOTAL DEATH RATE** | | | | | | |
| 1. Particulates | 0.804 | 0.102 | 0.001 | 0.032 | 0.682 | 0.013 |
| t statistic* | | 2.83 | 2.58 | 3.41 | 18.37 | .93 |
| 2. Sulfates | .813 | .085 | .001 | .033 | .652 | .006 |
| t statistic* | | 3.73 | 1.86 | 3.56 | 17.60 | .49 |
| **DEATH RATE FOR INFANTS OF LESS THAN 1 YEAR** | | | | | | |
| 3. Particulates | .545 | .393 | ---------- | .190 | ---------- | .150 |
| t statistic* | | 3.07 | ---------- | 6.63 | ---------- | 3.28 |
| 4. Sulfates | .522 | .150 | ---------- | .200 | ---------- | .123 |
| t statistic* | | 1.91 | ---------- | 6.83 | ---------- | 2.70 |
| **DEATH RATE FOR INFANTS LESS THAN 28 DAYS OLD** | | | | | | |
| 5. Particulates | 0.260 | 0.273 | ---------- | 0.089 | ---------- | 0.063 |
| t statistic* | | 2.48 | ---------- | 3.61 | ---------- | 1.60 |
| 6. Sulfates | .263 | .170 | ---------- | .097 | ---------- | .047 |
| t statistic* | | 2.57 | ---------- | 3.96 | ---------- | 1.23 |
| **FETAL DEATH RATE** | | | | | | |
| 7. Particulates | .434 | .274 | .004 | .171 | ---------- | .106 |
| t statistic* | | 2.02 | 2.01 | 5.70 | ---------- | 2.11 |
| 8. Sulfates | .434 | .171 | .004 | .181 | ---------- | .085 |
| t statistic* | | 1.95 | 1.82 | 5.87 | ---------- | 1.71 |

*The t statistic: for a 1-tailed t-test, a value of 1.65 indicates significance at the 0.05 level.

†Total death rate per 10,000: mean, 91.5; S.D., 15.2. Infant death rate (age, <1 year) per 10,000 live births: mean, 255.1; S.D., 36.1 Infant death rate (age, <28 days) per 10,000 live births: mean, 188.0; S.D., 24.4. Fetal death rate per 10,000 live births; mean, 153.9; S.D., 34.4. Suspended particulates ($\mu g/m^3$), minimum reading for a biweekly period: mean, 45.2; S.D., 18.7. Total sulfates ($\mu g/m^3$) (× 10), minimum reading for a biweekly period: mean, 46.9; S.D., 30.6. Persons per square mile: mean, 763.4; S.D., 1,387.9. Percentage of nonwhites in population (× 10): mean, 125.2; S.D., 102.8. Percentage of population over 65 (× 10): mean, 84.2; S.D., 21.2. Percentage of families with incomes under $3,000 (× 10): mean, 181.6; S.D., 65.7.

‡The coefficient of determination: a value of 0.804 indicates a multiple correlation coefficient of 0.90, and indicates that 80 percent of the variation in the death rate is "explained" by the regression.

§ Persons per square mile.

Regression 3 shows how the 1960 infant death rate (age, less than 1 year) varies. A smaller proportion (55 percent) of the variation in the death rate is explained by the regression, although the minimum air-pollution level, the percentage of nonwhites, and the proportion of poor families continue to be significant explanatory variables. Regression 5 is an attempt to explain variation in the neonatal death rate. The results are quite similar to those of regression 3. The fetal death rate is examined in regression 7. Here the minimum air-pollution level, population density, the percentage of nonwhites, and the percentage of poor falimies are all significant explanatory variables.

Regressions 2, 4, 6, and 8 are an attempt to relate these death rates to the atmospheric concentrations of sulfates for the 114 statistical areas of the study. Regression 2 shows that the total death rate is significantly related to the minimum level of sulfate pollution, to population density, and to the percentage of people over age 65; 81 percent of the variation is explained. Regressions 4, 6, and 8 show that the minimum atmospheric concentration of sulfates is a significant explanatory variable in three categories of infant death rates.

One might put these results in perspective by noting estimates on how small decreases in the air-pollution level affect the various death rates. A 10 percent decrease in the minimum concentration of measured particulates would decrease the total death rate by 0.5 percent, the infant death rate by 0.7 percent, the neonatal death rate by 0.6 percent, and the fetal death rate by 0.9 percent. Note that a 10 percent decrease in the percentage of poor families would decrease the total death rate by 0.2 percent and the fetal death rate by 2 percent. A 10 percent decrease in the minimum concentration of sulfates would decrease the total death rate by 0.4 percent, the infant mortality rate by 0.3 percent, the neonatal death rate by 0.4 percent, and the fetal death rate by 0.5 percent.

Each of the relations in Tables 1 and 3 was estimated in alternative ways, including transformation into logarithms, a general quadratic, and a "piecewise" linear form as documented elsewhere.[13] The implications about the roles of air pollution and of the socioeconomic variables were unchanged by use of the different functional forms. Another result to be stressed is that, in Table 1, comparable regressions for males and females show almost precisely the same effects for air pollution. This suggests that occupational

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exposure does not affect these results; the result lends credence to the estimates. A result that we document elsewhere [54] is that it is minimum level of air pollution that is significant, not the occasional peaks. People dealing with this problem should worry about abating air pollution at all times, instead of confining their concern to increased pollution during inversions.

### SOME CAVEATS

In preceding sections we have described a number of studies which quantify the relationship between air pollution and both morbidity and mortality. Is the evidence conclusive? Is it possible for a reasonable man still to object that there is no evidence of a substantial quantitative association? We believe that there is conclusive evidence of such association.[55]

In the studies discussed, a number of countries are considered, and differences in morbidity and mortality rates among different geographical areas, among people within an occupational group, and among children are examined. Various methods are used, ranging from individual medical examinations and interviews to questionnaires and tabulations of existing data. While individual studies may be attacked on the grounds that none manages to provide controls for all causes of ill health, the number of studies and the variety of approaches are persuasive. It is difficult to imagine how factors such as general habits, inherited characteristics, and lifetime exercise patterns could be taken into account.

To discredit the results, a critic would have to argue that the relationships found by the investigators are spurious because the level of air pollution is correlated with a third factor, which is the "real" cause of ill health. For example, many studies do not take into account smoking habits, occupational exposure, and the general pace of life. Perhaps city dwellers smoke more, get less exercise, tend to be more overweight, and generally live a more strained, tense life than rural dwellers. If so, morbidity and mortality rates would be higher for city dwellers, yet air pollution would be irrelevant. This explanation cannot account for the relationships found.

Apparently there is little systematic relationship between relevant "third" factors and the level of air pollution. An English study [56] in which smoking habits are examined reveals little evidence of differences by residence. There is evidence in the United States that smoking is more prevalent among lower socioeconomic groups [57] but income or other socioeconomic variables would account for this effect and still leave the pollution coefficient unbiased. More importantly, the correlations between air pollution and mortality are better when one is comparing areas within a city (where more factors are held constant) than when one is comparing rural and urban areas.[57] It is especially hard to believe that the apparent relation between air pollution and ill health is spurious when significant effects are found in studies comparing individuals within strictly defined occupational groups, such as postmen or bus drivers (where incomes and working conditions are comparable and unmeasured habits are likely to be similar).

When there are uncontrolled factors, some studies may show inconclusive or even negative results; only by collecting samples large enough to "average away" spurious effects can dependable results be guaranteed. In the main, each of the studies cited above was based on a substantial sample. It is the body of studies as a whole that we find persuasive.

*An examination of contrary results.* Uncontrolled factors, together with small samples, are certain to lead to some results contrary to the weight of evidence and to our expectations. For example, in some studies [58] no attempt is made to control even for income or social status. From the evidence of studies which did provide such controls, we know that failure to control for income leads to biased results, and so we place little credence in either the positive or negative findings of studies lacking these controls.

Sampling error can be extremely important. For example, Zeidberg *et al.*[59] find mixed results in crosstabulating respiratory disease mortality with level of air pollution and with income class. In general the relationships are in the expected direction, but they are often insignificant. Insignificant results might occur often, if the samples are small, even if air pollution is extremely significant, since sampling errors dominate the explanatory variables.

Another study in which sampling error is important is reported by Ferris and Whittenberger.[7] They compared individuals in Berlin, New Hampshire, with residents of Chilliwack (British Columbia), Canada, and—not surprisingly in view of the small samples—failed to find significant differences in the occurrence of respiratory disease. Prindle *et al.*[60] compared two Pennsylvania towns in the same fashion. These two studies are admirable in that individuals were subjected to careful medical examinations. However, only a few hundred individuals were studied, and this means that sampling errors tend to obscure the effects of air pollution. Moreover, there were no controls for other factors, such as smoking. Also, one must be careful to control for a host of other variables if the sample is small. For example, the ethnic origins of the population and their general habits and occupations are known to affect mortality rate. It is exceedingly difficult to control for these factors; use of carefully constructed large samples seems the best answer. Finally, air pollution is measured currently, and it is generally assumed that relative levels have been constant over time and that people have lived at their present addresses for a long period. It is hardly surprising that statistical significance is not always obtained when such assumptions are necessary.

Since investigators are more reluctant to publish negative results than positive ones, and since it is more difficult to get negative results published, it is probable that we are unaware of other studies that fail to find a strong association between air pollution and ill health. We are somewhat reluctant to come to strong conclusions without knowledge of such negative results. However, there seems to be no reasonable alternative to evaluating the evidence at hand and allowing for uncertainty. Thus, we conclude that an objective observer would have to agree that there is an important association between air pollution and various morbidity and mortality rates.

### THE ECONOMIC COSTS OF DISEASE

Having found a quantitative association between air pollution and both morbidity and mortality, the next question is that of translating the increased sickness and death into dollar units. The relevant question is, How much is society willing to spend to improve health (to lower the incidence of disease)? In other words, how much is it worth to society to relieve painful symptoms, increase the level of comfort of sufferers, prevent disability, and prolong life? It has become common practice to estimate what society is willing to pay by totaling the amount that is spent on medical care and the value of earnings "forgone" as a result of the disability or death.[61] This cost seems a vast underestimate for the United States in the late 1960's. Society seems willing to spend substantial sums to prolong life or relieve pain. For example, someone with kidney failure can be kept alive by renal dialysis at a cost of $15,000 to $25,000 per year; this sum is substantially in excess of forgone earnings, but today many kidney patients receive this treatment. Another example is leukemia in children; enormous sums are spent to prolong life for a few months, with no economic benefit to society. If ways could be found to keep patients with chronic bronchitis alive and active longer, it seems likely that people would be willing to spend sums substantially greater than the foregone earnings of those helped. So far as preventing disease is concerned, society is willing to spend considerable sums for public health programs such as chest x-rays, inoculation, fluoridation, pure water, and garbage disposal and for private health care programs such as annual physical checkups.

While we believe that the value of earnings forgone as a result of morbidity and mortality provides a gross underestimate of the amount society is willing to pay to lessen pain and premature death caused by disease, we have no other way of deriving numerical estimates of the dollar value of air-pollution abatement. Thus, we proceed with a conventional benefit calculation, using these forgone earnings despite our reservations.

*Direct and indirect costs.* Our figures for the cost of disease are based on *Estimating the Cost of Illness*, by Dorothy P. Rice.[61] Unfortunately, Rice calculated disease costs in quite aggregate terms, and so the category "diseases of the respiratory system" must be broken down. It seem reasonable to assume that both direct and indirect costs would be proportional to the period of hospitalization (total patient-days in hospitals) by disease category.[62]

Rice defines a category of direct disease costs as including expenditures for hospital and nursing home care and for services of physicians, dentists, and members of other health professions. "Other direct costs" (which would add about 50 percent to those just enumerated) consist of a variety of personal and nonpersonal expenditures (such as drugs, eyeglasses, and appliances), school health services, industrial in-plant health services, medical activities in federal units other than hospitals, medical research, construction of medical facilities, government public health activities, administrative expenditures of voluntary health agencies, and the net cost of insurance. Since Rice does not allocate "other direct costs" among diseases, we omit it from our cost estimates. However, we conjecture that respiratory diseases represent a substantial portion of this category. Thus, our direct cost estimate is likely to be a substantial underestimate of "true" direct costs (probably more than 50 percent too low).

Estimating indirect cost is an attempt to measure the losses to the nation's economy caused by illness, disability and premature death. We would argue that such a calculation gives a lower bound for the amount people would be willing to pay to lower the morbidity and mortality rates. These costs are calculated in terms of the earnings forgone by those who are sick, disabled, or prematurely dead.[63]

### THE HEALTH COST OF AIR POLLUTION

The studies cited in this article show a close association between air pollution and ill health. The evidence is extremely good for some diseases (such as bronchitis and lung cancer) and only suggestive for others (such as cardiovascular disease and nonrespiratory-tract cancers). Not all factors have been taken into account, but we argue that an unbiased observer would have to concede the association. More effort can and should be spent on refining the estimates. However, the point of this exercise is to estimate the health cost of air pollution. We believe that the evidence is sufficiently complete to allow us to infer, roughly, the quantitative associations. We do so with caution, and proceed to translate the effects into dollars. We have attempted to choose our point estimates from the conservative end of the range.

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Footnotes at end of article.

We interpret the studies cited as indicating that mortality from bronchitis would be reduced by about 50 percent if air pollution were lowered to levels currently prevailing in urban areas with relatively clean air. We therefore make the assumption that there would be a 25 to 50 percent reduction in morbidity and mortality due to bronchitis if air pollution in the major urban areas were abated by about 50 percent. Since the cost of bronchitis (in terms of forgone income and current medical expenditures) is $930 million per year, we conclude that from $250 million to $500 million per year would be saved by a 50 percent abatement of air pollution in major urban areas.

Approximately 25 percent of mortality from lung cancer can be saved by a 50 percent reduction in air pollution, according to the studies cited above. This amounts to an annual cost of about $33 million.

The studies document a strong relationship between all respiratory disease and air pollution. It seems likely that 25 percent of all morbidity and mortality due to respiratory disease could be saved by a 50 percent abatement in air pollution levels. Since the annual cost of respiratory disease is $4887 million, the amount saved by a 50 percent reduction in air pollution in major urban areas would be $1222 million.

There is evidence that over 20 percent of cardiovascular morbidity and about 20 percent of cardiovascular mortality could be saved if air pollution were reduced by 50 percent. We have chosen to put this saving at only 10 percent—that is, $468 million per year.

Finally, there is a good deal of evidence connecting all mortality from cancer with air pollution. It is difficult to arrive at a single figure, but we have estimated that 15 percent of the cost of cancer would be saved by a 50 percent reduction in air pollution—a total of $390 million per year.

Not all of these cost estimates are equally certain. The connection between bronchitis or lung cancer and air pollution is much better documented than the connection between all cancers or all cardiovascular disease and air pollution. The reader may aggregate the costs as he chooses. We estimate the total annual cost that would be saved by a 50 percent reduction in air-pollution levels in major urban areas, in terms of decreased morbidity and mortality, to be $2080 million. A more relevant indication of the cost would be the estimate that 4.5 percent of all economic costs associated with morbidity and mortality would be saved by a 50 percent reduction in air pollution in major urban areas.[34] This percentage estimate is a robust figure; it is not sensitive to the exact figures chosen for calculating the economic cost of ill health.

A final point is that these dollar figures are surely underestimates of the relevant costs. The relevant measure is what people would be willing to pay to reduce morbidity and mortality (for example, to reduce lung cancer by 25 percent. It seems evident that the value used for forgone earnings is a gross underestimate of the actual amount. An additional argument is that many health effects have not been considered in arriving at these costs. For example, relatively low levels of carbon monoxide can affect the central nervous system sufficiently to reduce work efficiency and increase the accident rate.[35] Psychological and esthetic effects are likely to be important, and additional costs associated with the effect of air pollution on vegetation, cleanliness, and the deterioration of materials have not been included in these estmiates.[36]

FOOTNOTES

[1] For a general discussion of inherent problems in handling residuals, see R. U. Ayres and A. V. Kneese, *Amer. Econ. Rev.* 59, 282 (1969).

[2] For summaries of studies relating air pollution to health, see J. R. Goldsmith in *Air Pollution*, vol. 1: *Air Pollution and Its Effects*, A. Stern, Ed. (Academic Press, New York, 1968), p. 547; E. C. Hammond, paper presented at the 60th annual meeting of the Air Pollution Control Association, 1967; H. Heimann, *Arch. Environ. Health* 14, 488 (1967). For more general reviews of the literature, see A. G. Cooper, "Sulfur Oxides and other Sulfur Compounds," *U.S. Public Health Serv. Publ. No. 1093* (1965); ———, "Carbon Monoxide," *U.S. Public Health Serv. Publ. No. 1503* (1966); "The Oxides of Nitrogen in Air Pollution," *Calif. Dep. Public Health Publ.* (1966); "Air Quality Criteria for Sulfur Oxides," *U.S. Public Health Serv. Publ. No. 1619* (1967); *Effects of Chronic Exposure to Low Levels of Carbon Monoxide on Human Health, Behavior, and Performance* (National Academy of Sciences and National Academy of Engineering, Washington, D.C. 1969).

[3] *Public Health* (*Johannesburg*) 63, 30 (1963); D. M. Johnson, *Good Housekeeping* 1961, 49 (June 1961).

[4] See A. V. Kneese, in *Social Sciences and the Environment; Conference on the Present and Potential Contribution of the Social Sciences to Research and Policy Formulation in the Quality of the Physical Environment*, M. E. Garnsey and J. R. Hibbs, Eds. (Univ. of Colorado Press, Boulder, 1967), p. 165; R. G. Ridker, *Economic Costs of Air Pollution* (Praeger, New York, 1967); "Air Quality Criteria for Sulfur Oxides, *U.S. Public Health Serv. Publ. No. 1619* (1967), pp. 54–57.

[5] L. Greenburg, M. B. Jacobs, B. M. Drolette, F. Field, M. M. Braverman, *Public Health Rep.* 77, 7 (1962); M. McCarroll and W. Bradley, *Amer. J. Public Health Nat. Health* 56, 1933 (1966); J. Firkert, *Trans. Faraday Soc.* 32, 1192 (1936); H. H. Schrenk, H. Heimann, G. D. Clayton, W. M. Gafafer, H. Wexler, "Air Pollution in Donora, Pennsylvania," *Public Health Bull. No. 306* (1949).

[6] See J. R. Goldsmith, *Med. Thoracalis* 22, 1 (1965).

[7] B. G. Ferris, Jr., and J. L. Whittenberger, *N. Engl. J. Med.* 275, 1413 (1966).

[8] For a summary of laboratory experiments see "Air Quality Criteria for Sulfur Oxides," *U.S. Public Health Serv. Publ. No. 1619* (1967) pp. 79–93.

[9] Chronic effects, where the incidence of the disease is small, can be studied only for large samples (millions of man-years of exposure); see J. R. Goldsmith, *Arch. Environ. Health* 18, 516 (1969); J. Rumford, *Amer. J. Public Health* 51, 165 (1961). Morbidity data would be more useful than mortality data, since death may result from a cause having no direct relationship to the original pollution-induced disease.

[10] For example, M. McCarroll and W. Bradley [*Amer. J. Public Health Nat. Health* 56, 1933 (1966)] correlate the daily mortality rate in New York City with daily pollution indices. See also J. R. McCarroll, E. J. Cassell, W. A. B. Ingram, D. Wolter, "Distribution of families in the Cornell air pollution study" and "Health profiles vs. environmental pollutants," papers presented at the 92nd annual meeting of the American Public Health Association, New York, 1964; ———, *Arch. Environ. Health* 10, 357 (1965); W. Ingram, J. R. McCarroll, E. J. Cassell, D. Wolter, *ibid.*, p. 364; E. J. Cassell, J. R. McCarroll, W. Ingram, D. Wolter, *ibid.*, p. 367. Other workers have attempted to explain daily variations in hospital admissions [see L Greenburg, F. Field, J. I. Reed, C. L. Erhardt, *J. Amer. Med. Ass.* 182, 161 (1962); W. W. Holland, C. C. Spicer, J. M. G. Wilson, *Lancet* 1961–II, 338 (1961); G. F. Abercrombie, *Ibid.* 1953–I, 234 (1953); A. E. Martin, *Mon. Bull. Min. Publ. Health Lab. Serv. Directed Med. Res. Counc.* 20, 42 (1961); R. Lewis, M. M. Gilkeson, Jr., R. O. McCaldin, *Public Health Rep.* 77, 947 (1962); T. D. Sterling, S. V. Pollack, D. A. Schumsky, I. Degroot, *Arch. Environ. Health* 13, 158 (1966); T. D. Sterling, S. V. Pollack, J. Weinkam, *ibid.* 18, 462 (1969)] absence rates (see J. Ipsen, F. E. Ingenito, M. Deane, *ibid.*, p. 402); symptoms in school children [see B. Paccagnella, R. Pavanello, R. Pesarin, *ibid.*, p. 495; T. Toyama, *ibid.*, 8, 1953 (1964)] the incidence of asthma attacks [see L. D. Zeldberg, R. A. Prindle, E. Landau, *Amer. Rev. Resp. Dis.* 84, 489 (1961); C. E. Schoettlin and E. Landau, *Public Health Rep.* 76, 545 (1961); R. Lewis, *J. La. State Med. Soc.* 115, 300 (1963)]; and other morbidity [see J. T. Boyd, *Brit. J. Prev. Soc. Med.* 14, 123 (1960); R. G. Loudon and J. F. Kilpatrick, *Arch. Environ. Health* 18, 641 (1969)].

[11] The most complete investigation of various pollutants was that of the Nashville studies. See L. D. Zeldberg, R. A. Prindle, E. Landau, *Amer. Rev. Resp. Dis.* 84, 489 (1961); L. D. Zeldberg and R. A. Prindle, *Amer. J. Public Health* 53, 185 (1963); L. D. Zeldberg, R. A. Prindle, E. Landau, *ibid.* 54, 85 (1964); L. D. Zeldberg, R. J. M. Horton, E. Landau, *Arch. Environ. Health* 15, 214 (1967); ———, *ibid.*, p. 225; R. M. Hagstrom, H. A. Sprague, E. Landau, *ibid.*, p. 237; H. A. Sprague and R. Hagstrom, *ibid.* 18, 503 (1969). It is conceptually possible to differentiate among pollutants, since, for example, the correlation between mean level of suspended particulates and mean level of sulfates for 114 U.S. Standard Metropolitan Statistical Areas is only .20.

[12] L. B. Lave, "Air pollution damage" in *Research on Environmental Quality*, A. Kneese, Ed. (Johns Hopkins Press, Baltimore, in press).

[13] D. J. B. Ashley, *Brit. J. Cancer* 21, 243 (1967); C. Daly, *Brit. J. Prev. Soc. Med.* 13, 14 (1959); J. Pemberton and C. Goldberg, *Brit. Med. J.* 2, 567 (1954); P. Stocks, *ibid.* 1, 74 (1959); R. E. Waller and P. J. Lawther, *ibid.* 2, 1356 (1955); ———, *ibid.* 4, 1473 (1957); P. J. Lawther, *Proc. Roy. Soc. Med.* 51, 262 (1958); ———, *Nat. Acad. Sci Nat. Res. Counc. Publ. No. 652* (1959), pp. 88–96; ———, *Instrum. Pract.* 11, 611 (1957); J. Pemberton, *J. Hyg. Epidemiol. Microbiol. Immunol.* (*Prague*) 5, 189 (1961); J. L. Burn and J. Pemberton, *Int. J. Air Water Pollut.* 7, 5 (1963); E. Gorham, *Lancet* 1958–I, 691 (1958); P. Stocks, *Brit. J. Cancer* 14, 397 (1960). These studies are updated and summarized in S. F. Buck and D. A. Brown, *Tobacco Res. Counc. Res. Paper No. 7* (1964).

[14] W. Winkelstein, Jr., S. Kantor, E. W. Davis, C. S. Maneri, W. E. Mosher, *Arch. Environ. Health* 14, 162 (1967).

[15] International Joint Commission U.S. and Canada, "Report on the pollution of the atmosphere in the Detroit River Area" (Washington and Ottawa, 1960).

[16] T. Toyama, *Arch. Environ. Health* 8, 163 (1964).

[17] F. L. Petrilli, G. Agnese, S. Kanitz, *ibid.* 12, 733 (1966); A. Bell, in *Air Pollution by Metallurgical Industries*, A. Bell and J. L. Sullivan, Eds. (Department of Public Health, Sydney, Australia, 1962), pp. 2:1–2: 144.

[18] P. Stocks, *Brit. Med. J.* 1, 74 (1959).

[19] P. Stocks, *Brit J. Cancer* 14, 397 (1960).

[20] D. J. B. Ashley, *ibid.* 21, 243 (1967).

[21] That the least-squares method provides the best linear unbiased estimates is the conclusion of the Gauss-Markov theorem, for which $E(ee') = \sigma^2 I$ and $E(e) = 0$ are the basic assumptions. These assumptions are that the basic model must be linear and that the distribution of the errors must have an expected value of zero, have finite variance, have a constant distribution over the various observations, and be independent. In addition, no explanatory variables may be omitted which are correlated with included variables. It is also convenient to assume that the explanatory variables are measured without error, although the framework can easily be adjusted to handle errors. In order to perform significance tests, one must make an assumption about the distribution of the error term. For all the relations we estimated, we plotted the residuals and discovered that

all distributions were unimodel, symmetric, and basically consistent with the normal [illegible]ibution. Thus, in the discussion that follows we have assumed that the error term is distributed normally.

[23] For example, for economic level 1 (defined below), the death rates (per 100,000) for pollution levels 2 to 4 (defined below) are 126, 271, and 392. For economic level 2, the death rates for air pollution levels 1 to 4 are 136, 154, 172, and 199. For economic level 4, the death rates for pollution levels 1 to 3 are 70, 80, and 177. The five economic levels, based on median family income in a census tract, are as follows: $3005–$5007; $5175–$6004; $6013–$6614; $6618–$7347; and $7431–$11,792. The four air pollution levels (in micrograms) of suspended particulates (per cubic meter per 24 hours) are as follows: less than 80, 80–100, 100–135, and more than 135.

[24] P. Stocks and J. M. Campbell, *Brit. Med. J.* 2, 923 (1955).

[25] In most of the early studies, pollution measures were not available, and so urban mortality rates were contrasted with rural rates. In these studies a substantial "urban factor" was found, which, unfortunately, was a compound of air pollution and many other factors. In the later studies the portion ascribable to air pollution is separated out.

[26] C. Daly, *Brit. J. Prev. Soc. Med.* 13, 14 (1959).

[27] Buck and Brown [*Tobacco Res. Counc. Res. Paper No. 7* (1964)], in examining data from England, control for population per acre, for social class, and for smoking habits. They find no relationship between smoking and lung cancer, and a relationship between $SO_2$ and lung cancer that is not consistent. Stocks uses three sets of data to isolate the effect of air pollution on lung cancer. Contrasting data for eight northern European cities, he finds a correlation between lung c[illegible]er and air pollution of .60, and correla[illegible] between lung cancer and smoking that ra[illegible]e between .27 and .36. Contrasting data for 19 countries, he finds that an index of solid fuel consumption is a much stronger variable than cigarette consumption per capita. Finally, with data from northern England, he finds confirmation of an association between lung cancer and air pollution. See P. Stocks, *Brit. J. Prev. Soc. Med.* 21, 181 (1966).

[28] E. C. Hammond and D. Horn, *J. Amer. Med. Ass.* 166, 1294 (1958).

[29] W. Haenszel, D. B. Loveland, M. G. Sirken, *J. Nat. Cancer Inst.* 28, 947 (1962).

[30] Haenszel and Taeuber analyzed data for 683 white American females who died of lung cancer, and for a control group. They found the crude rate of death from lung cancer to be 1.32 times as high in urban areas as in rural areas for 1958–1959 and 1.29 times as high for 1948–1949 (in subjects 35 years and older, with adjustments made for age). When adjustments were made for both age and smoking history, the ratio was 1.27. This ratio increased with the duration of residence in the urban or rural area, from 0.80 for residence of less than 1 year to 1.76 for lifetime residence. See W. Haenszel and K. E. Taeuber, *J. Nat. Cancer Inst.* 32, 803 (1964).

[31] L. D. Zeidberg, R. J. Horton, and E. Landau [*Arch. Environ. Health* 15, 214 (1967)] are not able to isolate an air pollution effect on mortality from lung cancer from data for Nashville for the years 1949 through 1960; C. A. Mills [*Amer. J. Med. Sci.* 239, 316 (1960)] investigated rates of death from lung cancer in Ohio. Stratifying according to the amount of driving done by the deceased, he found that the death rate varied with driving and urban exposure; L. Greenburg, F. F[illegible], J. I. Reed, M. Glasser [*Arch. Environ. H[illegible]* 15, 356 (1967)] investigated 1190 cancer deaths that occurred on Staten Island between 1959 and 1961 and found a relationship between lung cancer and air pollution; M. L. Levin, W. Haenszel, B. E. Carroll, P. R. Gerhardt, V. H. Handy, S. C. Ingraham II [*J. Nat. Cancer Inst.* 24, 1243 (1960)] found significant differences between urban and rural mortality rates (for periods around 1950) in New York State, Connecticut, and Iowa. For males, the death rates were 41 percent higher in urban areas in New York, 57 percent higher in Connecticut, and 184 percent higher in Iowa. For females, the differences were 7 percent, 24 percent, and 47 percent, respectively; P. Buell, J. E. Dunn, L. Breslow [*Cancer* 20, 2139 (1967)] utilized 69,868 questionnaires covering 336,571 man-years, in their study of lung cancer in California veterans. They found rates of death from lung cancer (adjusted for differences in age and smoking habits) to be 25 percent higher in the major metropolitan areas than in the less urbanized areas. Among nonsmokers, the rates of death from lung cancer were 2.8 to 4.4 times as high for major metropolitan areas as for more rural areas.

[32] P. Buell and J. E. Dunn, Jr., *Arch. Environ. Health* 15, 291 (1967).

[33] W. Winkelstein, Jr., and S. Kantor, *ibid.* 18, 544 (1969).

[34] For economic level 2 (see 22), the mortality rate per 100,000 for gastic cancer in white males 50 to 69 years old changed from 45 to 41, 48, and 84 as the pollution level (see 22) rose. For economic level 4, the rates were 15, 38, and 63 for the first three pollution levels. For white women 50 to 69 years old, the death rates for economic level 2 were 8, 18, 25, and 40 per 100,000. For economic level 4, the death rates were 5 and 21 for the first two pollution levels.

[35] R. M. Hagstrom, H. A. Sprague, E. Landau, *Arch. Environ. Health* 15, 237 (1967).

[36] The four measures of pollution are suspended particulates (soiling), dustfall, $SO_3$ and $SO_2$. For all cancer deaths, the number per 100,000 for middle class residents (defined to include about 75 percent of all residents) fell from 153 for high-pollution areas, to 130 for moderate-pollution areas, to 124 for low-pollution areas when a soiling index (concentration of haze and smoke per 1000 linear feet) was used to classify air pollution. When $SO_3$ (milligrams per 100 square centimeters per day) was used as a basis for classification, the corresponding death rates were 150, 129, and 145, respectively. With dustfall as a measure, the figures were 145, 130, and 131, and with 24-hour $SO_2$, in parts per million, they were 141, 129, and 138.

[37] M. L. Levin, W. Haenszel, B. E. Carroll, P. R. Gerhardt, V. H. Handy, S. C. Ingraham II, *J. Nat. Cancer Inst.* 24, 1243 (1960).

[38] P. E. Enterline, A. E. Rikli, H. I. Sauer, M. Hyman, *Public Health Rep.* 75, 759 (1960).

[39] L. D. Zeidberg, R. J. M. Horton, E. Landau, *Arch. Environ, Health* 15, 225 (1967).

[40] When air-pollution level was measured on the basis of sulfation ($SO_3$, in milligrams per 100 square centimeters per day), the morbidity rates (for white, middle-class males aged 55 and older) were 64.0 man-years per 1000. many-years for high-pollution areas, 34.1 for moderate-pollution areas, and 36.8 for low-pollution areas. Measurement of air pollution on the basis of 24-hour concentrations of $SO_2$ gave morbidity rates of 47.2, 36.8, and 22.2, respectively. For these same white, middle-class males, in areas of high atmospheric concentrations of $SO_3$, the mortality rate was 425.6 per 100,000 population; in moderate-concentration areas, 327.41; and in low-concentration areas, 361.97. With $SO_2$ concentrations as a measure, the corresponding figures were 424.87, 319.19, and 364.93. When soiling (smoke or suspended particles) was used as the pollution index, the figures were 376.65, 339.13, and 399.88, respectively.

[41] G. Friedman, *J. Chronic Dis.* 20, 769 (1967).

[42] The effect of air pollution on pneumonia, tuberculosis, and asthma has also been investigated. C. Daly (see *25*) reports simple correlations of .60 for pneumonia mortality and pollution from domestic fuel and .52 for pneumonia mortality and pollution from industrial fuel. For tuberculosis mortality the correlations are .59 and .22, respectively. The death rates for pneumonia rise from 30 to 52 per 100,000, and those for tuberculosis rise from 47 to 89, as one goes from rural setting to conurbations. Stocks (*19*) reports data on pneumonia mortality, by sex, for 26 areas of northern England and Wales. As shown by regressions 27 through 30 in Table 1, there appears to be a strong relationship between a smoke index and pneumonia mortality. The relationship is much stronger for men than for women. C. A. Mills [*Amer. J. Hyg.* 37, 131 (1943)], in a classic study of wards in Pittsburgh and Cincinnati for 1929–30, reports substantial correlation between pneumonia death rates and local pollution indices. He found the correlation between dustfall and rates for pneumonia mortality in white males to be .47 for Pittsburgh and .79 for Cincinnati. The actual variation in these death rates is 41 to 165 per 100,000 population for Cincinnati and 0 to 7852 for Pittsburgh. Mills argues that omitted socio-economic variables could not account for these correlations, but he made no attempt to control for such variables in his studies. He also found that death rates fell significantly as the altitude of an individual's residence increased; there was a drop of approximately 10 percent in death rate for every 100 feet (30 meters) of elevation [see also C. A. Mills, *Amer. J. Med. Sci.* 224, 403 (1952); E. Gorham, *Lancet* 1959–II, 287 (1959)]. Zeidberg, Prindle, and Landau [*Amer. Rev. Resp. Dis.* 84, 489 (1961)] studied 49 adult and 35 child asthma patients for a year. They found that the attack rate (attacks per person per day) for adults rose from .070 during days when atmospheric concentrations of sulfates were low to .216 when concentrations were high. In children, the effect of increased concentrations of sulfates was insignificant. Schoettlin and Landau [*Public Health Rep.* 76, 545 (1961)] investigated 137 asthma patients in Los Angeles during the fall months. They found that 14 percent of the variance in daily attacks ($n=3435$) could be explained by the maximum atmospheric concentrations of oxidants for that day. These two studies document a strong relationship between asthma and air pollution; Lewis, Gilkeson, and McCaldin [*Public Health Rep.* 77, 947 (1962)] found no association between the daily frequency of visits to charity hospitals for treatment of asthma attacks and measures of air pollution.

[43] J. W. B. Douglas and R. E. Waller, *Brit. J. Prev. Soc. Med.* 20, 1 (1966).

[44] A. S. Fairbairn and D. D. Reid, *ibid.* 12, 94 (1958).

[45] L. D. Zeidberg, R. A. Prindle, E. Landau, *Amer. J. Public Health* 54, 85 (1964).

[46] Morbidity rates associated with a soiling index were 140, 122, and 96, respectively, for high, moderate, and low pollution; corresponding rates associated with an $SO_2$ index were 177, 117, and 81. For white females, morbidity rates associated with an $SO_2$ index were 169, 134, and 160; with a soiling index, 158, 139, and 127; and with an $SO_2$ index, 172, 136, and 116. For nonwhite males, the morbidity rates associated with an $SO_2$ index were 86 for high concentrations and 84 for moderate and low concentrations; corresponding rates associated with a soiling index were 94 and 67, and with an $SO_2$ index, 84 and 88. For nonwhite females, morbility rates of 136 and 140 were associated with high and with moderate and low $SO_2$ concentrations, respectively; corresponding rates associated with soiling were 140 and 129, and with $SO_2$ concentrations, 145 and 126. The effects for working women and for housewives, between the ages of 14 and 65, were similar.

[47] E. C. Hammond, paper presented at the 60th annual meeting of the Air Pollution Control Association, 1967.

[48] S. Ishikawa, D. H. Bowen, V. Fisher, J. P. Wyatt. *Arch. Envision. Health* 18, 660 (1969).

[40] W. W. Holland and D. D. Reid, *Lancet* 1965–I, 445 (1065).

[41] D. D. Reid, *ibid.* 1958–I, 1289 (1958).

[42] C. J. Cornwall and P. A. B. Raffle, *Brit. J. Ind. Med.* 18, 24 (1961).

[43] F. C. Dohan, *Arch. Environ, Health* 3, 387 (1961); ——— and E. W. Taylor, *Amer. J. Med. Sci.* 240, 337 (1960).

[44] H. A. Sprague and R. Hagstom, *Arch. Environ. Health* 18, 503 (1969).

[45] L. B. Lave and E. P. Seskin, in preparation.

[46] "Country and City Data Book," *U.S. Dep. Commerce Publ.* (1962); "Analysis of Suspended Particulates, 1957–61," *U.S. Public Health Serv. Publ. No. 978*—(1962); "Vital Statistics of the United States (1960)," *U.S. Dep. Health Educ. Welf. Publ.* (1963); "Vital Statistics of the United States (1961)," *U.S. Dep. Health Educ. Welf. Publ.* (1963).

[47] For a discussion of the limitations of these studies, see B. G. Ferris, Jr., and J. L. Whittenberger (7) and J. R. Goldsmith, *Arch. Environ, Health* 18, 516 (1969).

[48] See "Smoking and Health Report of the Advisory Committee to the Surgeon General of the Public Health Service," *U.S. Public Health Serv. Publ. No. 1103* (1964), p. 362.

[49] This might be explained by noting that farmers tend to be exposed to a high level of pollution in the course of their work (from fertilizers, insecticides, and the exhaust fumes from farm equipment), which causes more deaths from respiratory disease than would be expected from the low level of general air pollution in rural areas.

[50] See, for example, T. Toyama (*16*) and F. L. Petrilli, G. Agnese, S. Kanitz, *Arch. Environ. Health* 12, 733 (1966).

[51] L. D. Zeldberg, R. J. M. Horton, E. Landau, *Arch. Environ. Health* 15, 214 (1967).

[52] R. A. Prindle, G. W. Wright, R. O. McCaldin, S. C. Marcus, T. C. Lloyd, W. E. Bye, *Amer. J. Public Health* 53, 200 (1963).

[53] D. P. Rice, "Estimating the Cost of Illness," *Public Health Serv. Publ. No. 947–6* (1966).

[54] The category "diseases of the respiratory system" encompasses numbers 470 through 527 of the 1962 International Classification of Diseases, Adapted (ICDA). A report of the Commission on Professional and Hospital Activitives, entitled Length of Stay in Short-Term General Hospital (1963–1964) (McGraw-Hill, New York, 1966), gives details on the average lengths of stay and number of patients in 319 U.S. general hospitals for 1963 and 1964 by specific ICDA classifications. From these figures we were able to compute the ratio of total hospitalization by specific disease to total hospitalization for all respiratory diseases. Of the 2,410,900 inpatient days for all respiratory diseases, 232,222 were for acute bronchitis and 177,232 were for "bronchitis, chronic and unspecified." Thus, approximately 17 percent of all inpatient days for respiratory diseases were for some form of bronchitis. On the basis of current hospitalization rates, we find the direct cost of diseases of the respiratory system to be $1581 million annually. An estimated 17 percent of this amount is due to bronchitis; thus, the direct cost of bronchitis is about $268.8 million annually.

[55] To calculate the indirect cost of bronchitis, we must do more than take 17 percent of the total indirect cost ($3,305,700) of all diseases of the respiratory system. Almost 50 percent of respiratory disease patients are hospitalized for "hypertrophy of tonsils and adenoids" (ICDA 510). Hospitalization is categorized by age of patient in the Commission on Professional and Hospital Activities report, and we note that 80 percent of these "tonsil and adenoid" patients were under 20 years of age. Thus, it seems clear that the "forgone earnings" of these patients is negligible, and so no indirect costs should be allocated to this group. We therefore excluded the hospitalization of "tonsil and adenoid" patients before computing the percentage of hospitalization due to bronchitis. Thus, we estimated that 20 percent of the indirect cost of respiratory disease can be ascribed to bronchitis.

[56] There is one bit of evidence that 25 to 50 percent of total morbidity (and therefore mortality) can be associated with air pollution; see L. D. Zeldberg, R. A. Prindle, E. Landau, *Amer. J. Public Health* 54, 85 (1964). If one accepted this evidence as conclusive, it would follow that the annual cost of air pollution, because of health effects, would run between $14 billion and $29 billion.

[57] See J. H. Schulte, *Arch. Environ. Health* 7, 524 (1963); A. G. Cooper, "Carbon Monoxide," *U.S. Public Health Serv. Publ. No. 1503* (1966); *Effects of Chronic Exposure to Low Levels of Carbon Monoxide on Human Health, Behavior, and Performance* (National Academy of Sciences and National Academy of Engineering, Washington, D.C., 1969).

[58] Another way to estimate the cost of air pollution is to examine the effect of air pollution on property values. See R. J. Anderson, Jr., and T. D. Crocker, "Air Pollution and residential property values," paper presented at a meeting of the Econometric Society, New York, December 1969; H. O. Nourse, *Land Econ.* 43, 181 (1967); R. G. Ridker, *Economic Costs of Air Pollution* (Praeger, New York, 1967); R. G. Ridker and J. A. Henning, *Rev. Econ. Statist.* 49, 246 (1967); R. N. S. Harris, G. S. Tolley, C. Harrell, *ibid.* 50, 241 (1968).

[59] P. Buell, J. E. Dunn, Jr., L. Breslow, *Cancer* 20, 2139 (1967).

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## AMERICAN PRISONERS OF WAR

Mr. GORE. Mr. President, during and after every war in which the United States has been engaged, Congress has concerned itself with the prisoner-of-war problem. This is surely the case today. Every Member of Congress is concerned and troubled over the treatment of Americans held prisoner by the various elements engaged in the fighting in Southeast Asia. It is particularly distressing that North Vietnam, claiming to be a sovereign nation and wanting to take its place in the family of nations, has so consistently and coldly refused to follow established practices of civilized man in caring for Americans held prisoner by them. It is particularly distressing, heartless on their part, that we are unable to determine with certainty just who is being held, and under what conditions.

I think we must face the fact that we live in an age of neobarbarity in several respects. The cruel handling of prisoners of war, the actions of guerillas in the Middle East, where established and recognized governments are not in control of their own territories or people, the kidnaping of diplomats in some South American countries, the easy resort to weapons of mass destruction, the disregard of the sovereignty and boundaries of small nations, the thoughtless threats or proposals of would-be leaders to "send in Marines" at every provocation, riots in our cities and on the campuses of our colleges, as well as disrespect for due process of law and justice generally, portend a general retrogression of the gravest sort in our civilization, in the way we treat our fellow man, in the way we view ourselves. This is a matter of the greatest gravity, at home and world over, and ought to be a matter of concern to everyone in a position of leadership in every country of the world. This retrogression is at work in warfare and in disorder in our own society.

In ancient times, wars were generally undertaken for purposes of economic exploitation. Additional lands and peoples were acquired primarily to add to the taxes collected by the ruling group. Soldiers were often paid in booty. One needs only to read casually of the destruction of Thebes, Carthage, Samaria, or Jerusalem, for example, to be impressed with the awful cruelties then so generally practiced.

Under such circumstances, it could not reasonably be expected that prisoners of war would be treated well. Prisoners were a part of the picture of exploitataion. They were sometimes ransomed, if they had sufficiently wealthy connections, but generally they were sold into slavery, into whatever kind of bondage the people of the time and place practiced.

But with the approach of modern times, particularly with the rise of nationalism, both the purpose and conduct of warfare generally changed. So did the handling and disposition of prisoners taken in war. Civilization moved to a higher level of conduct in this regard. Even with the rise of nationalism and its attendant conflicts, the increased reliance on militarism—Prussia adopted universal, peacetime military conscription in the 1860's—the acceleration of the cost of war and size of armies, prisoners of war began to receive better treatment, and it became customary to release and repatriate prisoners of war as a part of all general conflict settlements.

Warfare is, by its very nature, brutal. I know of no way to negate the brutality of armed conflict. But the unarmed, wounded, or captured former combatant who is now no longer a combatant can, should, and I hope always will be treated with humane consideration.

As I have said, mankind has made great strides in this sort of humaneness. And so we find that, insofar as prisoners of war and their final disposition are concerned, the general practice in modern times has been to release prisoners of war without ransom at the conclusion of a conflict. We can date this practice from the Treaty of Westphalia in 1648, which brought to a close the bloody and ideologically bitter 30 years war. And this, despite the fact that Grotius, writing in his monumental work, "On the Law of War and Peace," just a few years earlier had set out the general practice then prevailing with respect to prisoners of war. He maintained that the legalities of warfare recognized the right of cap-

# The effects of urban air pollution on health

*An impressive body of scientific information points to the inescapable conclusion that the levels of pollutant contamination existing today in many American cities are sufficient to produce profound health consequences. This review describes the relationship between pollutant emission, atmospheric cleansing processes, and ambient air pollutant concentrations. Toxicologic studies involving the administration of sulfur dioxide, nitrogen dioxide, carbon monoxide and particulate suspensions to both animals and man are reviewed and demonstrate that single pollutants cannot explain the irritant potential of the urban atmosphere. A number of important epidemiologic studies are presented which emphasize the relationship between human illness and atmospheric pollution. Synthesis of both toxicologic and epidemologic studies leads to the conclusion that the noxious nature of the environment is due to a complicated "mix" of pollutant and meteorologic factors.*

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The breathing of polluted air has been suspected of injuring health since coal was introduced into the English economy in the early fourteenth century. Characteristic of the public attitude to all types of health protective programs, even the most tentative action was not undertaken until a series of large-scale disasters demonstrated the urgent need for air pollution control programs. Beginning steps to regulate the use of coal were initiated in England during the reign of Richard III (1377-1399) and later under Henry V (1413-1422). That such action was not effective is seen in the essay on air pollution written by a distinguished member of the Royal Society, John Evelyn, some 250 years later. The failure to take Evelyn or his many successors seriously led to a series of air pollution episodes, producing as many as 1,063 deaths in 1909 and 4,000 deaths in the London smog of 1952.

England's role as a leader in the Industrial Revolution was inevitably followed by her role as a leader in producing air pollution. The Greater New York Area has closely followed the pattern established across the Atlantic and today ranks as the most highly polluted region in the United States. Almost nothing was done either to study or control pollutant emissions until the episodes of 1953, 1962 and 1966 produced a public reaction culminating in government action.

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Exhibit I

### The effect of climate on air pollution and health

Complaints of climate influencing health are commonly expressed in the consulting room and many physicians concur with the general opinion that the northeastern part of the United States may be considered the "sinus belt." Climatologic influences may affect health in two general ways: weather factors influence the degree of air pollution, and they may also have a direct effect on human health.

The concentration of pollutant material in the ambient air depends both on the absolute quantity of pollutants emitted into the air and the quantity removed by atmospheric cleansing.[76] Wind currents are excellent cleansing agents and produce lateral movement with dilution of emitted pollutants. Vertical movement is produced by convection currents created by the temperature decline with increasing altitude. Normally, the barometric pressure decreases with increasing height above ground, allowing gas molecules to spread and leading to a decrease in gas temperature (adiabatic lapse). Since warm air tends to rise, convection currents are formed, lifting upwards earthborne pollutants.

Failure of the normal cleansing mechanisms produces an atmosphere which has a high pollution potential. High emission rates of pollutants into such an environment may produce high concentrations of pollutant material in the ambient air. In the Northeastern United States, a high pollution potential is frequently produced in the late fall and early winter by a stagnating high-pressure system or anticyclone which is associated with fair weather, low wind speeds, and temperature inversions. These periods of atmospheric stagnation lead to high concentrations of pollutants and result in "air pollution episodes" with associated injury to plants, animals, buildings, and human beings.

Weather conditions also influence the rate of pollutant production. Sulfur dioxide levels are highest in cold weather when large amounts of fuel oil and coal are consumed; they fall to low levels in the summer months.

### Air contaminants found in urban air

The pollutant composition of the ambient air is closely related to economic development. The term "smog," a popular conjugation of "smoke" and "fog," was used to describe the English particulate-laden environment produced by the universal burning of coal. This type of air pollution, produced by various-sized particulates and sulfur oxides, is characterized by its chemical reducing action and is the dominant type of atmospheric pollution found in large industrialized areas such as New York, Philadelphia, and Chicago where coal and other fossil fuels are consumed in large quantities.

Another major type of air pollution is the well-known Los Angeles smog which, although irritating eyes, decreasing visibility, and injuring plants, contains much lower concentrations of sulfur oxides and particulates than the reducing smog described above. Professor A. J. Haagen-Smit[51] demonstrated that ultraviolet irradiation of mixtures of hydrocarbons and nitrogen oxides produced ozone and other oxidants, leading to a smog similar in biologic properties to that occurring naturally in Los Angeles. Subsequent studies have shown characteristic diurnal variations. Hydrocarbon and nitrogen oxide levels are high early in the day corresponding with the peak use of automobiles, while oxidant levels are at their maximum several hours later reflecting the delayed effect of sunlight on the hydrocarbon–nitrogen oxide mixture. Photochemical smog accumulates in congested areas with high densities of automobiles, low wind speeds, temperature inversions, and adequate sunlight to permit photochemical transformation. While initially recognized in the Los Angeles area, photochemical smog has now been observed in every region of the United States.

A detailed account of photochemical

atmospheric reactions has recently been published.[52] Briefly, the most important primary photochemical reaction appears to be the photodissociation of nitrogen dioxide into nitric oxide:

$$NO_2 + h\nu = NO + O$$

where hv is the symbol for a light energy unit. Another important reaction is the photodissociation of aldehydes into free radicals:

$$RCHO + h\nu = \dot{R} + \dot{H}CO$$

Ozone may be formed by the reaction of free and molecular oxygen:

$$O + O_2 = O_3$$

or various peroxy compounds formed by combination of the free radical with oxygen:

$$\dot{R} + O_2 = R\dot{O}O$$

The peroxy radicals react further with nitrogen oxides and other pollutant substances to produce a number of secondary substances including alkyl nitrates, peroxyacyl nitrates, alcohols, ethers, acids, and peroxyacids. An important peroxyacyl nitrate, peroxyacetyl nitrate (PAN) exerts a specific toxic effect on plants which may be used as an indicator for its presence.

Table I lists average urban air based on 1963 figures.[54] Although a large number of organic and inorganic compounds are found in urban air, most studies of pollution-related health effects have monitored but several of these. A health correlation based on the observed concentrations of sulfur dioxide might be strengthened or weakened if based on the concentration of another pollutant. Obviously the ideal approach would be to measure a large number of pollutants and biologic effects and to interrelate them by statistical techniques.

**Table I.** *"Average" urban air, 1963, approximate composition*

| *Compound*[a] | *Concentration (μg/1,000 M.³)* |
|---|---|
| Carbon dioxide | $6.3 \times 10^8$ |
| Carbon monoxide | $8 \times 10^6$ |
| Methane | $1 \times 10^6$ |
| Ethylene | $1 \times 10^5$ |
| Benzene | $1 \times 10^5$ |
| Airborne particulates | $1 \times 10^5$ |
| Sulfur dioxide | $8 \times 10^4$ |
| Formaldehyde solution | $7 \times 10^4$ |
| Nitrogen dioxide | $6 \times 10^4$ |
| Nitric oxide | $4 \times 10^4$ |
| Phenols | $2 \times 10^4$ |
| Ammonia | $2 \times 10^4$ |
| Oxidants (as ozone) | $2 \times 10^4$ |
| Particulate acid (as $H_2SO_4$) | $1.4 \times 10^4$ |
| Acrolein | $1.4 \times 10^4$ |
| Sulfates | $1 \times 10^4$ |
| Benzene-soluble particulates | $7 \times 10^3$ |
| Large aliphatic hydrocarbons | $3 \times 10^3$ |
| Nitrates | $2 \times 10^3$ |
| Iron | $2 \times 10^3$ |
| Lead | $8 \times 10^2$ |
| Large n-alkanes ($C_{14}$ to $C_{30}$) | $5 \times 10^2$ |
| Zinc | $2.3 \times 10^2$ |
| n-Tricosane | $8 \times 10^1$ |
| Manganese | $7 \times 10^1$ |
| Copper | $6 \times 10^1$ |
| Titanium | $3 \times 10^1$ |
| Nickel | $3 \times 10^1$ |
| Arsenic | $2 \times 10^1$ |
| Tin | $2 \times 10^1$ |
| Vanadium | $2 \times 10^1$ |
| Chromium | $1 \times 10^1$ |
| 7H-Benz(de)anthracen-7-one | 8 |
| 3,4-Benzpyrene | 6 |
| Phenalen-1-one | 2 |
| Benz(c)acridine | 1 |
| Dibenz(a,h)acridine | $2 \times 10^{-1}$ |
| Phenols/3,4-benzpyrene | 3,300 |
| Aliphatic hydrocarbons/ 3,4-benzpyrene | 500 |
| n-Alkanes/3,4-benzpyrene | 83 |

### Measurement of air pollutants and relative concentrations in various areas

An understanding of measurement techniques and levels is important for interpretation of the health effects to be described in the following sections.

*Sulfur and sulfur compounds.* Oxidized sulfur, a product of combustion of fossil fuel, has been extensively studied and related causally to health effects. Sulfur dioxide is the major form found in the atmosphere although smaller amounts of nonvolatile sulfuric acid and sulfate salts are also present. Sulfur dioxide, measured in parts per million, is probably the most widely measured pollutant. Unfortunately,

the various methods vary in specificity, and the concentration measured by one technique may not be identical with that measured by another.[75]

Particulate sulfates are measured by high-volume sampling devices which force air through filter paper. The filtered particles may be weighed, sized, and analyzed by chemical methods. Suspended sulfate measured by this technique averages 5 to 15 μg per cubic meter. Total sulfation rates may also be determined by the lead peroxide candle method in which lead paste is converted to lead sulfate over varying periods of time. Total sulfation is usually reported in units of milligrams of sulfate per 100 cm.² of exposed lead peroxide candle per day.

***Particulate pollution.*** A number of techniques for analysis of particulate pollution are in current use. Unfortunately it is frequently impossible to extrapolate data obtained with one technique to another.[74] Dustfall is the measure of particles which settle and generally is an index of particles greater than 10 microns in size. These particles are not respirable and the dustfall measurements do not correlate well with biologic effect. Three other techniques are in widespread use and are generally selected for health studies.

Particles may be sized and counted in a photoelectric device which consists of a light source designed to illuminate a small volume of sample and a photomultiplier tube to detect flashes of light reflected by the individual particles. Perhaps the most widely used devices are tape samplers which draw air through successive areas of filter paper for a given period of time. The amount of particulate material filtered is measured by either reflectance or transmittance techniques. The former is widely used in the United States and the measurements are expressed as coefficient of haze (COH) units per thousand linear feet of air. The high volume sampler is used to measure total particulate concentration in large volumes of air. A major advantage is that the particles may be separated and analyzed chemically for various components.

***Photochemical smog.*** The intensity of photochemical smog may be indicated by the measurement of total oxidants, ozone, or certain organic oxidants such as peroxyacetyl nitrate (PAN).

***Other pollutants.*** Carbon monoxide is commonly measured by an infrared gas analyzer and reported in parts per million. Specialized techniques exist for the measurement of oxides of nitrogen, hydrocarbons, and other pollutants.[91]

***Average values and seasonal variations in urban areas.*** Figs. 1 and 2 represent soiling index (COH), particulate concentration, and sulfur dioxide and nitrogen dioxide concentrations found in New York City during 1967. Note the marked decrease in sulfur compounds and particulates in the summer months reflecting a decrease in fuel consumption, while nitrogen oxides produced primarily by automobile exhaust remain relatively constant. Note that while the two measures of particulate pollution correlate reasonably well, occasional discrepancies occur.

The time of sampling and averaging is extremely important. Both monthly maximum 24 hour averages and monthly averages are presented in Figs. 1 and 2. A real problem exists in the presentation of air quality data. A low annual average may conceal a peak period of extremely high air pollution and health effects may well be sensitive to extremely high peaks as well as to average exposure. Most monitoring networks report hourly, daily, and yearly averages. Individual 24 hour maximum averages may vary from annual means by as much as 300 to 700 per cent.

Table II lists yearly mean values and maximum 24 hour values for certain gaseous pollutants and suspended particulates for a number of American cities.[40]

### The effects of air pollution on health

Characterization of the specific effects of urban air pollution on human health is based on evaluation of a series of epi-

demiologic, toxicologic, and physiologic studies. Casual observations suggesting that London coal smoke might lead to respiratory impairment have formed the basis for epidemiologic studies clearly relating certain types of urban air pollution to respiratory disease. Limited studies of controlled human exposure, buttressed by a number of detailed animal exposure studies, have attempted to evaluate the irritant and toxic potential of specific environmental pollutants. Air pollution con-

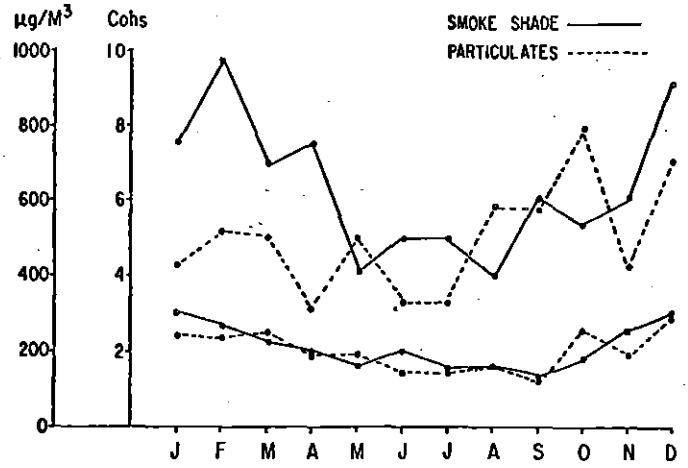


**Fig. 1.** Smoke shade (COH units) and suspended particulates (micrograms per cubic meter) for New York City in 1967. The upper two lines represent 24 hour maximums while the lower two lines represent monthly averages. Note that the 24 hour maximums may be considerably higher than monthly averages. There is a striking seasonal variation with peak concentrations observed in the winter months.

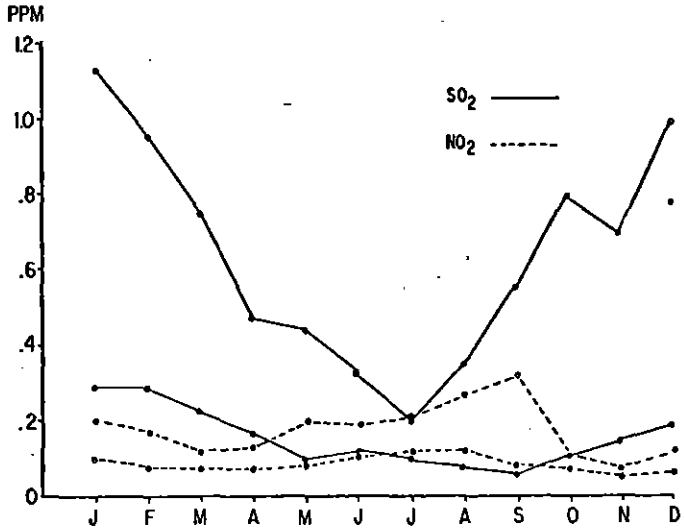


**Fig. 2.** Sulfur dioxide and nitrogen dioxide levels (parts per million) for New York City in 1967. Upper two lines represent 24 hour maximums and lower two lines monthly averages as in Fig. 1. Sulfur dioxide concentrations show marked seasonal variation and considerably higher daily maximums compared to monthly means. In contrast, nitrogen dioxide, produced primarily by automotive exhaust, is relatively stable throughout the year and does not show the striking difference between 24 hour maximums and monthly means.

**Table II.** *Pollutant levels in selected cities*

| | *Chicago* | *Cincinnati* | *Philadelphia* | *Denver* | *St. Louis* | *Washington, D. C.* |
|---|---|---|---|---|---|---|
| Sulfur dioxide | 0.08 ( 1.14) | 0.03 ( 1.86) | 0.09 ( 0.87) | 0.01 ( 0.96) | 0.04 ( 1.25) | 0.04 ( 0.47) |
| Nitric oxide | 0.10 ( 0.74) | 0.04 ( 1.18) | 0.06 ( 1.98) | 0.04 ( 0.59) | 0.03 ( 0.61) | 0.04 ( 1.15) |
| Nitrogen dioxide | 0.06 ( 0.35) | 0.04 ( 1.59) | 0.04 ( 0.29) | 0.03 ( 0.35) | 0.03 ( 0.21) | 0.04 ( 0.19) |
| Carbon monoxide | 13.0 ( 66.0 ) | 5.0 ( 32.0 ) | 7.0 ( 47.0 ) | 8.0 ( 63.0 ) | 6.0 ( 68.0 ) | 3.0 ( 47.0 ) |
| Total oxidants | 0.02 ( 0.23) | 0.02 ( 0.13) | 0.03 ( 0.60) | 0.03 ( 0.30) | 0.04 ( 0.25) | 0.03 ( 0.22) |
| Hydrocarbons | 2.8 ( 14.9 ) | 2.7 ( 12.8 ) | 2.5 ( 14.4 ) | 2.4 ( 19.1 ) | 3.0 ( 14.3 ) | 2.4 ( 14.5 ) |
| Suspended particulates | 140.0 (244.0 ) | 141.0 (255.0 ) | 182.0 (312.0 ) | 156.0 (510.0 ) | 152.0 (260.0 ) | 98.0 (199.0 ) |

First value listed is annual mean. Values in parentheses are 24 hour maximums. All are reported in parts per million (p.p.m.) except for suspended particulates which are reported in micrograms per cubic meter ($\mu g/M.^3$).

trol—the ultimate aim of health effects studies—is based on the establishment of air quality standards derived from a synthesis of epidemiologic and toxicologic data.

### Toxicologic investigations into the effects of air pollutants

Epidemiologic investigations to be reviewed in the next section have stimulated toxicologic studies of the physiologic effects of individual pollutants. While important information has been obtained from these investigations, it has generally been impossible to reproduce human health effects in a laboratory environment in concentrations similar to those existing in polluted urban air. This discrepancy between toxicologic and epidemiologic study suggests that the total irritant potential of polluted air is related to a mixture of air contaminants and to associated unfavorable weather conditions such as low temperatures, high barometric pressures, and high humidity.

The toxicologic literature pertaining to air pollution is large and this review will merely sample several particularly pertinent areas of study.

***Effects of deliberate exposures to sulfur dioxide.*** An example of toxicologic design and interpretive difficulties is the study of the effects of inhaled sulfur dioxide on respiratory function. One of the earliest toxicologic studies was that of Amdur and associates[7] who administered sulfur dioxide to 14 normal subjects and observed an increase in pulse and respiratory rate and a decrease in tidal volume when exposed to sulfur dioxide at a concentration of 5 p.p.m. for ten minutes. Changes were also seen at levels as low as 1 p.p.m. Lawther[65] was unable to confirm these findings and suggested that they were due to chance observations in a small series of individuals.

A detailed series of experiments evaluating the effect of various agents on pulmonary flow resistance in the guinea pig was then undertaken by Amdur with the

use of a technique developed by her and Mead.[6] A summary of her sulfur dioxide studies discussed against the background of sulfur dioxide absorption studies of Strandberg has been recently published.[4] Amdur plotted dose-response curves with the use of a one hour exposure to various concentrations of sulfur dioxide. A biphasic effect was observed with an increase in airway resistance occurring with as little as 0.16 p.p.m. but greater proportional effects being observed at concentrations above 20 p.p.m. Strandberg[92] had shown that the efficiency of upper respiratory scrubbing and pollutant removal was much greater with high concentrations of $SO_2$, so that greater percentages of lower concentrations reached the lower airway. Amdur took Strandberg's absorption data, applied them as a correction factor to her own data, and observed a reasonably straight dose-response curve, over the range 0.16 to 835 p.p.m. of $SO_2$.

Human exposure studies have been published by a number of investigators with varying results. Frank and associates[36] demonstrated increases in airway resistance in 11 healthy subjects when 5 and 13 p.p.m. of $SO_2$ were breathed for 5 to 30 minutes. While the two higher concentrations increased airway resistance, only one of the subjects experienced an increase in airway resistance with the lowest concentration. Snell and Luchsinger[87] were able to construct a dose-response curve by administering 0.5, 1.0, and 5.0 p.p.m. for 15 minutes with the use of maximum expiratory flow rates at half lung volume as an indicator. Five of the 9 subjects had decreased flow rates at the lowest concentration but the changes were not significant for the entire group. Significant changes were observed following breathing of either 1 or 5 p.p.m. of $SO_2$. Speizer and Frank[88] found that 15 or 28 p.p.m. of $SO_2$ breathed for 10 minutes significantly increased airway resistance but that the effects were substantially greater when the gas was mouth breathed rather than administered by nasal mask.

In contrast to these studies, Wright[106] did not observe consistent changes in airway resistance following breathing of 2.5 to 23 p.p.m. of $SO_2$ for 20 minutes, and Burton and associates[20] failed to alter airway resistance when their 10 subjects breathed 2 to 3 p.p.m. for 30 minutes.

Partial explanation for the apparent inconsistency in these studies is found in our own published data. We exposed 96 subjects with or without pulmonary disease to a high concentration (50 p.p.m.) of $SO_2$ for a short period (10 breaths) in an attempt to determine the variability of response. Considerable variation in response was found although the patients with bronchitis and asthma had significantly greater responses, as a group, than did the normal subjects. This individual variation may explain the inconsistency in reported studies. The observation that bronchitic and asthmatic patients have greater responsiveness to inhaled pollutants confirms Amdur's findings that guinea pigs with high resistances appeared more sensitive to airway irritants[3] and also suggests that certain individuals in an exposed population may be more likely to suffer health effects during periods of high pollution.

Although statistical changes in pulmonary function are found following inhalation of sulfur dioxide, it is difficult to imagine how community air pollution with average levels of 0.1 to 0.4 p.p.m. of $SO_2$ and occasional peaks to 1.0 to 1.5 p.p.m. can produce the significant health effects suggested by epidemiologic studies. The inability to reproduce clinical effects at levels encountered in the urban atmosphere has focused attention on other components—particularly particulate material—found in polluted environments.

*Nitrogen oxides.* Nitrogen oxides are important toxic constituents of both automotive exhaust and tobacco smoke, are precursors of ozone under conditions promoting photochemical transformation, and are believed to exert significant independent effects on pulmonary tissue. The acute

pulmonary insufficiency seen in farmers working in silos, silo-fillers' disease, is believed related to inhalation of high concentrations of nitrogen dioxide and provides a human experimental model of the consequences of exposure to that substance. This pollutant may well explain part of the relationship between chronic obstructive pulmonary disease and smoking, since tobacco smoke contains approximately 250 parts per million of nitrogen dioxide.[93] Table II and Fig. 2 show that the concentration of nitrogen dioxide in urban air is usually less than 1 p.p.m.

Freeman and associates[37] have published a series of studies reporting the effects of various concentrations of nitrogen dioxide on the rat lung. Rats exposed continuously to 0.8 p.p.m. $NO_2$ survived natural lifetimes but consistently exhibited mild tachypnea. Continuous exposure to 2 p.p.m. $NO_2$ produced changes in the terminal bronchiole and alveolar duct with broadening of bronchiolar epithelial cells and loss of cilia. Inclusion bodies within lining cells suggested deficient cleansing of inhaled or metabolic waste material. Exposure to 10 to 25 p.p.m. produced large, air-filled heavy lungs without pulmonary edema which resembled those in human emphysema and which produced death from respiratory failure in 20 to 22 weeks. Microscopic study revealed narrowing of the terminal bronchiolar lumens due in part to epithelial cell hypertrophy and in part to accumulation of cellular and noncellular debris at the junction of alveolar duct and bronchiole. Distention and fragmentation of alveoli resembled that seen in human emphysema. Of interest, alveolar lining cells were hypertrophied and appeared to compress septal capillaries presenting an additional barrier to gas exchange and presumably leading to the uniformly observed polycythemia.

Respiratory mechanics and alveolar gas exchange were studied in rabbits continuously exposed to 8 to 12 p.p.m. of $NO_2$ for 3 months by Davidson and associates.[38] Functional residual capacity and airway resistance increased, static lung compliance was unchanged, and arterial oxygen tension decreased. Arterial carbon dioxide tension was unchanged.

Boren[17] studied the interaction of nitrogen dioxide with carbon particles in an attempt to approximate part of the "pollutant mix" found in the community atmosphere. Exposure of mice to 250 to 500 p.p.m. $NO_2$ produced pulmonary edema and frequent death while exposure to carbon particles alone or daily exposures to 25 p.p.m. of $NO_2$ for 30 minutes was without effect. Exposure to carbon particles previously treated with $NO_2$ produced focal destructive lesions with loss of alveolar walls.

***Behavior of inhaled particles.*** While inhaled gases may move rapidly in and out of the respiratory system, the removal of inhaled particles is considerably slower and depends upon the efficiency of the tracheobronchial mucociliary carpet and of alveolar macrophage activity. The physiologic response produced by an inhaled gas is related to its solubility.[25] Sulfur dioxide, a highly soluble gas, may produce an immediate bronchoconstrictor effect because it is immediately absorbed by upper respiratory receptors; nitrogen dioxide is considerably less soluble, may reach more distant lung regions, and produce delayed nonreflex effects. The physiologic response of a particle, in contrast, is determined by its chemical composition and size.

The most meaningful characterization of particle dimension is the equivalent aerodynamic diameter which is the diameter of a sphere of density 1 gm. per cubic centimeter which falls in air with the same terminal settling velocity as the particle in question. Hatch and Hemeon[55] showed that the alveolar retention of particles is related to two basic processes, particle deposition and particle clearance. Particles greater than 3 to 5 $\mu$ in size tend to be deposited in the upper respiratory tract while alveolar deposition increases with decreasing particle sizes. Particle

clearance, on the other hand, is more efficient for smaller particles. The net result of these conflicting factors is to produce a zone of maximal alveolar retention which varies among particle species but ranges from 0.5 to 3 $\mu$. The effect of particle species on retention is seen in the study of Landahl and Herrmann[64] who found that the particle diameter corresponding to 50 per cent retention ranged from 0.9 $\mu$ for $NaHCO_3$ to 3 $\mu$ for corn oil.

Wilson and LaMer[102] confirmed theoretic predictions in human subjects by measuring alveolar and total retention following inhalation of a radioactive aerosol ($Na^{24}Cl$). Peaks of maximal retention at diameters ranging from 0.3 to 1.0 $\mu$ were observed. Prolonged particle persistence was demonstrated by Albert and co-workers[1] who administered radioisotope-tagged iron oxide particles of various sizes to human subjects and followed chest radioactivity with sodium iodide scintillation counters. In one experiment, 30 per cent of 3.6 $\mu$ particles remained in the lung after 56 days. In another study, about 30 per cent of 5.0 $\mu$ particles and 65 per cent of 2.9 $\mu$ particles were retained at 24 hours.

The combined effects of particle size and composition are shown in the study of Amdur and Corn.[5] The percentage increases in guinea pig airway resistance produced by inhalation of similar concentrations of zinc ammonium sulfate were 80 per cent, zinc sulfate 40 per cent, and ammonium sulfate 25 per cent. Dose-response curves were then prepared for increasing concentrations of particulate sulfate at different particle sizes. The slopes of the different curves were dramatically different; increasing concentration of particles of 1.4 $\mu$ diameter produced small increments in airway resistance while increasing concentrations of particles of 0.3 $\mu$ produced dramatic increments in resistance. Equivalent concentrations of these two particle sizes produced 5 per cent and 80 per cent increases in airway resistance, respectively.

Zinc ammonium sulfate had been selected by Amdur and Corn because earlier studies suggested its possible irritant role in the acute air pollution episode occurring in Donora, Pennsylvania. The relevancy of the particle sizes investigated was later demonstrated by Corn and DeMaio[26] who found that 90 per cent by number of the total particulate sulfates in Pittsburgh air were less than 1.9 $\mu$ in diameter.

The studies reviewed in this section have given rise to the concept of "respirable" air pollutants. While measures of total suspended particulates are widely available, health effects may be more closely related to the concentration of respirable particulates. The chemical composition of these two groups of particulates may vary widely. Benzene soluble organic substances, total sulfates, and iron have been shown to make up 7.7, 15.3, and 5.8 per cent of respirable dust and 3.5, 9.2, and 17.3 per cent of total suspended particulate material.

*Gas-particle interactions.* The ubiquitous occurence of certain pollutant gases and the demonstrated retention and irritability of small particles have led to the concept of gas-particle interactions. A particle might potentiate the effect of an absorbed gas by promoting deposition or by providing a surface for catalytic transformation of the gas to a more toxic form. Amdur[2] showed that an 0.04 $\mu$ aerosol of sodium chloride potentiated the effect of sulfur dioxide on the guinea pig while a 2.5 $\mu$ aerosol did not. Zinc sulfate particles 0.29 $\mu$ in diameter were shown by Amdur and Corn to potentiate the effect of sulfur dioxide. Carbon particles were shown by Boren[17] to act as a carrier for nitrogen dioxide producing focal destructive pulmonary lesions reminiscent of human emphysema, while administration of nitrogen dioxide alone produced pulmonary edema.

Several investigators have attempted to reproduce the animal observations of Amdur and associates in man. While neither Frank and associates[35] nor Burton and

associates[20] could demonstrate an increased effect with a sulfur dioxide acrosol mixture, Snell and Luchsinger[57] found that a distilled water aerosol (mean particle size about 0.3 $\mu$) augmented the response to sulfur dioxide while a saline aerosol (mean particle size about 6 to 8 $\mu$) did not.

***Experimental observations of breathing filtered air.*** While it may be ethically impossible to perform certain toxicologic studies, the reverse procedure—elimination of pollutants from an urban atmosphere—is both ethically proper and scientifically rewarding. Motley and associates[73] demonstrated significant improvement in pulmonary function studies in emphysematous patients who breathed filtered air for at least 40 hours. Recently Ury and Hexter[97] analyzed an experiment performed by Remmers and Balchum and were able to demonstrate a correlation between pulmonary function tests and pollutant levels in a group of 15 patients with severe obstructive emphysema who lived for 3 weeks in a controlled environment room.

***Biologic effects of photochemical smog.*** Toxicologic studies of the products of photochemical smog on human subjects stand in a different position than those on the gases and particulates discussed above because definite laboratory effects may be observed at levels occuring in community atmospheres. Most toxicologic studies have measured either total oxidant or ozone concentrations. Since ozone may constitute up to 90 per cent or more of the total oxidant level, the two measures may be roughly equated. The studies described below should be analyzed with regard to the fact that total oxidant levels in certain communities may average 0.2 to 0.5 daily and may peak to levels of 1.0 p.p.m. in dense photochemical smog.

Eye irritation is experienced when total oxidant levels reach 0.1 to 0.2 p.p.m. and concentrations of ozone between 0.2 to 0.5 p.p.m. reduce visual acuity. Brief exposure to 0.05 to 0.1 p.p.m. produces irritation and dryness of the upper respiratory passages and concentrations between 0.30 to 1.0 produce choking, coughing, and severe fatigue.[61] Diffusing capacity and other pulmonary function studies were significantly decreased in normal subjects exposed to 0.6 to 0.8 p.p.m. ozone for 2 hour periods,[108] and the decrease in function persisted for up to 24 hours. Griswold and associates[49] exposed a normal volunteer to 1.5 to 2.0 p.p.m. and produced a syndrome characterized by impaired lung function, severe chest pains, coughing, headache, and difficulty in coordinating which persisted for almost 2 weeks.

### Epidemiologic studies

Goldsmith[42] has emphasized that epidemiology is literally translated as "the science of that which is upon the people." He pointed out that the total management of environmental problems from a general concern for disease states, through identification of causative environmental factors, to the establishment and observation of workable control systems is basically the responsibility of the epidemiologist. This review will outline certain epidemiologic principles and present data from a number of important studies attempting to evaluate the relationship between urban air pollution and health.

Air pollution epidemiology attempts to relate various air phenomena with various health phenomena. Health phenomena may be observed by recording general or specific death rate or by various indices of morbidity including clinic visits, absenteeism in working populations, observation of panels of selected patients, or interview techniques on various population groups. Physiologic effects which may or may not produce symptoms may be identified by the application of physiologic testing procedures or by pathologic examination of autopsy or biopsy material. Air phenomena are evaluated by meteorologic pollutant concentration and pollutant emission studies. The total body burden of certain air pollutants may be determined by fre-

quent air quality measurements or predicted from mathematic models with the use of emission and meteorologic data.

Interpretation of air pollution epidemiologic data is facilitated by the suggestion of Ipsen and associates[59] that air and health phenomena may be interrelated in at least four ways. The obvious occurrence of both high levels of air pollution and excessive mortality and morbidity rates has been called the "double phenomena" and is typified by the classic air pollution episodes. The obvious outbreak of a specific disease (epidemic) may be related to a recognized air contaminant, an example of specific epidemiology, or a unique air phenomenon may be studied in retrospect and related to more subtle health phenomena. A fourth interrelationship is the statistical association of subtle air and health effects over a definite time period.

Quantitative study of the above relationships requires accurate measurement of both air and health phenomena and definition of the relationship between these two factors. A number of considerations may confuse the relationships between air pollution and health effects. The unmeasured variable may either produce an apparent relationship or may obscure an actual relationship. Frequency of cigarette smoking, genetic background, climate, presence of influenza virus or other respiratory infectious agent, and economic level are other variables which may alter the frequency of health phenomena. Both air pollution and health effects might be related to a third variable and not themselves interrelated. For example, cold weather might produce upper respiratory infections and also increase fuel consumption producing an increase in air pollution. A study correlating upper respiratory infections and air pollution would predict a causal effect where, in fact, none might exist. If the effect of cold temperature could be controlled by making a series of health observations during two periods—both with cold temperature but one with high pollution, and the other with low pollution—more meaningful data might be obtained. Many of the studies reviewed below have attempted to control certain of these factors by evaluating populations in different geographic locations, and different areas of the same urban area and children (presumably nonsmokers) or by measuring all conceivable variables and eliminating them statistically.

The conclusions of most epidemiologic studies are based on statistical techniques ranging from simple standard testing procedures to complicated analyses made possible by high-speed digital computers. Unfortunately for many physicians, the statistical techniques used to support a given conclusion are frequently unfamiliar and reliance must be placed on the statistical ability of the editorial review. The papers of Ury and Hexter,[97] Reinke,[82] and Sterling and associates[90] should be consulted for an introduction to air pollution statistics. Standard analysis of variance and simple correlation procedures may be used when the data are normally distributed. Nonparametric tests such as chi square, sign test, or Wilcoxon tests may be used if the data are not normally distributed. Multiple regression with either linear or nonlinear treatment is especially useful when evaluating the effect of multiple factors on various health indices. Verma and associates[98] related both health and environmental variables to time and attempted to remove time trends in order to study the relationship between health effects and air pollution. This study and the series of papers by McCarroll and associates[70] make use of a series of correlations for each time interval. The latter authors, for example, published "correlograms" which graphically presented both cross- and autocorrelations for a group of symptoms and a group of air pollutants.

*Air pollution episodes: The double phenomena.* Certain striking episodes characterized by obvious increase in air pollution and obvious health effects provided the earliest suggestion that air quality and health might be closely related. This see-

tion deals with the major air pollution disasters (double phenomena of Ipsen[59]) and also reviews certain other episodes of high pollution which were retrospectively associated with increased death and morbidity. Obviously, as public and professional awareness increases, more such episodes may be regarded as double episodes.

On Monday, December 1, 1930, a thermal inversion markedly reduced the diluting capacity of the atmosphere in the Meuse River Valley in Belgium, a river valley 15 miles in length surrounded by hills rising to 300 feet on either side. Chest pain, cough, shortness of breath, and eye and nasal irritation were common symptoms; 60 persons died in a period of one week. Air quality measurements were not made but it is estimated that sulfur dioxide concentrations ranged between 10 and 38 p.p.m. Goldsmith[41] has suggested that sulfuric acid, produced by combination of sulfur dioxide with water vapor in the presence of other pollutants, was probably one of the major irritating substances present in the atmosphere.

The effect of a similar atmospheric inversion occurring in Donora, Pennsylvania, located in a valley of the Monongahela River, has been masterfully portrayed by Berton Roueché[93] in his book, *Eleven blue men: Tales of medical detection.* The episode began on the morning of Tuesday, October 26, 1948. Over 40 per cent of the population became ill with lower and upper respiratory symptoms; 20 died, most on the third day of the episode. While the pollutants responsible for the irritant effects have not been identified—measurements were not made during the episode—sulfur dioxide concentrations were estimated to be as high as 2.0 p.p.m.[41]

The most disastrous air pollution episode occurred in the British Isles from December 5 to 9, 1952. Fig. 3 shows the number of deaths registered in Greater London for each week beginning with November 15 and continuing through January 10. The dashed line shows the average death rate for the period of 1947 through 1951; deaths above the dashed line represent "excess" deaths. The total excess was between 3,500 and 4,000 deaths for the entire period. Even though atmospheric conditions improved within 4 days,

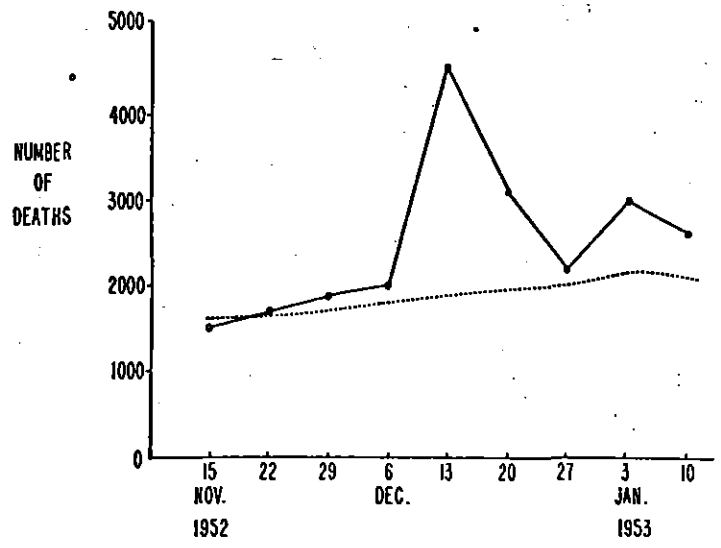


**Fig. 3.** Daily mortality data during 1952 to 1953 in the Greater London area showing the striking increase in death rate during a period of extremely high pollution. Dashed line shows daily mortality data for the period 1947 to 1951 and the difference between the two lines is considered "excess mortality." (Redrawn from Goldsmith.[41])

the increase in deaths persisted throughout the month of December, suggesting that the initial pollutant insult was complicated by other factors (presumably infection) which perpetuated the mortality rate.

A number of periods of high air pollution have been recorded in New York City—a city which consistently experiences extremely high levels of atmospheric contaminants. A period of persistent temperature inversions occurred from November 15 to November 24, 1953. The intensity of air pollution was seen in the increase in the daily average smoke shade readings from a peak (for the period of observation) of 2.42 in 1950 through 1952 and 2.76 in 1954 through 1956 to a peak of 8.38 on November 20, 1953. Greenburg and associates[45] compared the daily death rate during that period with that observed in 1950 through 1952 and 1954 through 1956. The daily number of deaths was greater than 250 in only 12 of the 210 control days (5.7 per cent), while that number was exceeded on 6 of the 10 days (60 per cent) of the November, 1953, inversion period. An increase in clinic visits for upper respiratory and cardiac illnesses but not for asthma was also observed during this period.[47]

Many of the New York City episodes have not been true "double phenomena," in which both health and air phenomena were immediately apparent. The subtle effects on human health may be seen in a series of statistical studies conducted by Greenburg and associates[45, 46] and by McCarroll and Bradley.[69] Fig. 4 is taken from the latter investigators and demon-

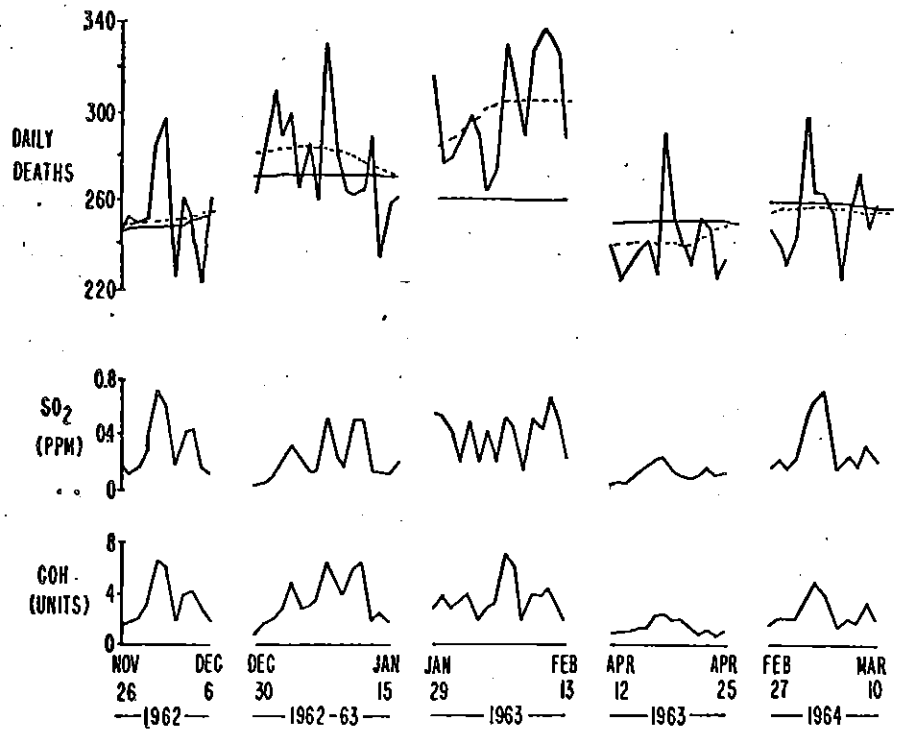


**Fig. 4.** The variety of interrelationships between air and health phenomena is shown in this composite figure. The upper panels present daily mortality rates in New York City. Fifteen day moving averages are shown in dotted lines and, predicted mortality rate based on previous years is shown in solid lines. Sulfur dioxide and smoke shade concentrations are presented as indicators of air pollution. See text for complete description. (Adapted from McCarroll and Bradley.[69])

strates the variety of interrelationships observed between human health and the environment. Daily deaths from all causes, sulfur dioxide and smoke shade concentrations, are shown. Two types of control mortality data are shown. The solid line shows the expected daily mortality rate based on data from previous years; the dotted line is a 15 day moving average based on the 7 days preceding and following the day in question.

*November 26 to December 6, 1962.* Sudden increases in daily death rate and air pollution which appear to be related are observed. An increase in morbidity among individuals living in nursing homes was also observed during this period.[45] McCarroll and Bradley[69] pointed out that while mortality rate tends to fall below expected levels following such a sudden rise in pollutant levels, this fall is never sufficient to compensate for the excess of deaths on the preceding days.

*December 30, 1962 to January 15, 1963.* This period demonstrates certain other environmental relationships confusing the direct effect of air pollution on health. A sudden temperature drop occurred on the night of December 30 to below 10° F. A broad peak of increased mortality rate follows this but two other mortality rate peaks appear related to air pollution peaks during a period of relatively constant temperature.

*January 29 to February 13, 1963.* The presence of an influenza epidemic may seriously distort mortality rate figures. The daily mortality rate is well above predicted levels and the moving average is obviously a more appropriate base line. Air pollution and mortality rate peaks appear to be related even though the mortality figures are considerably higher than usual.

*April 15 to April 25, 1963.* This period demonstrates the presence of an increased mortality rate peak without increase in the air pollution indices but during a period of decreased wind speed and increased frequency of inversions. The mortality rate peak is statistically unexpected and difficult to explain. The sudden rise is not compatible with an infectious disease process. Other unmeasured pollutants may have been elevated or other yet undetermined environmental factors may have been responsible. Cold temperature and influenza virus could be eliminated as possible causal factors.

*February 27 to March 10, 1964.* This episode was characterized by extremely high levels of air pollution which suddenly appeared and were associated with extremely low wind speeds and an increased frequency of temperature inversion. It appears to be an inescapable conclusion that the sudden change in concentration of air pollutants from low levels to very high levels is responsible for the sharp increase in mortality rate.

*The Thanksgiving Day air pollution episode.* On November 19, 1966, a large mass of cold air—an anticyclone—moved over the Eastern seaboard and persisted until November 25. Wind velocity fell to 4.3 miles per hour and daily temperature inversions appeared. Fig. 5A shows hourly concentrations of carbon monoxide, smoke shade, and sulfur dioxide. The intensity of the pollution is shown by the hourly maximum for sulfur dioxide which reached 0.69, 0.97, and 1.02 on November 23, 24, and 25, respectively. Pollutant concentrations dropped precipitiously on the evening of November 25 due to a sudden change in meteorologic conditions with increasing wind speeds.

Four separate health indices are presented in Fig. 5B. Pollution levels are indicated by 24 hour average values for sulfur dioxide. The second panel shows the number of positive responses to a query regarding eye irritation contained in a questionnaire administered by Becker, Schilling, and Verma.[15] The middle panel shows daily mortality data together with predicted mortality rate (dashed line) from Glasser, Greenburg, and Field.[39] The two lower panels show the frequency of emergency room visits for respiratory com-

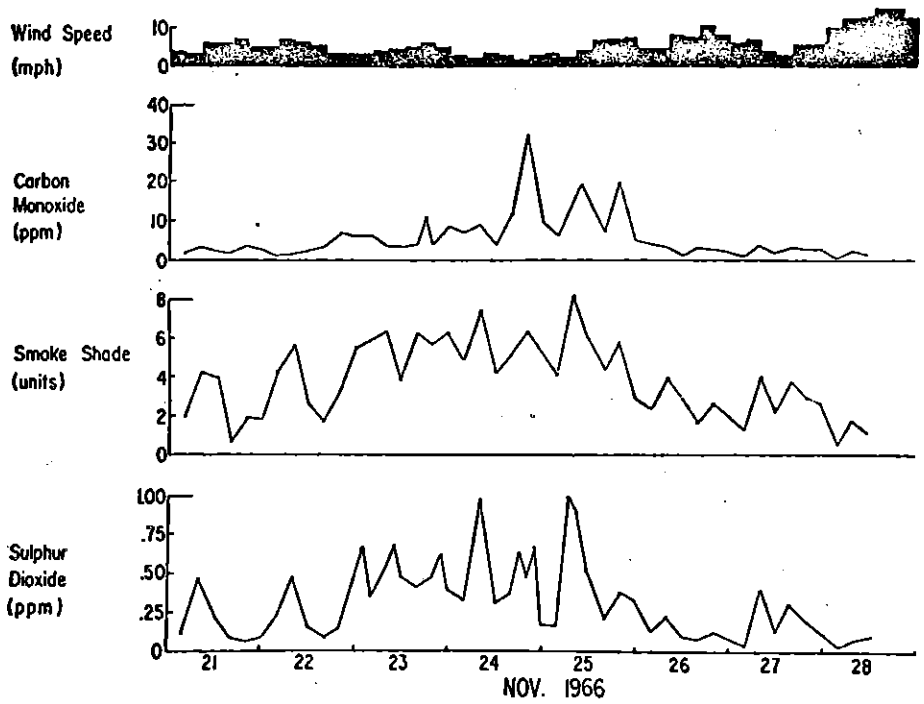


**Fig. 5A.** Air pollutant and wind speed measurements for the period before and after Thanksgiving Day, 1966. Thermal inversions and decreased wind speeds created a stable atmosphere with striking increases in carbon monoxide, smoke shade, and sulfur dioxide.

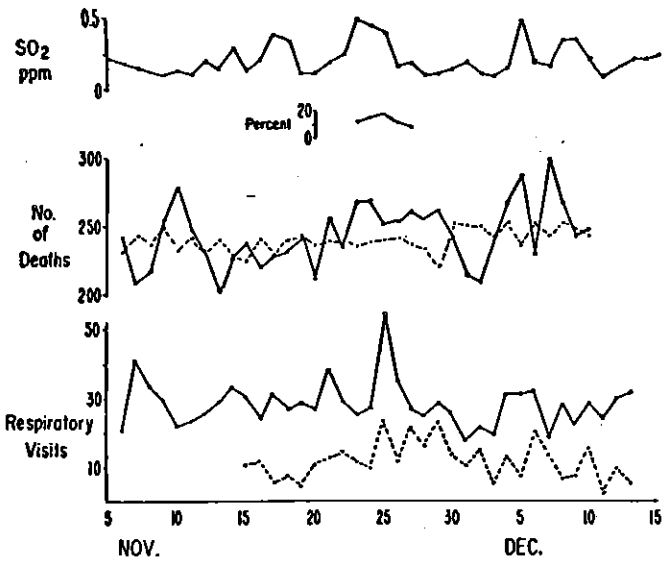


**Fig. 5B.** Four separate health indices from three different investigators demonstrate the effects of the Thanksgiving Day inversion on human health. From above downward, the top panel shows sulfur dioxide concentrations while the second panel shows the incidence of eye irritation during a five day period studied by Becker, Schilling, and Verma.[15] The middle panel shows daily mortality data together with predicted mortality *(dashed line)* from Glasser, Greenburg, and Field.[39] The two lower panels show the pattern of emergency room visits for respiratory complaints from Glasser, Greenburg, and Field[39] together with our own unpublished data *(dashed line)*.

plaints from the study of Glasser, Greenburg, and Field[39] together with our own unpublished data (lower panel). Thus, four separate health indices demonstrated a significant increase during the period of high pollution.

***Non-episodic-correlated health effects.*** Health effects of community air pollution are most obvious during the episodes of unusually high pollution reviewed in the previous section. Evidence to be reviewed in this section suggests that exposure to regularly occurring concentration of air pollution may also exert a deleterious effect on health. The precautions regarding epidemiologic interpretations discussed earlier apply with equal urgency to the studies reviewed here. An observed health effect may be due to variables other than air pollution or an actual health effect due to air pollution may be masked by some more powerful factor such as cigarette smoking.

Obviously all such papers could not be included. We have in general selected papers which have either attempted to control most extraneous variables or have presented important observations that could be due to positive findings. While negative findings frequently do not find their way into print, several such papers have emphasized that "negative" findings cannot be equated with "no air pollution effect." Louden and Kilpatrick,[65] for example, were unable to find a correlation between the frequency with which antitussive medication was prescribed and the concentrations of certain air pollutants. They pointed out that this technique might not be sufficiently sensitive to demonstrate

**Table III.** *Air quality measurements in regions used for epidemiologic study*

| | *High* | *Low* | *High/low ratio* |
|---|---|---|---|
| ***Prindle et al.[50]*** | | | |
| Sulfation, mg. $SO_3$/100 cm.²/day | 3.7 | 0.6 | 6.2 |
| Suspended particulates, μg/M.³ | 151 | 109 | 1.39 |
| Dustfall, tons/mile²/month | 83 | 26 | 3.2 |
| ***Holland and Reid[57]*** | | | |
| Sulfation, mg. $SO_3$/100 cm.² | 1.65 | 0.95 | 1.7 |
| Dustfall, mg./M.² | 136 | 59 | 2.3 |
| ***Burn and Pemberton[19] (winter means)*** | | | |
| Sulfur dioxide, p.p.m. | 0.25 | 0.12 | 2.08 |
| Smoke concentration, μg/M.³ | 770 | 450 | 1.7 |
| ***Winkelstein[104]*** | | | |
| Sulfation, mg. $SO_3$/100 cm.²/day | 1.25 | 0.20 | 6.3 |
| Suspended particulates, μg/M.³ | 206 | 75 | 2.7 |
| ***Dohan et al.[29]*** | | | |
| Suspended sulfate, μg/M.³ | 19.8 | 7.4 | 2.7 |
| Suspended particulates, μg/M.³ | 173 | 101 | 1.7 |
| ***Toyama[95] (Kawasaki City—April)*** | | | |
| Sulfation, mg. $SO_3$/100 cm.²/day | 1.7 | — | — |
| Dustfall, tons/Km.²/month | 70.0 | 12.2 | 5.7 |
| ***Ishikawa et al.[60] (emission data)*** | | | |
| Sulfur oxides, tons × 10³/year | 455 | 36 | 12.6 |
| Particulates, tons × 10³/year | 147 | 82 | 1.8 |

This table reflects the variety of air pollution indices found in the literature. Since the results from one instrument may not be directly translated to those from another, no attempt at conversion has been made.

an effect of air pollution on the symptom of cough.

*Geographic differences in disease frequencies.* A number of studies have demonstrated an increased incidence of respiratory disease among urban populations compared with that among rural populations. Since the demonstration of an urban-rural health gradient obviously depends upon the demonstration of an urban-rural pollution gradient, pollutant ratios (for indices of sulfation and particulate pollution) are given. Absolute levels of pollution in the studies cited are presented in Table III to enable comparison of air quality among areas. Moreover, the studies discussed emphasize that other variables such as economic level, indoor heating techniques, and frequency of cigarette smoking may also produce an urban-rural health gradient.

Prindle and associates,[50] in 1959, studied two neighboring communities in Pennsylvania which were believed to have different air quality characteristics. Dustfall and sulfate pollution were 3.2 and 6.2 times more intense in Seward as compared with New Florence. In addition, sulfur dioxide vegetation damage was demonstrated in Seward but not in New Florence. While most pulmonary function tests were similar, subjects in Seward had significantly higher airway resistances suggesting a subtle effect of some environmental factor.

Respiratory disease incidence was studied in 293 London men and 477 rural Englishmen by Holland and Reid.[57] Pollutant ratios averaged 2.3 for dustfall and 1.7 for sulfation. The Medical Research Council's short questionnaire and several simple pulmonary function studies were administered to each subject. Both age and residence gradients were observed. Persistent cough and sputum production were observed in 38.7 per cent of the London men between the ages of 50 and 59 years compared to

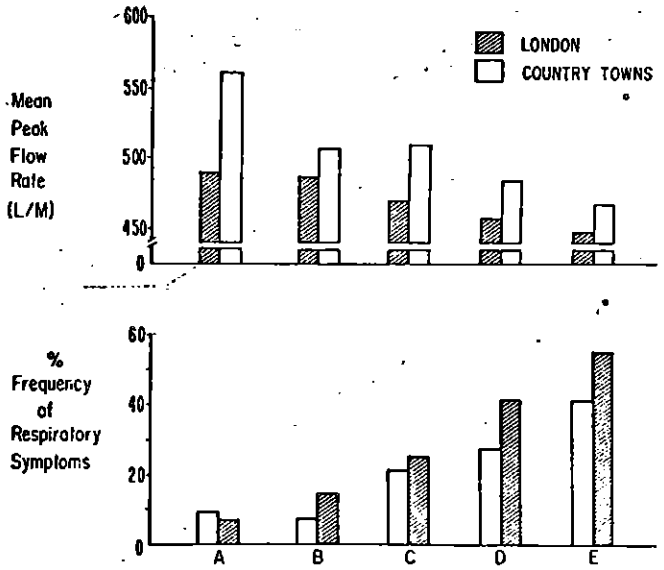


**Fig. 6.** The interrelationships between smoking and exposure to air pollution are shown. Data obtained from men living in London are shown in hatched area; data from men living in rural areas are shown in clear areas. Smoking history as follows: *A*, nonsmoker; *B*, exsmoker; *C*, 1 to 14 Gm. tobacco per day; *D*, 15 to 24 Gm. per day; *E*, 25 Gm. or more. Note that the frequency of cough and sputum production increases and mean peak flow rate decreases with increasing smoking exposure. For each smoking class, symptoms are more frequent and pulmonary function poorer in men living in London compared to those for men living in rural areas. (From Holland and Reid.[57])

18.9 per cent in men of the same age living in country towns. In contrast, significant differences were not found between younger men living in London or in English country towns. Fig. 6 is taken from their study and shows the effect of both cigarette smoking and place of residence on symptoms of respiratory disease and pulmonary function. Clearly the two factors are additive. The Londoner who smokes has more than five times the frequency of bronchitis and 80 per cent of the pulmonary function of a rural dweller who does not smoke.

Holland and Reid later combined their data with those obtained from American telephone workers by Seltser and Stone. The combined data[58] provide an interesting perspective on the comparative frequency of respiratory disease in the two countries. The frequency of persistent cough and sputum production was 22.2 per cent in the fifth decade and 25.8 per cent in the sixth decade in the American subjects. These combined data suggest that little difference exists in the frequency of chronic bronchitis among men between the ages of 40 and 49 living in London, English country towns, or the United States. In the decade 50 to 59, however, bronchitis is much more common in London than in either English country towns or the United States. A marked age gradient is seen in the London men but not in the other two groups suggesting that life in that city predisposes to the development of bronchitis. Fig. 7, taken from the combined study, shows the relationship of a single pulmonary function test, the $FEV_1$ (one-second forced vital capacity), and cigarette smoking in the three populations. Some factor in addition to cigarette smoking appears to depress pulmonary function in Englishmen, and this appears to be the levels of air pollution.

A third study by Colley and Holland[24] shows the application of the questionnaire technique to family groups in an effort to assess the varying influences of smoking, area of residence, place of work, family size, social status, and genetic factors in the development of chronic respiratory disease. Two areas of London were selected for study. In fathers, smoking and social class influenced the prevalence of cough

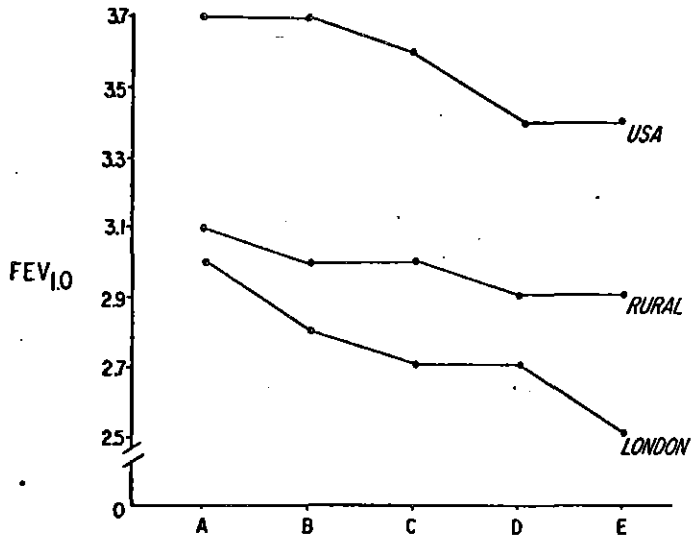


**Fig. 7.** Data from the combined study of Holland, Reid, Seltzer, and Stone[58] show the relationship of a single pulmonary function test, $FEV_1$, to smoking history and place of residence. Smoking classes on abcissa are the same as in Fig. 6.

while the area of home residence did not. In both children and mothers the area of residence influenced the incidence of cough; mothers were not influenced by social class. Studies such as this are useful in attempting to separate the interacting factors influencing the frequency of respiratory disease in a given population.

Burn and Pemberton[19] took advantage of differences in air pollution within the town of Salford to study the effects of air pollution on the incidence of chronic bronchitis and lung cancer. The average smoke pollution for the entire area is extremely high (510 $\mu$g per cubic meter) but ranges from 170 on the periphery to 680 centrally. Measurements of both sulfur dioxide and particulate concentrations indicate air pollution in the central areas to be about four times more intense than that in outlying areas. Incidence ratios based on observed incidence divided by expected incidence were calculated and tested by chi square analysis. Incidence ratios for episodes of bronchitis were 130 in the high pollution area and 60 in the low pollution area. Mortality ratios for deaths from bronchitis, lung cancer, arteriosclerotic heart disease, and cerebral vascular disease were 128, 124, 90, and 75, respectively, in the high pollution area and 52, 79, 120, and 111 in the low pollution area. Differences in morbidity and mortality rates from chronic bronchitis and death from lung cancer were highly significant.

A similar geographic approach within the greater Buffalo area was undertaken by Winkelstein and associates[103, 104] and demonstrated similar findings. In addition, this study also evaluated economic status as a possible causal factor in death from chronic obstructive lung disease. Standardized mortality ratios were calculated from death certificates, and economic class was derived from census information. Mortality rates from respiratory disease and gastric carcinoma within each economic group were closely related to air pollution levels which averaged greater than 135 $\mu$g per cubic meter in the high pollution area and less than 80 $\mu$g per cubic meter in the low pollution area. A similar relationship could not be established for lung cancer. Correlation between mortality rate and air pollution with the use of sulfation (lead peroxide candle method) as the index of pollution was poor, demonstrating the importance of selection of air quality indices in such epidemiologic stud-

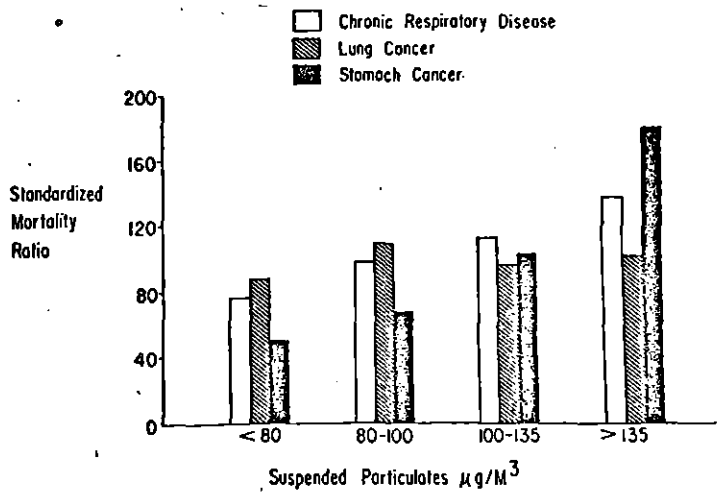


**Fig. 8.** Standardized mortality ratios for four air pollution regions in Buffalo–Erie County, New York. Data adapted from Winkelstein and associates[103, 104] show a relationship between air pollution and mortality rates for chronic respiratory disease and stomach cancer but not for lung cancer.

ies.[108] Fig. 8 shows the standardized mortality ratios for chronic respiratory disease, lung cancer, and gastric carcinoma for the four air pollution areas.

Two other studies demonstrate the advantages and pitfalls of correlative studies among illness rates and pollution levels in multiple geographic areas. Hickey and associates,[56] in a startling and provocative paper, correlated atmospheric concentrations of a number of trace metals and of suspended particulates with mortality data from a number of disease states for 26 American cities. Correlation coefficients between cadmium, zinc, tin, and vanadium concentrations and diseases of the cardiovascular system were 0.73, 0.56, 0.55, and 0.50, respectively. Lung cancer was correlated with the same trace metals but not with suspended particulates. Such data must be considered as an opening epidemiologic wedge rather than evidence that cadmium causes heart disease since some unspecified variable might affect both trace metal pollutant levels and mortality rate from heart disease. Dohan and associates[29] correlated the incidence of respiratory disease absences lasting more than 7 days for five plants located in cities with varying air pollution. A close correlation between absence rates and suspended sulfates (correlation coefficient, 0.96) but not with suspended particulate was demonstrated. A similar relationship at a higher level was demonstrated when a year with an influenza epidemic was compared with other nonepidemic years.

The problem of air pollution is worldwide and similar geographic studies have appeared from other countries. Toyama[95] recently reviewed air pollution research in Japan and demonstrated high correlation coefficients between bronchitis and air pollution in 21 districts of Tokyo but not for lung cancer or cardiovascular disease. Oshima and associates[17] administered a health questionnaire to a group of workers and found respiratory symptoms to be considerably more common in the high pollution Tokyo-Yokohama area compared to the low pollution Nigata area.

Another epidemiologic approach is the study of geographic variations in observed pathology. Thurlbeck[94] has recently reviewed the criteria for the pathologic diagnosis of emphysema and outlined an approach to "geographic pathology." Toyama[95] studied the incidence of pulmonary fibrosis in accidental deaths autopsied by the Tokyo Municipal Medical Examiner. Fibrosis was found in 49 per cent of lungs from persons living in highly polluted areas but only 16 per cent of lungs from those living in areas of low pollution.

Ishikawa and associates[60] used a quantitative technique to measure the presence

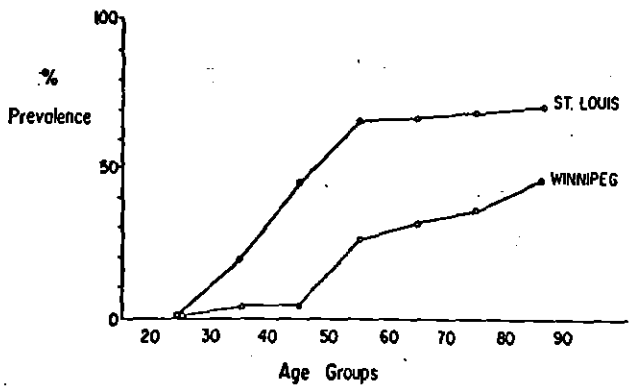


**Fig. 9.** Incidence of anatomic emphysema as a function of age in a highly polluted city, St. Louis, compared to a relatively clean city, Winnipeg. (Redrawn from Ishikawa and associates.[60])

and severity of emphysema in 300 routine autopsies from each of two cities with differing air quality. St. Louis, Missouri, is heavily contaminated emitting six to thirteen times the pollutants as Winnipeg in Canada. Their findings are shown in Figs. 9 and 10 adapted from their study. The incidence of emphysema increases with age in both cities but is always considerably more prevalent in St. Louis. For each category of smoking history, emphysema was always more common in St. Louis. The interacting role of cigarette smoking is seen in the observation that severe emphysema although more common in smokers living in St. Louis than in Winnipeg was never seen in nonsmokers living in either city. Such studies may explain the wide variation in incidence of emphysema which ranges from 12 per cent in the nonsmoking resident of Winnipeg to almost 80 per cent in the smoker from St. Louis.

A number of informative epidemiologic studies have been performed on children since variation due to tobacco smoking, occupation, and frequent change of address is generally minimized. Douglas and Waller[31] studied a sample of 3,866 children from birth in 1946 to the age of 15 in 1961. Four air pollution areas, based on domestic coal consumption, were constructed. Table IV lists several of the many indices reported in this study and reveals a consistent relationship between lower (but not upper) respiratory disease and level of air pollution.

Toyama[95] studied pulmonary function and administered a questionnaire to a large group of children attending six schools in the Tokyo area. Pollution levels were about three to four times higher in schools located in industrial areas compared to those in residential areas. The frequency of cough and eye irritation ranged from 2.0 and 13.8 per cent, respectively, in the

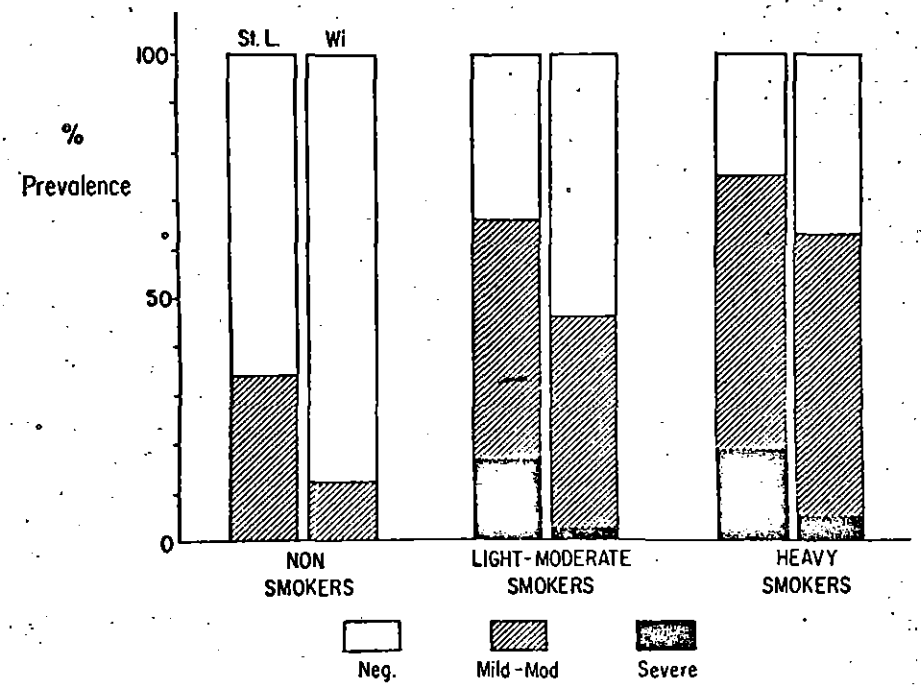


**Fig. 10.** Influence of smoking history and place of residence on prevalence of anatomic emphysema from study of Ishikawa and associates.[60] For each smoking history more emphysema was found in St. Louis compared to Winnipeg. Differences were less marked in heavy smokers. Note that severe emphysema was not seen in nonsmokers living in either city.

**Table IV.** *Incidence of respiratory infections in children (per cent of sample) from Douglas and Waller*[21]

| | *Air pollution exposure* | | | |
|---|---|---|---|---|
| | *Very low* | *Low* | *Moderate* | *High* |
| *Hospital admission for:* | | | | |
| Bronchitis | 0.0 | 0.9 | 1.0 | 1.4 |
| Pneumonia | 1.1 | 1.4 | 1.6 | 1.8 |
| Upper respiratory infection | 0.4 | 0.3 | 0.4 | 1.1 |
| Tonsillitis | 4.4 | 6.2 | 5.7 | 5.2 |
| *More than one attack of lower respiratory infection in first two years of life* | | | | |
| Middle class | 3.0 | 4.0 | 7.7 | 9.3 |
| Working class | 5.1 | 10.8 | 13.9 | 15.4 |
| *Rales or rhonchi recorded* | | | | |
| Once or more | 10.8 | 13.7 | 17.5 | 17.3 |
| Twice or more | 0.5 | 2.1 | 2.5 | 2.7 |
| At age 15 | 0.2 | 1.2 | 2.1 | 2.2 |

lowly polluted area to 13.2 and 59.8 per cent in the high pollution area, while peak flow rate measured during February averaged 306 ± 3.7 L. per minute in the low pollution area and 270 ± 3.3 in the high.

***Temporal variations in mortality rate and morbidity.*** In addition to studying geographic variations in illness rates, the air pollution epidemiologist may attempt to study temporal variations in disease rates within a single community and attempt to correlate these variations with certain environmental variables.

One of the earliest demonstrations of the relationship between illness rates and air pollution levels was the study of Waller and Lawther[99] who followed 180 bronchitic patients in Greater London by means of regular diary entries. The patients entered a single letter in their diary each day and this was scored as follows: condition better than usual, −1; condition unchanged, 0; condition worse than usual, +1; condition much worse than usual, +2. Smoke and sulfur dioxide concentrations were measured by several techniques. Fig. 11 reveals the striking correlation in smoke and illness peaks during a 4 month period in 1955 to 1956. A smog episode began during the first week of January and smoke concentration reached the extremely high level of 10 mg. per cubic millimeter later in the evening of January 3. Early the next morning, a wet fog appeared decreasing visibility and smoke concentration fell to almost normal limits. The illness score exceeded 0.7 indicating that, on the average, 70 per cent of the chronic bronchitics felt worse. The authors concluded that air pollution appeared to exert significant adverse health effects but that dense wet fog did not appear to intensify these effects.

A detailed study of "Health and the urban environment" was undertaken by McCarroll and associates[70] within a half-mile square area in the lower east side of Manhattan. A daily record of such symptoms as cough and burning or itching eyes was kept in over 1,000 adults for a full year. Smoking history was recorded and air pollution measured by a specially constructed monitoring station within the area.

Their data were initially analyzed by a series of correlation coefficients between each symptom and each measure of air pollution. These cross-correlations were calculated with a time lag of between 0 to 28 days since the appearance of a symp-

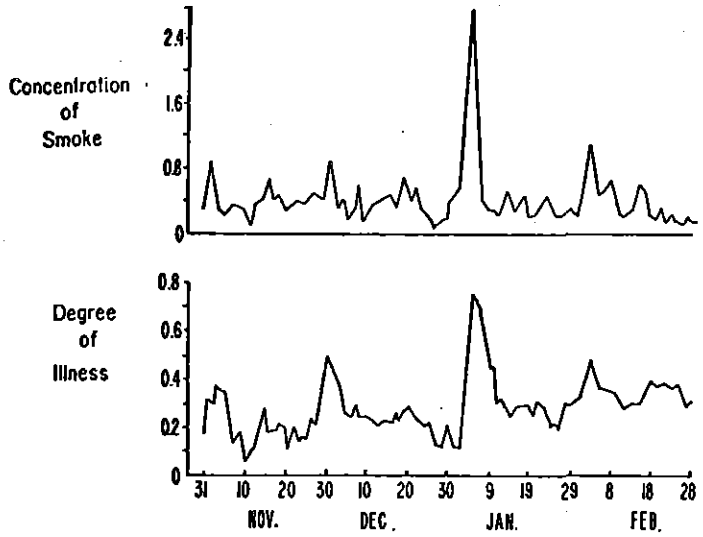


**Fig. 11.** Striking correlation between smoke concentration and an arbitrary illness index in 180 bronchitics studied by Waller and Lawther[99] in Greater London during the winter of 1955 to 1956. This study provided the first experimental evidence that the health of patients with chronic obstructive lung disease was impaired by exposure to atmospheric pollutants.

tom might be related to environmental events occurring at some point in the past. In addition, autocorrelations, correlations between each symptom, and index of pollution and the corresponding value for each preceding day back to 28 days were calculated as indices of phenomena persistence. For rapid inspection purposes, each set of correlations was plotted against the lag in days as multiple correlograms.

The data demonstrated that eye irritation lasted for short periods of time while cough persisted for considerably longer periods of time. The best correlations between eye irritation and sulfur dioxide appeared when lag was not introduced; the best correlation between cough and sulfur dioxide appeared when levels of pollutant measured one to three days prior to onset of cough were used. A similar relationship between cough and particulate density was observed; eye irritation did not correlate with particulate density.

The same data were reevaluated by Cassell and associates[21] in a recent paper. Noting that previous papers had pointed to a multivariate nature of both stimulus and response, the authors report results from multiple correlation analysis and from a relatively new statistical technique, principal components analysis. Correlation coefficients between the symptom of cough and wind speed were 0.217; temperature, –0.494; barometric pressure, 0.269; particulate pollution, 0.194; and sulfate pollution was 0.112.

Principal components analysis was undertaken to study the interaction of groups of environmental factors on respiratory symptoms. The symptom complex of cough, sore throat, and "common cold" was found to be associated with two sets of environmental conditions: cold, wet, windy, "terrible" weather or cloudy, humid, not too cold, windless weather associated with atmospheric stagnation. Eye irritation, in contrast, was associated with sunny, windless days during periods of high automotive pollution.

The multiple-factor problem may be well seen in the studies of Spodnik and associates[59] and of Verma and associates,[98] who serially studied airway resistance and absence rates, respectively. Both groups noted a strong cyclical time trend. Airway resistance was observed by Spodnik and

associates to be closely correlated with outdoor temperature (–0.46) and only poorly associated with particulate concentration. Unfortunately, only a single index of air pollution, suspended particulate concentration, was included in the experimental design. Verma and associates found that 46 per cent of the respiratory illness rate variability was accounted for by a time model and 20 per cent of the variability by a linear air pollution model, while combination of both models explained 50 per cent of the variation. They concluded that respiratory illness rates were highest on cool days when sulfur dioxide levels exceeded 0.05 p.p.m.

An informative study on the appearance of minor respiratory illnesses in factory and office workers was undertaken by Angel and associates[9] from the Hammersmith Hospital. A questionnaire, pulmonary function studies, and sputum collections were made every 3 weeks on a sample of 92 workers. The classification and frequency of respiratory illness observed in the period between October, 1962 and May, 1963 were: simple coryza, 53; chest colds, 57; mucopurulent bronchitis, 39; influenza-like illnesses with systemic symptoms, 29; and wheezy attacks, 21. That mysterious "pathogen" *Hemophilus influenzae* was found in 9 per cent of specimens between illnesses but in 25 per cent of specimens with mucopurulent bronchitis. Correlation coefficients between the attack rate of respiratory illness and smoke were 0.57, sulfur dioxide was 0.56, and temperature was –0.26. The first two were significant at the one per cent level.

An extensive study of hospital admissions for certain "relevant diseases" based on Blue Cross Hospitalization Plan Data was undertaken by Sterling and associates.[90] The large number of observations rendered even small correlation coefficients strikingly significant. Correlations were markedly improved by the addition of nonlinear and multiple variable analysis and demonstrated a close relationship between a number of environmental variables and admission rates. The multiple correlation coefficient including linear and nonlinear factors and interactions for pollutant concentrations, temperature, and humidity was 0.373 with 4,564 degrees of freedom.

Ipsen and associates[59] studied industrial absenteeism from upper respiratory infections and observed the illness rate to correlate with temperature (–0.614), particulate concentration (0.556), and particulate sulfate concentration (0.289).

The studies reviewed in this section reveal a strong time dependence of respiratory infection and other illnesses. Interrelationships among individual pollutants and other environmental factors such as temperature, humidity, and barometric pressure complicate interpretations and force reliance on complicated statistical techniques. The data suggest, however, a meaningful relationship between urban air pollution and health.

***Asthma and air pollution.*** Episodic bronchospasm has dramatically increased in urban areas suggesting the causal role of infectious and pollutant agents rather than classical pollen allergy. Certain outbreaks of bronchospasm have assumed sufficient proportion to be assigned generic names. Booth and associates[16] from the United States Public Health Service studied emergency room visits for asthma in ten hospitals located in seven cities and found great similarity in seasonal peaks with major increases in asthma visits occurring in the fall months after the completion of the pollinating season. Peaks during months of high pollen count were not seen. These observations have stimulated a search for possible environmental factors on the development of episodic bronchospasm.

The striking increase in asthma admissions in New York City was revealed in a study by Greenburg and associates.[44] In 1952, 3.2 and 6.6 per cent of emergency room visits at Harlem and Metropolitan Hospital were for asthma. By 1962, these percentages had risen to 25.7 and 15.7

per cent. An attempt to correlate asthma attacks with environmental factors was made by Girsh and associates[28] in Philadelphia who found a threefold increase in asthma on days of high air pollution, a fourfold increase during days of high barometric pressure, and a ninefold increase during periods of stable atmosphere when both high barometric pressure and high pollutant levels coincided.

A unique form of asthma, Tokyo-Yokohama asthma, was first observed at the United States Army Hospital in Yokohama in 1946.[79] Large numbers of American servicemen became afflicted with a condition characterized by nocturnal coughing and wheezing which disappeared when they left the highly polluted Kanto Plain region of Japan. The disease is more properly termed bronchitis than asthma, is more common in smokers, and appears to be related to both irritant and allergenic components of the ambient air. Another outbreak of asthma, New Orleans asthma, appears to predominantly affect allergic individuals without prior evidence of bronchitis. Patients with this syndrome had a significantly higher rate of positive skin tests to extracts of atmospheric pollutants than did control subjects without bronchospasm.[101]

### Carbon monoxide

The toxicity of carbon monoxide has been the subject of many reviews since the series of courageous experiments performed upon himself was first reported in 1895 by John Haldane.[34] Haldane did not observe serious toxic symptoms until at least one third of his blood was saturated with carbon monoxide, and most subsequent investigations emphasized dramatic toxic effects of exposure to high doses. Important as these early investigations were, they tended to minimize the effects of exposure to low dosages and tacitly implied that carboxyhemoglobin levels associated with cigarette smoking and urban air pollution were probably harmless. In this review we propose to summarize recent work pointing toward important physiologic effects of low concentrations of carbon monoxide as well as present current concepts regarding mechanisms of action.

In many respects, carbon monoxide serves as a model pollutant. Ideally, one would like to identify the body burden of a given pollutant and be in a position to measure the physiologic effects of that particular body burden. With most pollutants, neither the body burden nor the quantitative relationships between burden and health effects are known. With carbon monoxide, in contrast, one can estimate body burden from blood levels and determine quantitative relationships by experimental observations made during the administration of known concentrations.

***Basic chemical reactions.*** Both oxygen and carbon monoxide combine reversibly with hemoglobin to form oxyhemoglobin and carboxyhemoglobin, respectively. Douglas, Haldane, and Haldane[30] first demonstrated that the toxicity of extremely low concentrations of carbon monoxide was due to its great affinity for hemoglobin relative to oxygen since the partial pressure of carbon monoxide required to fully saturate hemoglobin is only $\frac{1}{200}$ to $\frac{1}{250}$ of the partial pressure of oxygen required for complete saturation with oxygen. When exposed to a mixture of both gases, equilibrium is gradually reached according to the Haldane equation:

$$\frac{HbCO}{HbO_2} = M \frac{Pco}{Po_2}$$

where HbCO, $HbO_2$, Pco and $Po_2$ represent hemoglobin saturations and partial pressures of carbon monoxide and oxygen, respectively. M is a constant expressing relative affinities which ranges from 200 to 250 in human blood. At equilibrium, for example, environments containing 25, 50, and 100 p.p.m. of carbon monoxide would lead to carboxyhemoglobin saturations of 4.7, 9.1, and 16.1 per cent if arterial oxygen tension were 80 mm. Hg.

The time required to reach equilibrium varies widely and is related to minute ventilation, dead space volume, diffusion capacity of the lung, total red cell mass, rate of blood flow, and COHb concentration in venous blood. Forbes and associates,[34] Pace and associates,[75] and Lilienthal and Pine[67] have studied the time course of carboxyhemoglobin during the steady-state breathing of various mixtures of carbon monoxide. While the relationships are complex and frequently exponential, the latter group found good agreement with experimental data with the use of a linear equation: COHb = (Pco in inspired air) (exposure time in minutes) (ventilatory rate in liters per minute) (0.05). Solution of this equation reveals that carboxyhemoglobin saturation in a lightly exercising man in an environment containing 50 p.p.m. of carbon monoxide would be 1.4, 2.3, 3.4, 4.6, and 5.7 per cent saturation at 1, 2, 3, 4, and 5 hours respectively.

While the physiologic variables listed above confuse the prediction of carboxyhemoglobin concentrations in a given individual, the obvious fact that individuals do not breathe a constant concentration of carbon monoxide further interferes with attempts at predicting blood levels from ambient air concentration. An individual may breathe 5 p.p.m. for several hours, spend 15 minutes driving through a tunnel containing 150 p.p.m., and then remain in traffic for 30 minutes breathing an atmosphere ranging from 20 to 50 p.p.m.

These relationships would be even further confused if he smoked several cigarettes, since cigarette smoke contains 3 to 4 per cent carbon monoxide and each diluted puff probably is equivalent to about 500 p.p.m. of carbon monoxide.

Goldsmith and associates[43] have attempted to study this problem of fluctuating exposures by developing a computer program which could rapidly calculate carboxyhemoglobin saturations from certain assumed constants and a changing environmental carbon monoxide concentration. Fig. 12 is redrawn from their work and shows that the blood concentration is

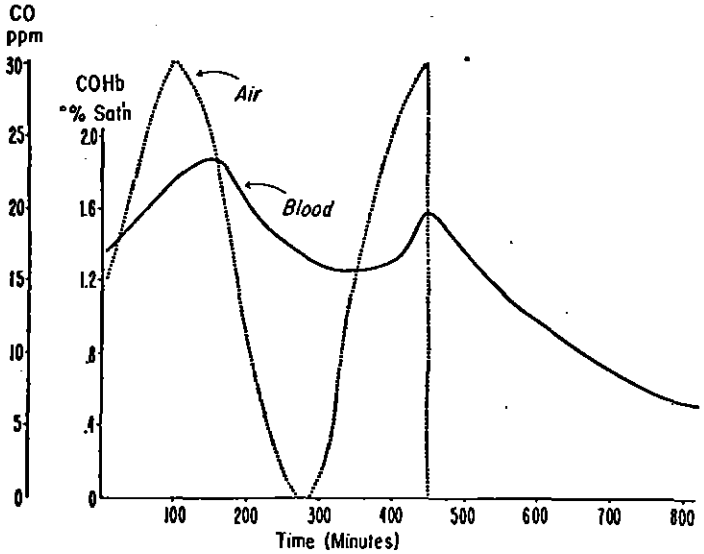


**Fig. 12.** The relationship between ambient air concentrations of carbon monoxide and blood carboxyhemoglobin levels. Note that blood levels change much more slowly than ambient air concentrations and are a damped representation of events occurring in the atmosphere. For this reason, measurement of blood levels provides a better estimate of the body burden of carbon monoxide. (Redrawn from Goldsmith and associates.[43])

a damped representation of the air concentration with a definite lag between the two systems.

***Assessment of human exposures to carbon monoxide.*** The human exposure to carbon monoxide, like that to other pollutants, may be estimated by the frequent measurement of atmospheric concentrations. While the concentrations of many other pollutants are relatively consistent within a given geographic area, carbon monoxide concentrations may vary widely because of the multiple point sources responsible for its production. A sensing probe at bumper level in traffic may reveal an extremely high level which progressively falls off as samples are taken at driver level, on the sidewalk, or on the second and third floors.

Average carbon monoxide levels taken from probes located in laboratories somewhat remote from traffic may vary from 2 to 50 p.p.m. In many urban areas, these levels are consistently below 10 p.p.m. but may have little relationship to events in traffic-congested areas. Ramsey[61] studied the carbon monoxide concentration at curbside in a number of traffic intersections in Dayton, Ohio. Samples were taken at 5 feet and averaged 36 p.p.m. with a range from 2 to 135 p.p.m. Haagen-Smit[50] equipped an automobile with sensing equipment and detected peak values of 120 p.p.m. in Los Angeles traffic. Miranda and associates[72] recently reviewed data from several tunnels in an effort to determine tunnel control techniques. Carbon monoxide concentration averaged 65 p.p.m. but peaked to 390 p.p.m. during a period of severe traffic congestion in the Holland Tunnel. Concentrations on the expressway leading to the George Washington Bridge in New York City were found to average 40 p.p.m. for the month, although peaks of from 200 to 300 p.p.m. were occasionally encountered.*

The theoretic considerations outlined above suggest that measurements of blood carbon monoxide concentrations provide a more consistent index of human exposure than measurement of ambient air concentrations. Fortunately, a number of extremely sensitive blood methods exist but the need for venesection limits the widespread epidemiologic application of this technique.

Alveolar and blood carbon monoxide tensions are quite similar permitting the use of alveolar tensions to estimate blood levels. Jones and associates[62] developed a breath-holding method which was sensitive enough to show that 90 per cent of the values obtained fell within ± 1.3 per cent saturation of the mean curve, more than adequate for epidemiologic studies. While direct blood measurements give the most reliable estimates of human exposure to carbon monoxide, alveolar sampling techniques appear to be almost as accurate and considerably more relevant than measurement of atmospheric levels.

Kjeldsen[63] recently reviewed reported observations on blood carboxyhemoglobin. The average carboxyhemoglobin concentration in 511 nonsmokers was 1.0 and ranged from 0 to 4.0 per cent saturation. The average carboxyhemoglobin in 509 smokers was 3.9 and ranged to levels as high as 19 per cent saturation. Fig. 13 shows the distribution of blood carboxyhemoglobin concentrations (determined by alveolar air sampling) in a series of observations made in a congestive area in New York City in cooperation with Dr. Eric Cassell and Commissioner Austin Heller. The distribution of concentrations was similar for the two groups in the lower range of concentrations but a splayed-out tail of the distribution curve revealed that a small number of smokers had carboxyhemoglobin concentrations up to 14 per cent saturation. These studies were performed during a period of relatively low air pollution.

***Physiologic effects of carboxyhemoglobin.*** The physiologic effects of carbon monoxide toxicity resemble the effects of hypoxia, and most investigators have con-

*The City of New York, Department of Air Pollution Control. Unpublished data.

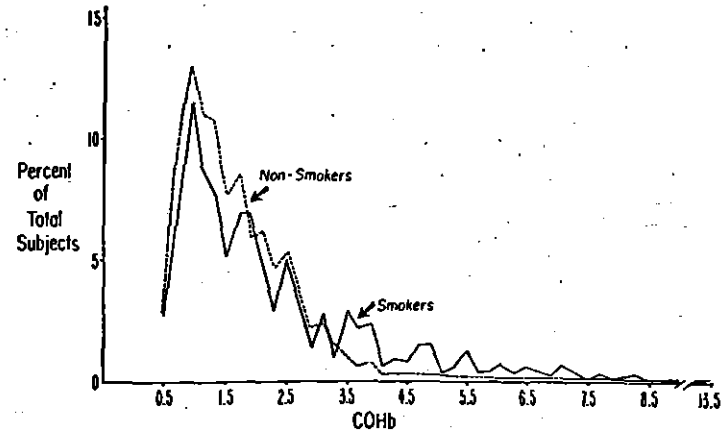


**Fig. 13.** Distribution of carboxyhemoglobin levels in 1,481 subjects studied in Herald Square, New York City, by the authors in cooperation with Dr. Eric Cassell and Commissioner Austin Heller. The dotted line represents nonsmokers, the solid line, smokers. Ordinal values are percentage of entire sample. Alveolar sampling techniques were used to estimate blood carboxyhemoglobin. The distributions are similar for the two groups, although smokers show a splayed-out tail with concentrations up to 14 per cent carboxyhemoglobin.

sidered that the primary action of carbon monoxide is exerted through its competition with oxygen for binding sites on the hemoglobin molecule. While undoubtably this is the major site of action, certain recent observations suggest that carbon monoxide may also have a direct effect on other iron-containing compounds (possible cytochrome oxidase or cytochrome $a_3$) or other yet unknown sites.[43]

Douglas and associates[30] showed that the dissociation curves for either carbon monoxide or oxygen with hemoglobin are identical, provided that the abscissal values for carbon monoxide pressure are multiplied by the affinity constant, M. In contrast, the oxyhemoglobin dissociation curve in the presence of COHb and reduced hemoglobin is unique and not classically sigmoid, but shifted to the left so that a lower oxygen tension exists for the same oxyhemoglobin saturation compared to blood without COHb present (Fig. 14). These investigators pointed out that this characteristic shift of the oxyhemoglobin dissociation curve explained the "contrast between the helpless condition of a person whose blood is half saturated with carbon monoxide and the comparatively slight symptoms when the hemoglobin is reduced to half its normal percentage in anemia." Carbon monoxide not only diminishes the total amount of oxygen available (by direct replacement of oxygen) but also alters the dissociation of the remaining oxygen so that it is held more tenaciously by hemoglobin and released only at lower oxygen tensions.

The oxyhemoglobin curve in the presence of COHb progressively resembles that of myoglobin as the concentration of COHb is increased (Fig. 14). Since myoglobin is a heme compound with only one heme unit per molecule and does not exhibit heme-heme interactions, it is possible that the combination of one or more of the four heme groups in hemoglobin with carbon monoxide decreases the heme-heme interactions of the remaining heme units and results in a molecule approaching the behavior of myoglobin.

The impact of conversion of part of the circulating oxyhemoglobin to carboxyhemoglobin may be seen in experimental studies performed during routine cardiac catheterization. We[13] recently acutely raised carboxyhemoglobin concentration to an average of 9.0 per cent saturation in

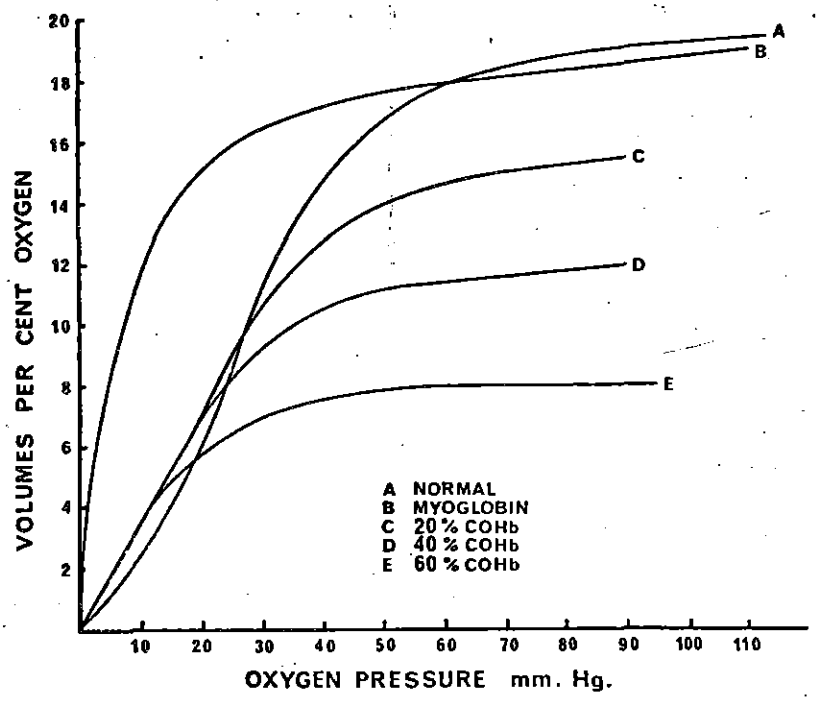


**Fig. 14.** Oxyhemoglobin dissociation curves for normal adult hemoglobin, myoglobin, and varying mixtures of oxyhemoglobin and carboxyhemoglobin. The presence of significant amounts of carboxyhemoglobin (curves *C*, *D*, and *E*) reduces the total amount of oxygen carried and also changes the shape of the curve so that a lower oxygen tension results from the same oxygen content. At lower oxygen tensions, the carboxy-oxyhemoglobin curves resemble the dissociation curves for human myoglobin.

26 subjects with or without heart disease. Mixed venous oxygen tension decreased from 39 to 31 mm. Hg suggesting a significant decrease in tissue oxygen tension since mixed venous oxygen tension must represent a maximum value for tissue oxygenation. Surprisingly, arterial oxygen tension decreased from 81 to 76 mm. Hg. Early investigators had suggested that arterial oxygen tension was unchanged during carboxyhemoglobin changes. Measurement of the alveolar-arterial oxygen difference revealed an increase from 20 to 29 mm. Hg and suggested that an augmentation of the shunt effect was probably responsible for both the increase in alveolar-arterial oxygen difference and decrease in oxygen tension. Brody and Coburn[18] have recently confirmed these findings.

***Effects of low concentrations of COHb on the central nervous systems.*** A number of recent studies have presented objective evidence that relatively low levels of COHb can interfere with certain of the higher integrative functions of the central nervous system. MacFarland and associates[71] were able to show a linear relationship between decrease in visual discrimination and increase in COHb and observed significant impairment in discrimination with COHb levels as low as four per cent saturation. Lilienthal and Fugitt[66] observed an impairment in flicker-fusion with COHb levels between 5 and 10 per cent at 6,000 feet altitude, and Trouton and Eysenck[96] demonstrated difficulty in limb coordination at similar concentrations of COHb. A battery of physiologic and psychologic tests was applied to a group of normal subjects by Schulte[85] before and after they breathed sufficient carbon monoxide to raise COHb levels to between 0 and 20.4 per cent. Although significant correlations between pulse rate, blood pressure or re-

spiratory rate and COHb were not observed, Schulte was able to closely relate seven psychologic responses to COHb. COHb concentrations below three per cent produced significant increases in errors in letter and color response tests, in the completion time of plural noun underlining tests, and other similar psychomotor tests. Similar findings were reported by Beard and Wertheim who observed psychologic impairment at levels below two to three per cent carboxyhemoglobin.[14] Such psychologic studies confirm the neurophysiologic observation of Xinteras and associates[107] who observed alteration in evoked potentials from the superior colliculus of unrestrained and unanesthetized rats following the inhalation of low concentrations of carbon monoxide.

***Cardiovascular effects.*** A number of studies on the hemodynamic effects of carbon monoxide inhalation have been described. Both Haldane[54] and Haggard[53] reported hyperventilation in man and in experimental animals. The contrast between hypoxemia caused by breathing low concentrations of oxygen and carbon monoxide poisoning was stressed by Asmussen and Chiodi[10] who observed a marked increase in both minute ventilation and cardiac output when arterial oxygen tension was lowered but not when carboxyhemoglobin levels were raised to 20 to 30 per cent. Although carboxyhemoglobin did not affect cardiac output, it increased pulse rate substantially leading the authors to suggest a compensatory chronotropic response to a primary decrease in stroke output. In a later more detailed study, Chiodi and associates[23] observed cardiac output and pulse rate to rise together with increasing concentrations of carboxyhemoglobin. While relatively high concentrations were evaluated, changes in pulse rate and cardiac output were noted with as little as 16 per cent carboxyhemoglobin.

We recently reported a series of systemic and coronary hemodynamic studies in 26 human beings and made additional measurements in a group of animals studied at high concentrations of carboxyhemoglobin.[13] Raising carboxyhemoglobin saturation to an average of nine per cent increased minute ventilation, cardiac output, and the oxygen extraction ratio. Similar concentrations increased coronary blood flow but decreased myocardial oxygen extraction so that myocardial oxygen consumption was essentially unchanged. Changes in lactate and pyruvate extractions suggesting anaerobic metabolism were observed in certain individuals with coronary artery disease and in one patient with obstructive emphysema and hypoxemia.

The effects of rest and exercise on oxygen uptake and heart rate before and after elevation of carboxyhemoglobin concentrations to four per cent were studied by Chevalier and associates.[22] This level of carboxyhemoglobin produced a significant increase in the oxygen debt of exercise and also decreased both resting pulse rates and the chronotropic response to exercise.

Many investigators have examined the effect of carbon monoxide on the electrocardiogram in patients who have been exposed to high concentrations of the gas. Cosby and Bergeron[27] studied the electrocardiogram of ten patients admitted for carbon monoxide poisoning and observed abnormalities such as sinus tachycardia, T wave abnormalities, S-T segment depression, and atrial fibrillation in nine. Five of 6 patients studied by Anderson and associates[8] had significant electrocardiographic abnormalities. A remarkable case of a young man who developed a chronic illness resembling primary myocardial disease following carbon monoxide poisoning was reported by Shafer and associates.[86] Animal studies performed by Ehrich and associates[32] demonstrated electrocardiographic abnormalities when the carboxyhemoglobin level was raised to about 20 per cent for two weeks.

Two studies from Astrup's laboratory[12, 100] demonstrated that relatively low

concentrations of carboxyhemoglobin (11 per cent) produced degenerative cardiovascular changes in rabbits and also enhanced aortic atheromatosis in rabbits fed cholesterol. Kjeldsen,[63] in Astrup's laboratory, reviewed much of the data relating smoking and carbon monoxide inhalation to atherosclerosis and presented a series of original investigations designed to test the hypothesis that carbon monoxide did increase the proclivity of experimental animals to develop atherosclerosis. Twenty-four rabbits were fed cholesterol and the carboxyhemoglobin concentration raised to between 10 and 20 per cent in twelve. Three fourths of the experimental animals developed focal degenerative changes with atheromatosis, while similar changes were observed in only one control animal. In another study, similar carboxyhemoglobin concentrations were observed to increase serum cholesterol in animals fed both standard and cholesterol-enriched diets. While similar effects have been observed with hypoxia, these studies suggest an additional mechanism for the relationship between carbon monoxide and heart disease.

The experimental studies performed in Astrup's[11] laboratory were suggested by clinical observations demonstrating that an abnormality in the oxyhemoglobin dissociation curve was responsible for ischemic symptoms in Buerger's disease and nonspecific myocarditis. Later work convinced Astrup that carboxyhemoglobin might well be the cause of the hemoglobin abnormality. More recently, Elliot and Mizukami[33] demonstrated that the blood of smokers with angina pectoris contained hemoglobin with an abnormal oxyhemoglobin dissociation curve. These patients, as well as Astrup's patients, may have abnormally high carboxyhemoglobin levels which could be responsible for their ischemic symptoms.

The experimental and clinical data presented above suggest that carboxyhemoglobin levels between 5 and 10 per cent (and in some situations substantially lower) can produce significant neural and cardiovascular effects. Such effects might be predicted to be particularly important in patients with pre-existing vascular disease.

### Conclusion: Toward a healthier environment

The data discussed in this review lead to the inescapable conclusion that community air pollution is capable of producing serious health effects. The Clean Air Act of 1967 directed the Surgeon General to develop "air quality criteria" which would be implemented by the several states in the form of air quality standards. Although much of the scientific work performed over the past three decades was not intended for the construction of legal criteria and standards, review and extrapolation of a massive amount of material has resulted in publication of *Air quality criteria for particulates and air quality criteria for sulfur oxides.*[74, 75]

The criteria conclude that a number of studies have demonstrated increased morbidity and mortality rates when particulate contamination exceeds 80 to 100 $\mu$g per cubic meter and sulfur dioxide concentrations exceed 0.10 to 0.20 p.p.m. These figures are annual averages and may have little relationship to the health effects of dramatic pollutant peaks. The responsibility is left to each state and urban community to develop workable standards which will reduce pollutant concentrations to safe levels.

The fields of environmental medicine—of man's adjustment to his surroundings—provide a noble example of a partnership between science and government designed to better human existence. Often beset by legislative inertia, scientific disagreement, and the reactionary interference of vested interests, the hope exists today that the clock may be rolled back and a healthful environment recreated. The critical reader of this review will recognize the many weak spots in the investigative fabric relating air pollution and human health.

Hopefuly it will stimulate further investigation in these areas.

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File - Automotive Pollution

APCA Paper 66-70

# THE EXPOSURE TO CARBON MONOXIDE OF OCCUPANTS OF VEHICLES MOVING IN HEAVY TRAFFIC

JUL 26 1966

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by

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June, 1966

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Public Health Service



Exhibit J

ERRATA

1) Page 6, line 18 --- change 11% to 10%.

2) Page 6, line 27 --- change 87 ppm to 90 ppm.

3) Page 7, Table 1 --- line opposite Denver should read:

| City | No. Samples | | Average CO | | Average HC | | Range CO | | Range Hydrocarbon | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CO | HC | In-traffic | CAMP site | In-traffic | CAMP site | In-traffic | CAMP site | In-traffic | CAMP site |
| Denver | 28 | 28 | 40 | 17 | 9.6 | 5.6 | 22-72 | 2-35 | 4.6-19.0 | 3.6-13.8 |

4) Page 10, Table 3 --- line opposite Denver should read:

| City | No. Samples | % of values ≤ stated concentration, ppm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | In traffic | | | | | CAMP site | | | | |
| | | 25 | 50 | 75 | 90 | 95 | 25 | 50 | 75 | 90 | 95 |
| Denver | 28 | 27 | 39 | 49 | 60 | 68 | 13 | 16 | 19 | 25 | 30 |

5) Page 11, Figure 2 --- curve for Denver is in error.

6) Page 12, Table 4 --- line opposite Denver should read:

| City | CONCENTRATIONS EXCEEDED THE STATED PERCENT AMONG ALL SAMPLES | | | |
|---|---|---|---|---|
| | 1% | 5% | 10% | 30% |
| Denver | 90 | 68 | 60 | 46 |

# The Exposure to Carbon Monoxide of Occupants of Vehicles Moving in Heavy Traffic

## ABSTRACT

Carbon monoxide and hydrocarbons were sampled at operator's nose height inside vehicles moving in moderate to heavy traffic in six cities. The samples were integrated over 20 to 30 minutes by collection in Mylar bags. Carbon monoxide and hydrocarbons were analyzed by infrared and flame ionization, respectively, with instruments at the Continuous Air Monitoring Program (CAMP) station in each city. Detector tubes for carbon monoxide were also used to determine 5-minute concentrations at suspected high points in the field. Estimates of traffic density were made.

Three types of traffic arteries were considered: 1) heavily traveled, wide expressways, 2) main city streets with moderately rapid vehicular traffic, and 3) center city streets with slow-moving traffic. Integrated half-hour CO concentrations obtained within the vehicles while in traffic were generally considerably higher than the concurrent concentrations measured at the CAMP sites. In-traffic CO values in all cities sampled exceeded 30 ppm in at least 10% of the integrated samples. The range of city averages was 21 to 39 ppm carbon monoxide and the range of individual integrated samples was 7 to 77 ppm of carbon monoxide.

Key words: Air Pollution

Carbon Monoxide

Hydrocarbons

Motor Vehicles

Mylar Bag Sampling

CAMP Cities - 1965

# The Exposure to Carbon Monoxide of Occupants of Vehicles Moving in Heavy Traffic

by

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## INTRODUCTION

The possible adverse effect of ambient air concentrations of carbon monoxide (CO) on the responses of drivers and pedestrians has prompted the investigation of in-traffic concentration levels.

Concentrations of CO inside automobiles traveling on or parked immediately adjacent to routes of high traffic density during maximum traffic-flow periods between 0700 and 1900 hours have been measured in six cities. This report considers data from samples taken with Mylar bags and with detector tubes; it represents the initial phase of a study that has recently been expanded to employ a mobile unit carrying continuous air monitoring instrumentation that records concentration of gases while moving in traffic.

In-traffic sampling for CO and hydrocarbons was done in cooperation with local air pollution control agencies. The objective of the sampling was to determine the levels of exposure of vehicle drivers on typical traffic routes in each city. Primarily, the concentrations measured represent exposures experienced by commuters traveling from outlying areas of the city to downtown and by bus drivers, taxicab drivers,

policemen, and others traveling on heavy traffic routes. The time for filling the Mylar bags was adjusted so that all samples except those determined by detector tubes represent concentrations integrated over periods of 20 to 30 minutes.

Hydrocarbon concentrations as well as CO concentrations were determined for each bag sample because, in general, atmospheric concentrations of both gases along streets in large cities come primarily from motor vehicles and because hydrocarbons are important in photochemical smog formation. The concentrations of both these pollutants in areas of high traffic density were expected to vary in a manner similar to corresponding concurrent concentrations at a reference point such as the CAMP site.

Studies currently in progress by other investigators are intended to determine the importance of the suspected relationships between various concentrations of CO in inspired air, and consequently in the blood, and the incidence of accidents or changes in physiological responses that could cause accidents. It is hoped that in-traffic air quality data from this study together with data from the other studies will aid in the assessment of the health hazards of CO in the air that is normally breathed by a large number of motor-vehicle occupants traveling in the midst of typical high traffic density.

## EXPERIMENTAL

Air samples were drawn from sampling probes mounted at approximately nose height alongside the drivers of automobiles. Most of the sampling was done during seasons when the front windows of the sampling vehicle were open. When sampling was done during periods of cool weather, the front windows of the vehicle were lowered 1 inch and the heater blower was turned to full speed with fresh air intake.

In this initial stage of the program, sampling was limited to Chicago, Cincinnati, Denver, Philadelphia, St. Louis, and Washington. The Division of Air Pollution, Public Health Service, operates Continuous Air Monitoring Program (CAMP) stations in cooperation with local agencies in these cities. CAMP stations are equipped with continuous carbon monoxide and hydrocarbon analyzers, [1] which provided a convenient means for analyzing the samples.

The varying contingencies of the local agencies prevented obtaining the same number of samples in each city or exactly similar types of samples. In Cincinnati, a relatively larger number of samples was obtained because of the availability of personnel from the Robert A. Taft Sanitary Engineering Center.

Concentrations at CAMP sites are compared with concurrent in-traffic concentrations to indicate the effects of sampling location. CAMP stations are located in the downtown areas of each city; however, they are generally positioned 50 to 70 feet off the street and the sample-intake probes are about 15 feet above the ground.

Sampling Equipment and Methods: *

The major sampling was done with Mylar bags [2,3,4] having about 70 liters capacity. These bags were filled by pumping air in directly with a 12-volt carbon vane pump powered from the vehicle cigarette lighter by means of an adapter. The sampling system was set up as indicated in Figure 1. The

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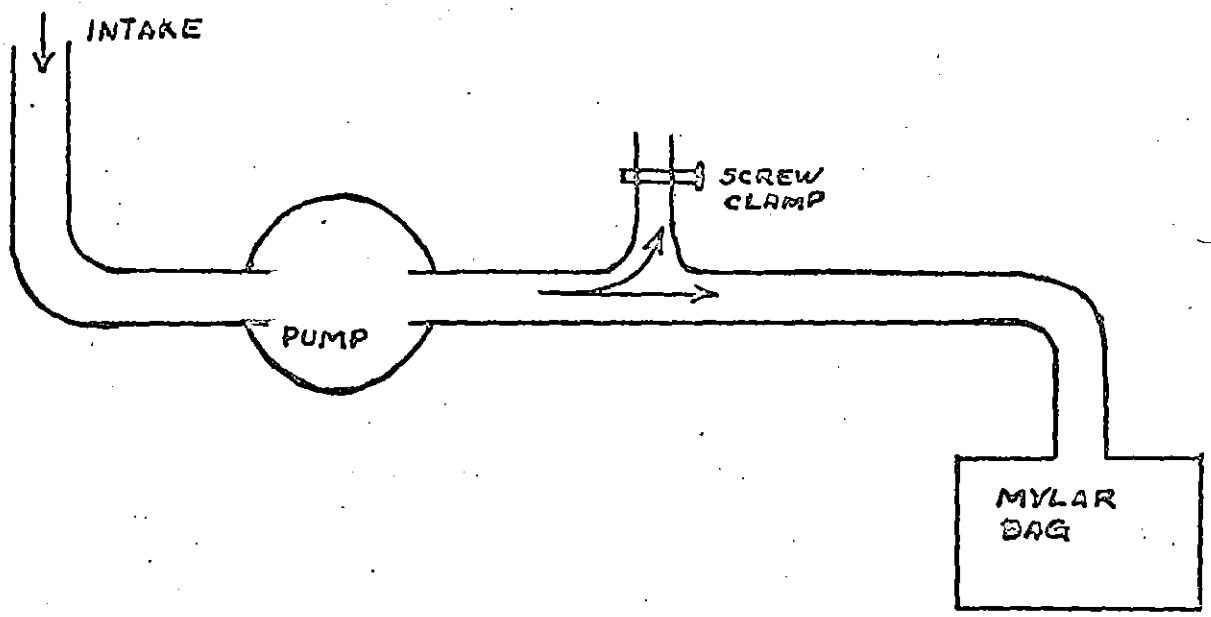
* Mention of commercial products does not constitute endorsement by the Public Health Service.

FIGURE 1.

BAG SAMPLING EQUIPMENT



clamp at the T adjusted airflows between the bag and a by-pass so that the bag would fill in about 30 minutes. Polyethelene was used for all tubing except for the T, which was glass.

After each sample was obtained, the filled bag was taken within 16 hours to the CAMP station and analyses made for CO and total hydrocarbons on the automatic infrared and flame ionization analyzers, respectively.[1] Laboratory studies showed that carbon monoxide concentrations, at levels pertinent to this study, did not change significantly when samples were stored as long as 16 hours in Mylar bags. Following analysis, the bags were evacuated, refilled with air from inside the CAMP station, and re-evacuated in preparation for subsequent sampling. The CO analyses are accurate within ± 1 ppm in the higher ranges reported and within ± 0.5 ppm in the lower ranges; hydrocarbon analyses are accurate within ± 0.1 ppm.

Color shade detector tubes (Mine Safety Appliance), calibrated under the conditions specified below, were employed to obtain estimates of 5-minute peak concentrations. Air was drawn through the detector tube, then through a critical orifice set to operate at 100 cc/minute, and finally through a small carbon vane vacuum-pump (the same pump used to fill the bags). Curves of CO concentration versus time were prepared to correspond to each of several color shades. Values from the detector tubes are accurate within ± 15%.

## DISCUSSION

### Carbon Monoxide

Table 1 shows the average concentration and range of concentrations of each pollutant in each city for all the

in-traffic samples, and the corresponding concurrent concentrations at the CAMP site. Data from samples taken inside moving vehicles on traffic routes are tabulated separately from those obtained from samples taken at stationary positions alongside the traffic route. In all cases the in-traffic concentrations were significantly higher than the concurrent concentrations measured at the CAMP sites.

The ratios of the average in-traffic concentration to the average concurrent CAMP-site concentration for each city are given in Table 2. The low ratio in Chicago corresponds to a high average concentration of CO at the CAMP site, which is attributed to the close proximity of that site to high-density traffic routes (25 feet off Congress Expressway near State Street).

Table 3 shows the frequency distribution of concentration levels among all samples taken in each city. In all cities, 75% of the samples taken in moving vehicles were at least 16 ppm CO and 11% of the samples contained at least 31 ppm CO. The distribution (Table 3) of concentrations among samples taken concurrently at the CAMP site shows that they were appreciably lower than the concentrations of samples taken in traffic. Figure 2 graphically shows the frequency distribution of CO concentrations among samples taken inside moving vehicles. The 99, 95, 90, and 70 percentile points from these curves are recorded in Table 4, which shows that an estimated 1% of the samples in all cities contained at least 40 ppm and were as high as 87 ppm carbon monoxide. Except for Cincinnati, the 99 percentile points were extrapolated. It should be emphasized that since the samples from which all the data were taken represent integrations over approximately half-hour periods, they do not represent the peak levels that occur for shorter times at specific locations.

TABLE 1: AVERAGES AND RANGES OF CONCENTRATIONS TAKEN IN OR NEAR HIGH DENSITIES OF MOTOR VEHICLE TRAFFIC AND AT CAMP SITES (VALUES IN ppm)

| City | No. Samples | | Average CO | | Average Hydrocarbon | | Range CO | | Range Hydrocarbon | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CO | HC | In-traffic | CAMP site | In-traffic | CAMP site | In-traffic | CAMP site | In-traffic | CAMP site |
| Samples taken inside moving vehicles in traffic | | | | | | | | | | |
| Chicago | 16 | 17 | 37 | 29 | 4.8 | 3.4 | 20-59 | 20-41 | 2.4-8.4 | 1.8-6.8 |
| Cincinnati | 145 | 132 | 21 | 3.1 | 5.7 | 2.3 | 8-50 | 0-10 | 3.6-11.6 | 1.0-5.2 |
| Denver | 17 | 17 | 39 | 16 | 8.3 | 6.1 | 22-69 | 2-35 | 4.6-12.4 | 3.6-13.8 |
| St. Louis | 47 | 47 | 36 | 17 | 9.3 | 3.5 | 11-77 | 3-35 | 4.4-19.0 | 0.6-7.6 |
| Washington | 44 | 44 | 25 | 5.3 | 6.2 | 2.7 | 7-43 | 1-15 | 2.0-23.0 | 1.6-15.0 |
| Samples taken at points alongside traffic routes | | | | | | | | | | |
| Chicago | 24 | 20 | 44 | 28 | 6.4 | 3.3 | 22-71 | 18-42 | 2.2-16.2 | 1.6-6.0 |
| Philadelphia | 46 | 46 | 19 | 14 | 2.7 | 3.6 | 11-44 | 10-25 | 1.7-8.7 | 1.2-4.9 |
| Washington | 24 | 20 | 17 | 5 | 6.9 | 2.7 | 1-49 | 2-10 | 3.0-19.0 | 1.2-8.4 |

TABLE 2: RATIOS OF AVERAGE OF IN-TRAFFIC CONCENTRATIONS OF CARBON MONOXIDE AND TOTAL HYDROCARBONS TO CONCURRENT CAMP-SITE CONCENTRATIONS

| City | Ratio of Carbon Monoxide Concentrations (In-traffic/CAMP | Ratio of Hydrocarbon Concentrations (In-traffic/CAMP) |
|---|---|---|
| | Samples taken inside moving vehicles in traffic | |
| Chicago | 1.3 | 1.4 |
| Cincinnati | 6.8 | 2.5 |
| Denver | 2.4 | 1.4 |
| St. Louis | 2.1 | 2.7 |
| Washington, D. C. | 4.7 | 2.3 |
| | Samples taken alongside traffic route | |
| Chicago | 1.6 | 1.9 |
| Philadelphia | 1.4 | 0.75 |
| Washington, D. C. | 3.4 | 2.5 |

TABLE III

EFFECT OF POTTING MIX ON SENSITIVITY OF PINTO BEAN TO OZONE a/

| POTTING MIX | INJURY INDEX b/ |
|---|---|
| Peat-perlite | 36 |
| Vermiculite | 36 |
| Soil mix | 7 |

a/ Plants were grown under controlled conditions (2,000 ft-c, 14-hr photoperiod, 80°F day, 70°F night, 65 ± 15% RH) and exposed in greenhouse exposure chambers for 1 hr at 20-55 pphm ozone.

b/ Values are given as percent injury to upper leaf surfaces.

Table 3: FREQUENCY OF CARBON MONOXIDE CONCENTRATIONS IN TRAFFIC AND AT CAMP SITES

| City | No. Samples | % of values ≤ stated concentration, ppm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | In traffic | | | | | CAMP site* | | | | |
| | | 25 | 50 | 75 | 90 | 95 | 25 | 50 | 75 | 90 | 95 |
| | | Samples taken inside moving vehicles in traffic | | | | | | | | | |
| Chicago | 16 | 24 | 30 | 46 | 50 | -- | 23 | 27 | 34 | 36 | -- |
| Cincinnati ** | 145 | 16 | 20 | 25 | 31 | 35 | 2 | 3 | 4 | 5 | 6 |
| Denver | 17 | 27 | 34 | 41 | 51 | 71 | 13 | 15 | 17 | 21 | 30 |
| St. Louis | 47 | 28 | 38 | 44 | 51 | 56 | 12 | 17 | 21 | 24 | 27 |
| Washington, D.C. | 44 | 16 | 20 | 30 | 36 | 39 | 3 | 4 | 8 | 9 | 13 |
| | | Samples taken at points alongside traffic routes | | | | | | | | | |
| Chicago | 20 | 28 | 45 | 56 | 60 | 66 | 22 | 26 | 37 | 40 | 40 |
| Philadelphia | 46 | 14 | 16 | 22 | 26 | 30 | 11 | 14 | 15 | 17 | 19 |
| Washington, D.C. | 24 | 11 | 15 | 20 | 30 | 33 | 3 | 5 | 9 | 9 | 9 |

*5-minute maximum during time period corresponding to in-traffic sampling.

** 99 Percentiles: In traffic - 46 ppm; CAMP site - 10 ppm.

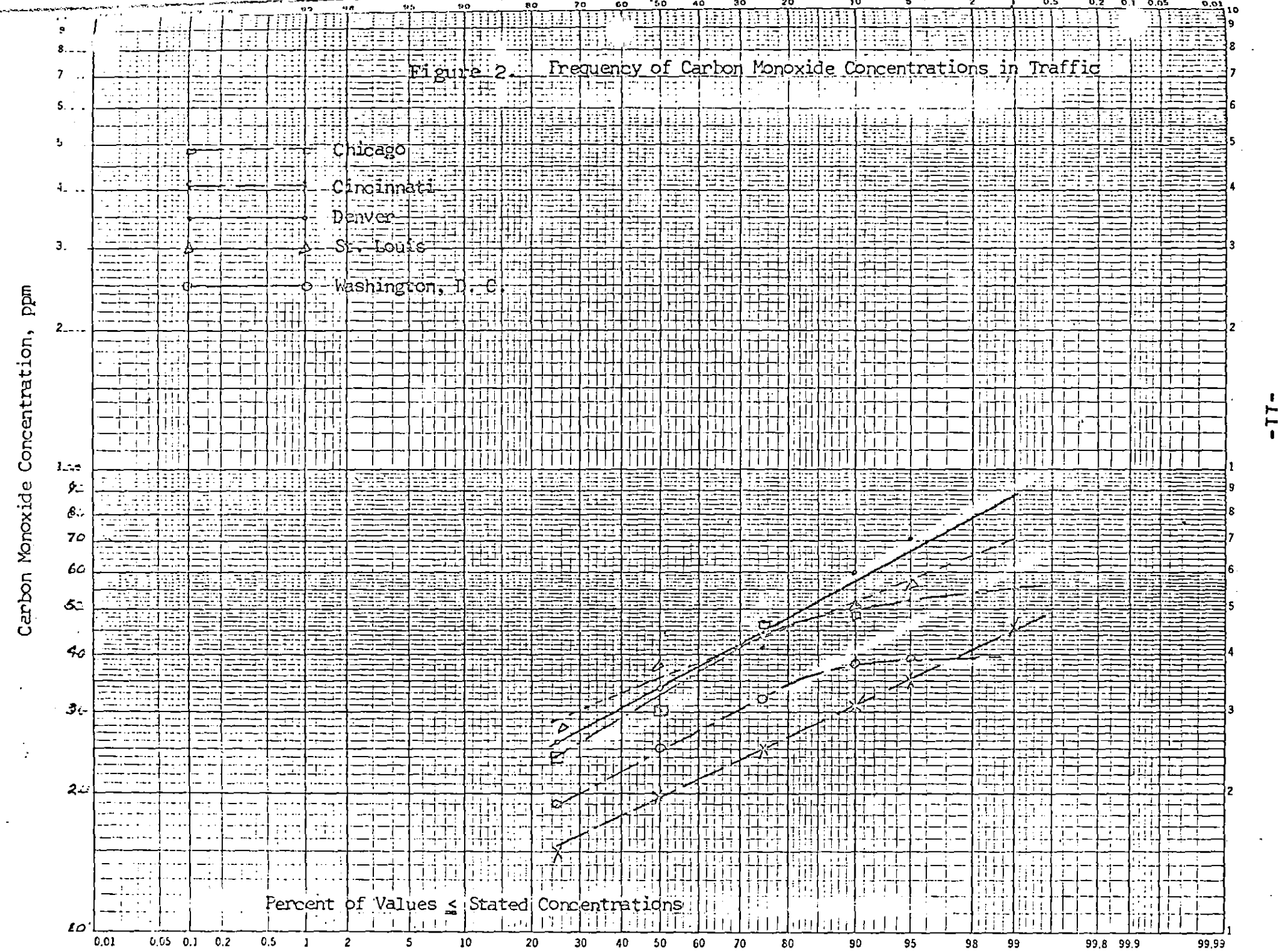


Figure 2. Frequency of Carbon Monoxide Concentrations in Traffic
Chicago
Cincinnati
Denver
St. Louis
Washington, D. C.
Carbon Monoxide Concentration, ppm
Percent of Values ≤ Stated Concentrations
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99

TABLE 4: CO CONCENTRATIONS ON HIGH-DENSITY TRAFFIC ROUTES DURING WEEK DAY HOURS 0700-1900
(Values in ppm)

| City | CONCENTRATIONS EXCEEDED THE STATED PERCENT AMONG ALL SAMPLES | | | |
|---|---|---|---|---|
| | 1% | 5% | 10% | 30% |
| | Samples taken inside moving vehicles | | | |
| Chicago | 55 | 53 | 48 | 44 |
| Cincinnati | 45 | 35 | 31 | 24 |
| Denver | 87 | 66 | 57 | 42 |
| St. Louis | 70 | 58 | 52 | 41 |
| Washington, D.C. | 40 | 39 | 38 | 31 |
| | Samples taken alongside traffic route | | | |
| Chicago | 68 | 64 | 62 | 54 |
| Philadelphia | 38 | 30 | 26 | 21 |
| Washington, D.C. | 49 | 35 | 30 | 20 |

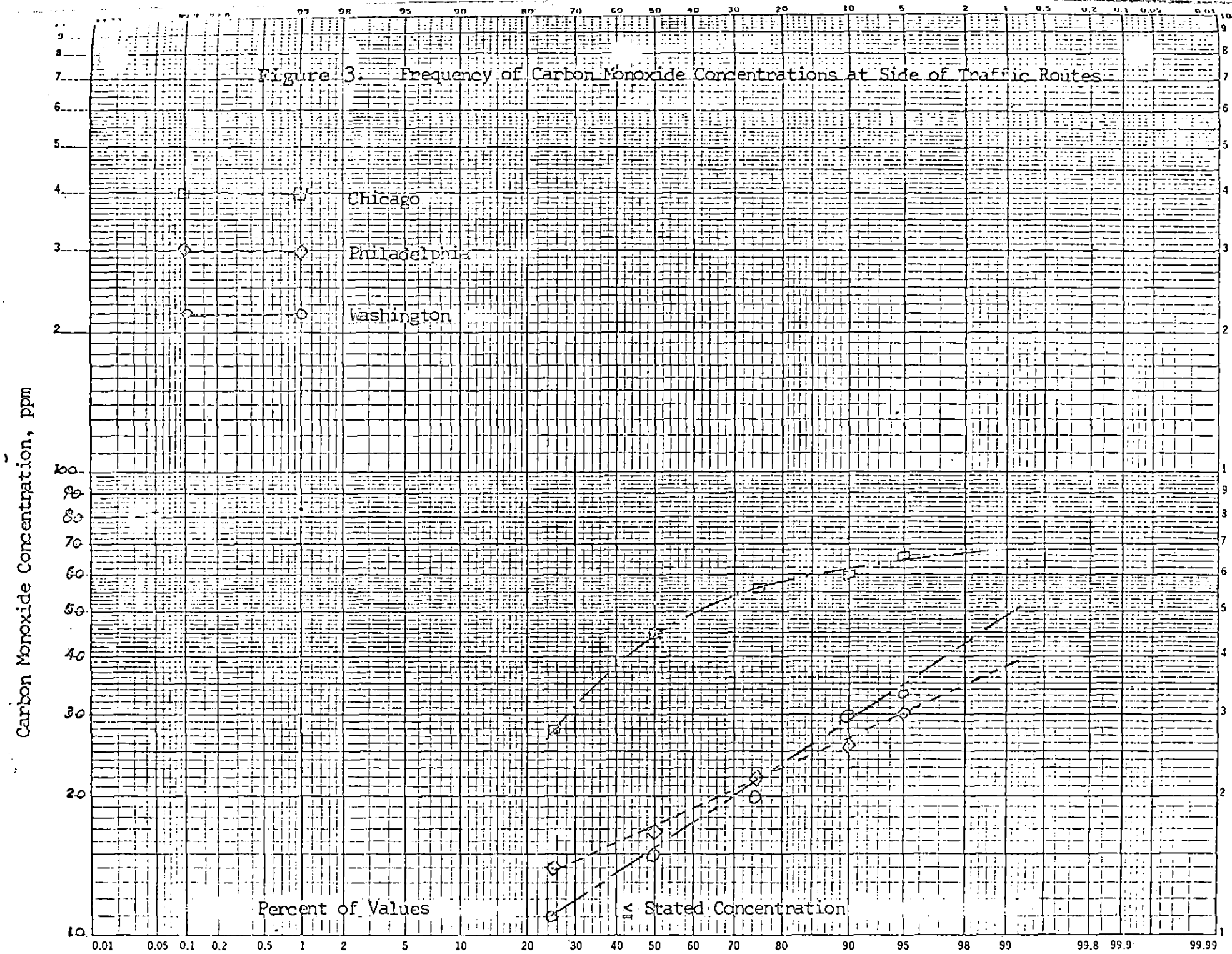



Figure 3. Frequency of Carbon Monoxide Concentrations at Side of Traffic Routes

Table 6 shows a categorization of CO concentration levels according to temperature range for the two cities where sufficient data were available. These data show no appreciable effects of temperatures between 20° and 80°F on the average concentration of CO within the vehicle. This lack of relationship between temperature and CO concentration is also indicated by the concurrent data at the CAMP station. The relationship will be investigated further as additional sampling is completed.

Table 7 summarizes the available data on wind speed versus average CO concentrations. Wind speed had a significant inverse effect on the in-traffic CO concentrations. The relationship of wind speed to CAMP-site concentrations is difficult to see except for Denver, where the inverse relationship is apparent.

In Cincinnati sufficient data were available to evaluate the distribution of CO concentrations according to individual sampling route, i.e. downtown, throughway, or expressway. Table 8 summarizes the distribution of these CO concentrations. The data indicate that concentrations were highest on the downtown route and lowest on the throughway route, although the differences are not large. The differences in concentrations are probably explained by the effect of topography. The downtown route is "boxed" in by tall buildings, which reduce ventilation regardless of wind direction; the throughway and expressway routes are generally more open.

In addition to the Mylar bag samples, which represent sampling periods of approximately 25 minutes, some 5-minute average CO concentrations were obtained with detector tubes. In Cincinnati this sampling was done in the midst of especially high traffic concentrations, including traffic jams. Thus these data tend to indicate maximum 5-minute in-traffic concentrations. In Philadelphia, detector-tube sampling was done

TABLE 5: TRAFFIC VS CARBON MONOXIDE CONCENTRATION ALONG HIGH DENSITY TRAFFIC ROUTES

| Traffic Density, average number vehiicles/minute | Concentrations, ppm * | | | | |
|---|---|---|---|---|---|
| | Cincinnati | | | | Washington, D.C. |
| | X-way north | X-way south | Thru way | Down-town | All Routes |
| 0-39 | 15(4) | 14(2) | 18(32) | 23(76) | 16(8) |
| 40-59 | 19(10) | 18(8) | | | 23(14) |
| 60-100 | 25(8) | 22(9) | | | 28(16) |

*Numbers in parentheses indicate number of samples averaged.

TABLE 6: TEMPERATURE VERSUS CONCENTRATION OF CARBON MONOXIDE SAMPLED INSIDE VEHICLE MOVING IN HEAVY TRAFFIC AND CONCURRENTLY AT CAMP SITE

| Temperature, °F | CO Concentrations, ppm * | | | |
|---|---|---|---|---|
| | In-traffic | | CAMP site | |
| | Denver | Washington | Denver | Washington |
| 20-39 | 34(8) | 22(22) | 17 | 5 |
| 40-59 | 35(8) | 29(14) | 14 | 4 |
| 60-79 | | 28(5) | | 6 |

*Numbers in parentheses indicate number of samples averaged.

TABLE 7: WIND SPEED VERSUS CONCENTRATION OF CARBON MONOXIDE SAMPLED INSIDE VEHICLE MOVING IN HEAVY TRAFFIC AND CONCURRENTLY AT CAMP SITE

| Wind Speed, mph | CO Concentration, ppm* | | | | | |
|---|---|---|---|---|---|---|
| | In-traffic | | | CAMP site | | |
| | Denver | St. Louis | Wash. | Denver | St. Louis | Wash. |
| $\leq 5$ | 44(3) | 46(4) | 29(14) | 22 | 18 | 5 |
| 6-9 | 34(7) | 37(27) | 26(24) | 15 | 16 | 5 |
| $\geq 10$ | 31(6) | 32(13) | 18(6) | 13 | 18 | 6 |

*Numbers in parentheses indicate number of samples averaged.

TABLE 8: FREQUENCY AND AVERAGE CONCENTRATION OF CARBON MONOXIDE SAMPLED INSIDE VEHICLE MOVING IN HEAVY TRAFFIC AND CONCURRENTLY AT CAMP SITE IN CINCINNATI

| Route | No. Samples | % of values ≤ stated concentration, ppm | | | | | | | | Average concentrations, ppm, among all samples | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | In-traffic | | | | CAMP site | | | | | |
| | | 25 | 50 | 75 | 90 | 25 | 50 | 75 | 90 | In-traffic | CAMP |
| Downtown | 75 | 18 | 21 | 26 | 34 | 1 | 2 | 3 | 4 | 23 | 2 |
| X-Way N | 18 | 16 | 19 | 24 | 28 | 4 | 4 | 5 | 5 | 21 | 5 |
| X-Way S | 19 | 16 | 21 | 22 | 25 | 3 | 4 | 5 | 8 | 20 | 5 |
| Thru-way | 33 | 15 | 18 | 20 | 22 | 3 | 4 | 5 | 6 | 19 | 4 |
| All Routes | 145 | 16 | 20 | 25 | 31 | 2 | 3 | 4 | 5 | 21 | 3 |

at curbside and the values indicate 5-minute concentrations to which pedestrians are exposed. The data from detector-tube sampling are shown in Table 9. The range of these samples obtained in vehicles moving on the downtown Cincinnati route is 30 to 75 ppm; the mediam is 60 ppm. Similarly, on the two expressway routes the range among samples is 30 to 80 ppm and the mediam, 50 ppm. Concentrations in curbside detector-tube samples in Philadelphia ranged from 10 to 45 ppm; median, 25 ppm. These data indicate that in Cincinnati downtown traffic, 5-minute exposures at least as high as 75 ppm occurred; in Cincinnati expressway traffic, 5-minute exposures at least as high as 80 ppm occurred. Pedestrians at curbside in Philadelphia were exposed to 5-minute concentrations at least as high as 45 ppm during the sampling period.

Hydrocarbon Concentration

Since both CO and hydrocarbons are emitted in appreciable quantities from motor vehicles, it was expected that their concentration levels would be elevated similarly in high density traffic areas. The average and the range of concentrations of all hydrocarbon samples are shown in Table 1. These data generally show significantly greater concentrations of hydrocarbons in or very close to heavy traffic, compared to concurrent concentrations at the corresponding CAMP site. Table 10 shows the ratios of the average hydrocarbon concentration in traffic to the corresponding CAMP-site concentration. These ratios range from 1.4 to 2.7 and are similar in magnitude to the corresponding ratios from CO data. The frequency distribution of hydrocarbon concentrations for each city is shown in Table 11. The data in this table also show that in-traffic

TABLE 9: CARBON MONOXIDE CONCENTRATIONS [a] RECORDED BY DETECTOR TUBES IN AREAS OF HIGH TRAFFIC DENSITY

| No. of samples | Carbon monoxide, ppm |
|---|---|
| Vehicle moving in downtown Cincinnati traffic | |
| 1 | 30 |
| 2 | 60 |
| 1 | 70 |
| 1 | 75 |
| Vehicle moving in Cincinnati expressway traffic | |
| 1 | 30 |
| 2 | 40 |
| 4 | 50 |
| 1 | 60 |
| 2 | 70 |
| 1 | 80 |
| Curb sites near dense Philadelphia traffic | |
| 2 | 10 |
| 5 | 15 |
| 3 | 20 |
| 4 | 25 |
| 3 | 30 |
| 2 | 35 |
| 2 | 40 |
| 1 | 45 |

[a] Approximately 5-minute samples.

concentrations of hydrocarbons are appreciably higher than concurrent CAMP-site concentrations.

TABLE 10. RATIOS OF AVERAGE HYDROCARBON CONCENTRATION AMONG SAMPLES TAKEN INSIDE MOVING VEHICLES IN HIGH TRAFFIC DENSITY TO AVERAGE OF CORRESPONDING CONCURRENT CAMP-SITE CONCENTRATIONS

| City | Ratio |
|---|---|
| Chicago | 1.4 |
| Cincinnati | 2.5 |
| Denver | 1.4 |
| St. Louis | 2.7 |
| Washington, D. C. | 2.3 |

In Cincinnati, where sufficient data were available on three types of routes, it was practicable to determine frequency distributions of hydrocarbon concentrations for individual routes. Table 12 shows these data, which, like the CO distributions, indicate that pollutant concentrations are highest on the downtown route.

TABLE 11: FREQUENCY OF HYDROCARBON CONCENTRATIONS IN TRAFFIC AND AT CAMP SITES

| City | No. Samples | % of values ≤ stated concentration, ppm | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | In traffic | | | | CAMP site | | | |
| | | 25 | 50 | 75 | 90 | 25 | 50 | 75 | 90 |
| | | Samples taken inside moving vehicles in traffic | | | | | | | |
| Chicago | 17 | 3.1 | 4.3 | 5.9 | 6.8 | 2.6 | 2.9 | 4.0 | 4.6 |
| Cincinnati | 132 | 4.5 | 5.1 | 6.2 | 8.0 | 1.8 | 2.0 | 2.4 | 3.2 |
| Denver | 17 | 6.2 | 7.4 | 9.0 | 11.8 | 3.8 | 5.0 | 6.6 | 9.0 |
| St. Louis | 47 | 7.1 | 8.4 | 12.3 | 15.0 | 2.2 | 4.0 | 5.6 | 5.8 |
| Washington, D. C. | 44 | 4.6 | 5.6 | 6.4 | 6.8 | 2.0 | 2.2 | 2.6 | 3.0 |
| | | Samples taken at points alongside traffic routes | | | | | | | |
| Chicago | 20 | 3.8 | 5.2 | 8.2 | 10.4 | 2.2 | 2.6 | 4.2 | 5.2 |
| Philadelphia | 46 | 2.6 | 3.2 | 4.2 | 5.0 | 2.1 | 2.7 | 3.1 | 4.2 |
| Washington, D. C. | 20 | 4.6 | 6.0 | 7.8 | 12.0 | 2.0 | 2.4 | 3.0 | 3.2 |

TABLE 12: FREQUENCY OF HYDROCARBON CONCENTRATIONS AMONG SAMPLES TAKEN IN TRAFFIC * AND AT CAMP SITE IN CINCINNATI

| Route | No. Samples | % of values ≤ stated concentration, ppm | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | In traffic | | | | CAMP site | | | |
| | | 25 | 50 | 75 | 90 | 25 | 50 | 75 | 90 |
| Downtown | 75 | 4.8 | 5.6 | 7.0 | 9.2 | 1.8 | 2.2 | 2.4 | 3.4 |
| X-Way N | 12 | 4.7 | 5.2 | 5.6 | 5.8 | 1.8 | 2.2 | 2.8 | 3.2 |
| X-Way S | 14 | 5.0 | 5.2 | 6.2 | 6.4 | 2.0 | 2.4 | 3.1 | 3.2 |
| Thru-way | 31 | 4.4 | 4.9 | 5.4 | 6.8 | 1.8 | 1.8 | 2.0 | 2.2 |
| All Routes | 132 | 4.5 | 5.1 | 6.2 | 8.0 | 1.8 | 2.0 | 2.4 | 3.2 |

* Samples taken inside moving vehicle.

## SUMMARY OF RESULTS

Approximately half-hour integrated concentrations of CO on busy streets in the six large cities investigated ranged from 7 to 77 ppm. Averages of all samples taken in each city ranged from 21 to 39 ppm of CO. In every city the CO concentration exceeded 30 ppm in at least 10% of the integrated samples. CO concentrations inside moving vehicles on high-density traffic routes were 1.3 to 6.8 times the corresponding concurrent concentrations at the CAMP site. Hydrocarbon concentrations were similarly significantly higher in traffic than at the CAMP site. These differences reflect the effect of proximity to moving vehicles.

In Cincinnati sufficient data were available to permit categorizing concentrations with sampling route; concentrations were higher in the downtown area, where high buildings tend to reduce ventilation.

Categorizing individual sample concentrations of CO by wind speed indicated an inverse relationship: concentrations were lower with greater wind speed.

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By HENRY A. SCHROEDER

# AIRBORNE METALS

AIR IS ONLY ONE PART OF A SYSTEM which includes the total physical environment to which man is exposed. When air contains foreign substances, rainfall carries them to the ground. When these substances are soluble in water, they may appear in the water supply; when they fall on the soil, they may appear in plant foods which are eaten by man and domestic animals. Therefore, the problem of air pollution is closely linked to that of soil and water pollution, and its effects can exceed irritation of the lungs from acutely toxic substances.

The scientist's version of the average man — a "standard man" weighing seventy kilograms—inhales and exhales about twenty cubic meters of air every twenty-four hours. This daily volume of air (weighing some 24.1 kilograms) is about one-third the weight of his body and about six times the weight of his daily intake of food and water.

When air contains abnormally high concentrations of trace metals—a trace metal is one which makes up less than 0.01 per cent of the body—they will be inhaled. Once in the lungs, trace metals vary in their behavior; some accumulate in the lungs, in various proportions, more or less permanently; of these, some are absorbed into other body tissues.

We are concerned here with those chemical elements which may produce slowly accumulating effects during years of exposure. We want the answers to several basic questions:

- What metals are in the air?
- What are their principal sources?
- Which metals remain in the lungs and which are absorbed into the rest of the body?
- Which metals are beneficial, which inert, and which harmful?

Eight of these metals—aluminum, chromium, copper, iron, lead, manganese, strontium and zinc—were present in all the lungs tested; barium, tin and titanium were almost as frequent in occurrence in human lungs.

For more than fourteen years, Professor Isabel H. Tipton, Dr. H. Mitchell Perry, Jr. and I have worked with others, to answer these questions. Professor Tipton and her colleagues have provided the basic data on the content of twenty-one trace metals in human tissues from ten cities in the United States[1] and fifteen cities in Europe, Asia and Africa,[2] comprising over 400 cases. Nine years ago E. C. Tabor and V. W. Warren reported the first comprehensive data on metals in the air of American cities.[3] J. J. Balassa and I have been collecting basic data on the lifetime effects of some twenty trace metals on growth, longevity, and lifespan of mice[4] and rats,[5] attempting to duplicate as nearly as possible trace metal exposures and accumulations which occur in humans, in hopes of discovering what diseases, if any, may result.

We have learned that of the various airborne trace metals that accumulate in the lungs and other tissues at least two, lead and cadmium, are known to have injurious effects on humans. Others have demonstrable toxic effects on mice and rats, suggesting additional research to determine the effects on human health of airborne metallic elements known to accumulate in human tissue.

Table I lists some of the metals present in the atmospheres of more than twenty American cities and those present in the lungs of Americans.



Exhibit K

These and all the other elements in Table I are found in coal, and most of them in petroleum.

In addition to these, other elements are found in coal: antimony, arsenic, beryllium, boron, gallium, germanium, lanthanum, mercury, rubidium, tungsten, uranium, yttrium, zirconium and probably niobium.[6] Many of these, including arsenic, cadmium, antimony, lead, mercury, zinc, and tellurium, vaporize at the burning temperatures of coal and oil, as do many other elements contained in chemical compounds, and all elements may be found in soot, ash, or smoke. Some elements—calcium, aluminum, silicon and iron —generally remain in ash and are not carried up chimneys into air; they are of little concern in the measurement of air-borne trace metals. There is no doubt, however, that the process of burning coal and oil adds greatly to trace metal contamination of the air as the trace elements in the fuels are vaporized. In fact, one of our most serious experimental problems is preventing trace elements from going up in smoke as we burn our tissue samples into ash for analysis.

In our consideration of possibly harmful trace elements, we can more or less eliminate those known to be essential for normal physiological processes; chromium, manganese, iron, cobalt, copper, zinc, and molybdenum. It is possible that vanadium and selenium also belong in this category. We would expect to find them normally in lung and other tissues, although air-borne contamination may deposit them in a form unusable by the body, thus making them a hazard.

All metals can be toxic to living tissue if they occur in large enough amounts and in the proper form. Those metals which are not essential for life and health, which may or may not be toxic, and which accumulate in lung tissue with age[7] must be carefully scrutinized; these include aluminum, cadmium, lead, titanium, vanadium and tin. We can probably eliminate from our consideration metals which are present in lungs in very small quantities and which do not accumulate with age in body tissues: bismuth, gold, nickel and silver. We know little about the behavior of germanium, tellurium, arsenic, antimony and niobium, which are probably present in air.

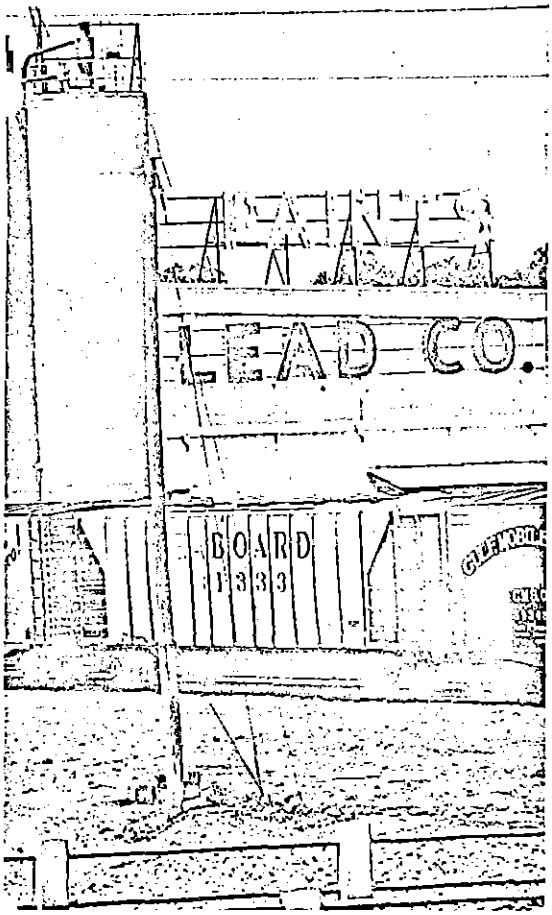
We can get some idea of the relative exposures of Americans to airborne metals by comparing the concentrations of these metals in their lungs with those of persons from other areas of the world. In Table II are the mean concentrations of trace elements in American, African, Near Eastern and Far Eastern lungs of males aged twenty through fifty-nine years. This table omits the trace metals essential for nutrition. It is apparent that there is less cadmium, lead and tin in African lungs than in American and Oriental. Aluminum, barium, strontium and titanium can enter the air in dust from soil, and their accumulation in African and Near Eastern lungs can be accounted for on this basis. The frequency of cadmium, lead, and tin in all but African lungs suggests industrial contamination as the source, for the lung tissues of Africans came from relatively non-industrial areas.

Study of the behavior and effects of cadmium and lead is especially important; these are the most common of the elements which accumulate in the lungs and which are also absorbed into the rest of the body. According to Tipton and Schafer,[7] aluminum, titanium, and vanadium, which accumulate with age, remain largely in the lung as insoluble contaminants, while lead "appears to enter the lung in soluble form and to be quickly carried to other parts of the body."

Lead and cadmium are among the elements known to shorten the life-spans of mice and rats. Lead poisoning in human beings is, of course, a long-recognized problem, and cadmium has been linked to at least one chronic disease of human beings, high blood pressure.[8] R. E. Carroll has shown that the death rate from cardiovascular disease, which includes high blood pressure and coronary heart disease, is significantly higher in areas where the concentration of cadmium in air is high, and significantly lower where the concentration of cadmium in air is low.[9] Most of the cadmium in the body, however, comes from food and water.

We know little about the sources of airborne cadmium, but it is likely that it enters the air as a by-product of industrial processing of zinc. Cadmium is a constant contaminant of zinc, and has a relatively low boiling point, 765 degrees C. Whenever zinc is heated to its boiling point, 906 degrees C., cadmium fumes can enter the air.

The principal source of airborne lead is undoubtedly tetra-ethyl lead, an anti-knock agent added to gasoline since 1924. The amount of mined lead annually used for gasoline additives amounts to about two pounds for each person in the United States (in 1963 the total was 192,811 tons).[10] This lead would offer no hazard if it were burned and retained in crank case oil, but, unfortunately, twenty-five to fifty-five per cent of it comes out of the exhaust, half to two-thirds in particles[11] and the remainder in gaseous form. The smaller particles can be blown by winds to surrounding areas and contaminate food crops; the larger particles may remain on the road; the gaseous forms enter the upper atmosphere and can be precipitated by rain and snow at far distant locations. All this lead accumulates in the environment year after year. We have detected lead in snow at ground level (but not at roof level) 200 yards from a suburban road within four hours after a snowfall. On the other hand, it took




**EXPOSURE to low levels of lead is now common in our cities from industrial and traffic sources. It has recently been suggested that lead may damage health at low levels of exposure.**

eight days for lead to be detected in snow in a mountain forest near a back road. Analyses of various sections of one-hundred year old elm trees have demonstrated rapidly increasing concentrations of lead since about 1937.[12]

Although *average* lead concentrations in the air are not considered high, varying from 0.2 micrograms per cubic meter on the Great Plains and Rocky Mountain areas to 0.7 micrograms per cubic meter in New England and the Pacific Coastal states, concentrations of six micrograms per cubic meter,[13] and in extreme cases seventeen to forty-five micrograms or more, have been measured in cities, especially on traffic-crowded streets or highways.[14]

At a concentration of one microgram of lead per cubic meter of air, a man would take into his lungs twenty micrograms of lead per day. Most of this lead is in time excreted by the body; if it were not, a man would accumulate in fifteen years of his life 110 milligrams of lead *by inhalation alone*, an amount almost equal to the average total body content of most Americans (estimated at 120 milligrams by the International Commission on Radiation Protection; other estimates are higher, ranging up to 220 milligrams).

But airborne lead is not the sole source of lead in the body. The average American also consumes about 300 micrograms of lead daily in foods and beverages. A man living in an area where lead concentration in air was fifteen micrograms per cubic meter would take in an additional 300 micrograms of lead by inhalation alone, roughly doubling his total lead intake. Lead poisoning would almost certainly develop in time, for the amount of lead absorbed by blood and tissues from the respiratory system is about five times as high as the lead absorbed from the alimentary tract. The blood and tissues absorb about fifty per cent of inhaled organic lead, and only about five to ten per cent of the lead intake from food and beverages (see Patterson article this issue). About ninety per cent of lead retained in the body is stored in bone.

An increase in airborne lead concentration from one microgram per cubic meter to fifteen micrograms per cubic meter would increase lead absorption, for the average man, from about twenty-three micrograms per day to 165 micrograms per day of lead absorbed by blood and tissue, based on the above estimates of absorption rates for inhaled lead and lead in foods and beverages.

Fifteen micrograms of lead per cubic meter of air is an extremely high concentration and relatively uncommon today, found only on or near heavily travelled streets and highways during rush-hour traffic;

but if the number of cars on U.S. roads doubles by 1980, as has been predicted, a concentration of fifteen micrograms of lead per cubic meter of air probably will be commonplace in American cities.

In one study of the effects of cadmium and lead on rats,[5] we attempted to achieve, by carefully controlled laboratory methods and diet, tissue concentrations within human ranges. All the experimental groups were kept in a low metal environment: the specially-built laboratory is situated on a hilltop more than a mile from the nearest road; the air is filtered and particulate contaminants are electrostatically precipitated.

The rats were fed a special diet of rye, dried skim milk and corn oil, devoid of cadmium and as low in other trace metals as is possible under laboratory conditions. The sole source of fluids was purified spring water to which was added vitamins and essential nutritive elements such as manganese, cobalt, copper and so forth. Five parts per million of cadmium or lead was added to the water of the test groups from the time of weaning until death; a control group received neither of these metals.

Briefly summaried, the experiments showed that cadmium and lead tissue concentrations in human ranges significantly decreased the life span of rats; in addition, the animals fed lead showed a higher mortality rate under exposure to infection. In one series of experiments, the median age at death of rats fed lead was 728 days, while the median age at death of control rats was 961 days; the median for cadmium-fed rats was 814 days. Of 249 rats fed cadmium or lead, forty died before the age of three months; none of the 104 control rats died before the age of three months. Autopsies showed neurological disease to be almost unknown in control groups but frequent in rats fed cadmium or lead. A majority of the cadmium fed rats displayed abnormally high blood pressure and hardening of the arteries in kidney, heart, lung, and liver, as well as enlargement of the left ventricle of the heart.

Table III is a partial summary of our experience in testing trace metals for innate toxic effects in rats and mice, as measured by a reduction in life span or the production of a chronic disease similar to those which humans suffer. It is noted that in addition to cadmium and lead, germanium, arsenic, tellurium and selenite decrease life span in mice or rats or both, and selenite appears to inhibit growth in rats. In most of these cases, the tissue concentrations were within the range of normal human levels. In no case was the incidence of cancers increased.

Many trace metals have been found in the air. Some come from soil dusts, others from the burning of fossil fuels (especially coal), others from industrial processing of metals. One, lead, comes primarily from gasoline additive wastes in auto exhausts.

Most of the trace metals, in the concentrations found, are not necessarily toxic to human beings; nor is there any evidence that they can cause cancer or any other disease when ingested, even though some of them accumulate in human lungs with age.

Two elements, however, cadmium and lead, appear to be toxic in the concentrations or distributions now found, either because of inhalation or because of ingestion of contaminated water supplies or agricultural soils.

As lead additives in gasoline are not absolutely necessary, the solution to the increasing lead burden in the atmosphere, soils and water is to discontinue the use of tetraethyl lead and related compounds, and to substitute for it some more inert metal compound, such as nickel or tin, which will have a similar anti-knock property and permit octane levels comparable to those now achieved. It will be much more difficult for industrialized societies to avoid cadmium contamination, but a program of industrial safeguards against release of cadmium fumes into the open air should help prevent contamination of food and water and result in a significant decrease in accumulation of cadmium in human tissues.

There is a need for the continued study of the effects of trace metals on the living organism. Our sixteen years of research in this field has not touched upon many questions which need answers. Little is known about such trace substances as germanium, tellurium, selenite, arsenic and antimony in their airborne forms. Whether or not they accumulate in lungs, whether or not they are toxic to humans in these forms, and in what concentrations, remain the objects for further study. Knowledge gained in these areas may have important implications for the future treatment of several major chronic diseases.

**Henry A. Schroeder, M.D.,** is Professor of Physiology, Dartmouth Medical School and Director of Research, Brattleboro Memorial Hospital. Dr. Schroeder and colleagues have been working on trace metals for many years. His recent publications on this subject have attracted a great deal of attention from the general public as well as from the scientific community.

**Table I**

**Some Metals in the Air of American Cities and in American Lungs**

| Metals | Percentage of samples containing the Metal.[3] | Percentage of lungs containing the metal.[7] | Accumulates* in lungs with age.[7] | Remarks |
|---|---|---|---|---|
| Aluminum | 100 | 100 | Yes | In soil |
| Barium | 57 | 98 | No | In soil |
| Bismuth | 43 | 4 | No | |
| Cadmium | 79 | 58 | Yes | Industrial contaminant |
| Chromium | 63 | 100 | Yes | Essential element |
| Cobalt | 14 | 20 | No | Essential element |
| Copper | 94 | 100 | No | Essential element |
| Gold | - | 2 | - | |
| Iron | 91 | 100 | Yes | Essential element |
| Lead | 99 | 100 | Yes | From gasoline waste |
| Manganese | 75 | 100 | No | Essential element |
| Molybdenum | 12 | 17 | No | Essential element |
| Nickel | 91 | 58 | No | |
| Silver | - | 39 | No | |
| Strontium | 100 | 100 | Yes | In soil |
| Tin | 67 | 98 | Yes | Industrial contaminant |
| Titanium | 77 | 99 | Yes | In soil |
| Vanadium | 20 | 57 | Yes | In soil |
| Zinc | 83 | 100 | - | Essential element |

* In other respiratory organs, trachea and larynx, iron, lead, barium and strontium accumulate with age. Accumulation, where shown, was statistically significant at the 0.1% level of confidence, or less.

**Table II**

**Trace Elements in Human Lung (Ash) by Geographical Location***

| | AMERICAN | | AFRICAN | | NEAR EASTERN | | FAR EASTERN | |
|---|---|---|---|---|---|---|---|---|
| Metals | Parts per million | Percentage of lungs containing | Parts per million | Percentage of lungs containing | Parts per million | Percentage of lungs containing | Parts per million | Percentage of lungs containing |
| Aluminum | 1800 | 100 | 3100* | 100 | 3100 | 100 | 2500 | 100 |
| Barium | 13 | 98 | 22 | 100 | 28† | 100 | 15 | 100 |
| Cadmium | 50 | 58 | N.D.† | 0 | 50 | 23 | 50 | 49 |
| Chromium | 14 | 100 | 16 | 100 | 22 | 100 | 23 | 100 |
| Lead | 51 | 100 | 26† | 98 | 47 | 100 | 48 | 99 |
| Nickel | 5 | 58 | 7 | 57 | 22 | 56 | 10 | 64 |
| Strontium | 8 | 100 | 10 | 100 | 12† | 100 | 9 | 100 |
| Tin | 32 | 98 | 5† | 59 | 16 | 85 | 29 | 90 |
| Titanium | 200 | 99 | 270 | 98 | 390 | 100 | 140 | 99 |
| Vanadium | 1 | 57 | 4 | 75 | 10† | 79 | 2 | 70 |

† Value significantly different from American at the 0.1% level of confidence or less.

* Values given in parts per million (ppm) ashed lung. About 1.1% of the lung is ash, or minerals.

N.D. None discovered.

Table III

Innate toxicity of several elements in terms of growth and life span of rats and mice exposed to traces equivalent to the human experience

| Element | Mice | | Rats | | Remarks |
|---|---|---|---|---|---|
| | Growth | Life Span | Growth | Life Span | |
| Titanium | + | 0 | | | Rats not tested |
| Vanadium | 0 | 0 | 0 | 0 | |
| Chromium | + | + | + | + | Diabetes with deficiency |
| Nickel | 0 | 0 | 0 | | Rats in process |
| Germanium | 0 | - | 0 | | Slightly toxic |
| Arsenic | 0 | - | 0 | 0 | Tumors depressed in mice |
| Zirconium | 0 | 0 | 0 | 0 | |
| Niobium | 0 | - | 0 | 0 | |
| Cadmium | 0 | - | + | - | High blood pressure |
| Tin | 0 | 0 | 0 | 0 | |
| Antimony | 0 | - | 0 | - | Toxic |
| Tellurium | 0 | - | 0 | | |
| Lead | 0 | - | + | - | Toxic at all ages |
| Selenite | 0 | - | - | - | Toxic |
| Selenate | 0 | | 0 | | In process |

0 = No effect
+ = Increased
- = Shortened or depressed

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14. Goldsmith, J. R., and A. C. Hexter. "Respiratory Exposure to Lead: Epidemiological and Experimental Dose-Response Relationships," *Science*, 158: 132-34, 1967.



The work done at this laboratory and summarized here was supported mainly by grants-in-aid from the National Heart Institute and the U.S. Army.

TABLE 1

ALERT SYSTEM CRITERIA, LEVELS AND ACTION GUIDES

| | FORECAST | ALERT | WARNING | EMERGENCY |
|---|---|---|---|---|
| Qualitative Description of Criteria | High air pollution potential for next 36 hours | Pollution levels high, accumulation expected for next 24 hours | Applicable ambient air standards have been exceeded | Dangerous levels which will be reached if actions not taken |
| Basic Contaminant Level - Carbon Monoxide | | 15 ppm | 20 ppm | 50 ppm |
| Formal Criteria Carbon Monoxide and Forecast to Persist for: | | 15 ppm<br>8 hours | 20 ppm<br>no forecast needed | 50 ppm<br>emergency state declared upon forecast of above levels being reached |
| Action Guides | Public notification | Voluntary reduction | Traffic curtailed | All-out emission reduction procedures instituted |

Exhibit L

DONALD E. CLARK · MULTNOMAH COUNTY COMMISSIONER

November 9, 1970

M. James Gleason, Chairman
Board of County Commissioners
Multnomah County

Terry D. Schrunk, Mayor
City of Portland

Gentlemen:

In conjunction with the proposed agenda item for the City-County meeting for up dating our emergency plans, I would like to discuss a contingency plan for the curtailment of all internal combustion vehicular traffic in the metropolitan area at such time as the air quality diminishes to a point of being an immediate hazard to the health of the citizenry.

Yours truly,

DONALD E. CLARK
Commissioner

DEC. s

Enc. cc letter to Dr. Donnelly
District Attorney opinion

Exhibit M

MEMORANDUM

TO: Members of the Environmental Quality Commission
B. A. McPhillips, Chairman
Edward C. Harms, Jr., Member
Storrs S. Waterman, Member
George A. McMath, Member
Arnold M. Cogan, Member

From: Air Quality Control Division

Date: November 25, 1970, for December 4, 1970, Meeting

Subject: Proposed Regulation for Board Products Industries

The Staff requests authorization to announce and hold a public hearing in January on the attached Proposed Regulations for Air Contaminant Emissions from Board Products Industries.

The proposed regulations are primarily related to particulate emissions from plywood, particle board and hardboard manufacturing operations, and are offered as a substitute for the process weight emission standard presented to the Commission at a public hearing in May, 1970.

The presently proposed regulations have been developed over a period of months during which the Staff has met with, and submitted drafts to industry and to the Regional Authorities. Many of the comments from these groups have been incorporated into the present draft. Attached hereto are comments received concerning the previous draft of the regulation.

In order to avoid conflicts with process weight standards previously adopted by the Regions, this proposed Department of Environmental Quality standard specifically excludes Regional territory from its area of applicability. The Staff is aware of some controversy over the advisability of doing so, and will discuss the issue in some detail in a staff report to be prepared for the public hearing. The problem is complicated by the fact that the proposed Department of Environmental Quality standard, while achieving essentially the same degree of control, is less stringent in some cases and more stringent in other cases than the various process weight standards of the Regions.

The proposed regulations establish two types of limitations. One type may be termed "performance standards", which prohibit or specify certain activities. Examples of performance standards in the regulation are the prohibition of open burning, the requirement that truck dump and storage areas be covered or controlled to prevent windblown fallout, and the requirement that hardboard tempering oven odor emissions be incinerated.

In addition to performance standards, the regulation establishes plant-site limitations on particulate emissions, based on plant production. These limitations, applicable to all process equipment other than boilers, incinerators and veneer dryers, are the following:

| | |
|---|---|
| Veneer/Plywood: | 1.0 lb/1000 sq.ft. plywood (3/8" basis) |
| Particle board: | 3.0 lb/1000 sq.ft. particle board (3/4" basis) |
| Hardboard: | 1.0 lb/1000 sq.ft. hardboard (1/8" basis) |

These allowable emission rates are constant without reference to plant size.

Veneer dryers are exempted from the above emission limits, with a provision calling for a public hearing on veneer dryer emission standards by June 1, 1971. This proposal is based on the fact that a comprehensive study of veneer dryer emissions, jointly funded by the American Plywood Association and the National Air Pollution Control Association, will not be completely reported until March 1, 1971, and the expectation that better knowledge of both emissions and applicable control technology will become available during early 1971.

As indicated above, a complete staff report will be prepared prior to the hearing which will more fully discuss the level of control required under this proposed regulation and assess its requirements in comparision to Regional standards.

The Staff believes that the proposed regulation is both stringent and technically feasible. Compliance with it is expected to achieve the necessary reductions in emissions from these sources and play an important part in meeting air quality standards in the affected areas.

ahe
Attachment

DEPARTMENT OF ENVIRONMENTAL QUALITY

AIR QUALITY CONTROL DIVISION

PROPOSED REGULATIONS

AIR CONTAMINANT EMISSIONS FROM BOARD PRODUCTS INDUSTRIES

I. Definitions:

1. "Emission" means a release into the outdoor atmosphere of air contaminants.

2. "Hardboard" means a flat panel made from wood that has been reduced to basic wood fibers and bonded by adhesive properties under pressure.

3. "Particleboard" means mat formed flat panels consisting of wood particles bonded together with synthetic resin or other suitable binder.

4. "Plywood" means a flat panel built generally of an odd number of thin sheets or veneers of wood in which the grain direction of each ply or layer is at right angles to the one adjacent to it.

5. "Tempering oven" means any facility used to bake hardboard following an oil treatment process.

6. "Veneer" means a single flat panel of wood not exceeding 1/4 inch in thickness, formed by slicing or peeling from a log.

II. General:

1. These regulations establish performance and emission standards for veneer, plywood, particleboard and hardboard manufacturing operations located outside the boundaries or jurisdiction of Regional Air Pollution Authorities.

2. Emission limitations established herein are in addition to, and not in lieu of, general emission standards for visible emissions, fuel burning equipment, and refuse burning equipment.

3. Emission limitations established herein and stated in terms of pounds per 1000 square feet of production shall be computed on an hourly basis using the maximum 8 hourly production capacity of the plant. ~~averaged over an 8-hour period.~~

4. Upon adoption of these regulations, each affected veneer, plywood, particleboard, and hardboard plant shall proceed with a progressive and timely program of air pollution control, applying the highest and best practicable treatment and control currently available. Each plant shall

at the request of the Department submit periodic reports in such form and frequency as directed to demonstrate the progress being made toward full compliance with these regulations.

III. Veneer and Plywood Manufacturing Operations:

1. Veneer Dryers - Public Hearing for Emission Standard

By no later than July 1, 1971, the Environmental Quality Commission shall hold a public hearing for the purpose of determining the feasibility of adopting an emission standard for particulate and gaseous emissions from veneer dryers, setting forth allowable emission levels and dates for compliance.

2. Other Sources

a. Requirement

Emissions of particulate matter from veneer and plywood mill sources, including, but not limited to, sanding machines, saws, presses, barkers, hogs, chippers and other material size reduction equipment, process or space ventilation systems, and truck loading and unloading facilities, but excepting veneer dryers, fuel burning, and refuse burning equipment, shall not exceed a total from all sources within the plant site of one (1.0) pound per 1000 square feet of plywood or veneer production on a 3/8 inch basis of finished product equivalent.

b. Compliance Schedule

By no later than July 1, 1971, each plywood mill shall submit to the Department of Environmental Quality a proposed schedule for compliance with this subsection.

c. Open Burning

As of the effective date of these regulations, open burning of wood residues or other refuse in conjunction with any veneer or plywood manufacturing operation is prohibited.

IV. Particleboard Manufacturing Operations:

1. Truck Dump and Storage Areas

a. All truck dump and storage areas holding raw materials to be used in a particleboard manufacturing operation shall be enclosed or otherwise controlled such that windblown particulate emissions from these areas

are not deposited upon property not under the ownership of the plant owner or operator.

b. Temporary storage of raw materials outside regularly used areas is prohibited without prior notification of the Department of Environmental Quality. Temporary storage areas shall be operated in such a manner that wind-blown particulate emissions are not deposited upon property not under the ownership of the plant owner or operator. Temporary storage areas shall not be operated continually for a period exceeding six (6) months.

2. Other Sources

Emissions of particulate matter from particleboard plant sources including, but not limited to, hogs, chippers and other material size reduction equipment, process or space ventilation systems, particle dryers, classifiers, presses, sanding machines, and materials handling systems, but excepting truck dump and storage areas, fuel burning equipment, and refuse burning equipment, shall not exceed a total from all sources within the plant site of 3.0 pounds per 1000 square feet of particleboard produced on a 3/4 inch basis of finished product equivalent.

3. Open Burning

As of the effective date of these regulations, open burning of wood residues or other refuse in conjunction with any particleboard manufacturing operation is prohibited.

4. Compliance

By no later than July 1, 1971, each particleboard plant shall submit to the Department of Environmental Quality a proposed schedule for compliance with subsections (1) and (2) of this section.

V. Hardboard Manufacturing Operations:

1. Subsections 1, 2 and 3 of Section IV, Particleboard Manufacturing Operations, shall apply equally to hardboard manufacturing operations with the single exception that the emission limitations for sources other than storage facilities and fuel or refuse burning equipment shall be 1.0 pound per 1000 square feet of hardboard production on a 1/8 inch basis of finished product equivalent.

2. Emissions from Hardboard Tempering Ovens

   Emissions of odorous gases and vapors from hardboard tempering ovens shall be controlled by incineration at temperatures of 1000° F for 0.3 seconds, or by other equivalent means. However, higher temperatures may be required for specific installations, and all fume incineration installations shall be capable of operation at temperatures as high as 1500° F.

3. Compliance Schedule

   By no later than July 1, 1971, each hardboard plant shall submit to the Department of Environmental Quality a proposed schedule for compliance with subsections (1) and (2) of this section.

TO : MEMBERS OF THE ENVIRONMENTAL QUALITY COMMISSION

B. A. McPhillips, Chairman
Storrs S. Waterman, Member
E. C. Harms, Member
George A. McMath, Member
Arnold M. Cogan, Member

FROM : AIR QUALITY CONTROL DIVISION

DATE : November 27, 1970 for the December 4, 1970 Meeting

SUBJECT: AUTHORIZATION FOR A PUBLIC HEARING
AMBIENT AIR STANDARD FOR SULFUR DIOXIDE

It is requested that authorization be granted and a hearing date be established for a public hearing on the adoption of an ambient air standard for sulfur dioxide. It is proposed that the standard be adopted for statewide application, including the Oregon portion of the Federal Region.

Under the time schedule of the Federal Clean Air Act relative to the established Portland Interstate Air Quality Control Region standards, for which criteria have been issued, must be adopted and submitted by March 8, 1971. Since other standards must be prepared, it is recommended that the proposed standard be authorized for public hearing.

The standard, as proposed, is considered restrictive and is essentially based upon the Federal criteria and the criteria document dated January 19, 1970, previously furnished you and mailed to Regions, companies, and interested persons under a memorandum dated February 5, 1970 (with minor modifications) requesting comments. Attached is a copy of revised "Figure I" and "Explanation of Figure I" from that criteria document. Number 1-5 deals with standards and objectives; 6-12 affects upon vegetation; 13-19 upon health effects; 20-23 on taste and odor; 29 on visibility; and 25 on materials.

More recently a draft of the standard was completed, mailed to the Regions, and their comments have been incorporated in the present draft where appropriate. Attached is a copy of that correspondence.

The proposed standard is in some instances more restrictive than standards for $SO_2$ of the Regions and is consistent with the state of Washington Ambient Air Standard previously adopted.

RECOMMENDATION:

A date for a public hearing for the adoption of an ambient air standard for sulfur dioxide be established.

Attachment

(Proposed)

DEPARTMENT OF ENVIRONMENTAL QUALITY

AIR QUALITY CONTROL DIVISION

# AMBIENT AIR QUALITY STANDARD FOR SULFUR DIOXIDE

## I. Definitions

(1) Ambient Air - The air that surrounds the earth excluding the general volume of gases contained within any building or structure.

(2) Primary Air Mass Station (PAMS $SO_2$) - A station designed to measure contamination in an air mass and representing a relatively broad area. The sampling site shall be representative of the general area concerned and not be contaminated by any special source. The probe inlet shall be a minimum of twenty feet and a maximum of 150 feet above ground level. Actual location and elevation should vary to prevent adverse exposure conditions caused by surrounding buildings and terrain.

(3) Primary Ground Level Monitoring Station (PGLM $SO_2$) - A station designed to provide information on contaminant concentrations near the ground and provide data valid for the immediate area only. The probe inlet shall be ten to twenty feet above ground level with a desired optimum height of twelve feet. The probe inlet shall not be less than two feet from any building or wall. The sampling site shall be representative of the immediate area and not be contaminated by any unique source.

(4) Special Station (SS-$SO_2$) - Stations that do not meet the criteria or purpose of Primary Air Mass Stations or Primary Ground Level Monitoring Stations are defined as special stations.

II. Air Quality Standard - Sulfur Oxides

Sulfur oxides in the ambient air, measured as sulfur dioxide at a Primary Air Mass Station, a Primary Ground Level Monitoring Station or a special station, shall not exceed the following concentrations averaged over the specified time periods:

(1) Four tenths (0.4) part per million parts by volume average for any one hour.

(2) Twenty-five one hundredths (0.25) part per million parts by volume average for one hour not to be exceeded more than two times in any consecutive seven days.

(3) One-tenth (0.1) part per million part by volume average for any one day (24 hours), ~~midnight to midnight~~).

(4) Two one hundredths (.02) parts per million parts by volume average for any one year.

III. Method of Measurement

For determining compliance with this regulation, sulfur dioxide shall be measured as sulfur dioxide by acidified peroxide reagent conductivity (continuous monitoring) or colorimetric techniques (manual sampling). Other continuous and manual methods for measurement may be used after approval by the Department of Environmental Quality provided they can be shown to be equivalent in sensitivity, accuracy, reproducibility, and selectivity.

NOTE: (The Department of Environmental Quality has on file copies of the method "Sampling and Analysis for Sulfur Dioxide in the Ambient Air.")

IV. Data Reporting

Local and Regional Air Pollution Control Agencies sampling for sulfur oxides shall notify the Department of Environmental ~~State Office of Air~~ Quality ~~Control~~ of all violations of this regulation. The notification shall be submitted by

the 15th of each month, summarizing the violations of the previous month, and by March 1 of each year if the annual standard was exceeded in the previous year. Summaries shall be on forms furnished by the Department of Environmental Quality and shall provide the following information:

(1) Location of sampler.

(2) Type of station - air mass (PAMS), ground level (PGLMS), or special station (SS).

(3) Time span involved (including specific hours, days and year).

(4) Actual concentrations recorded that exceeded the standard.

(5) Action taken or planned to prevent recurrence.

The ~~State Agency~~ DEQ shall notify the Regional ~~or local Agency~~ of results which exceeds the standards within the ~~agency~~ Region's jurisdiction on a monthly basis. This notification shall include:

(1) Location.

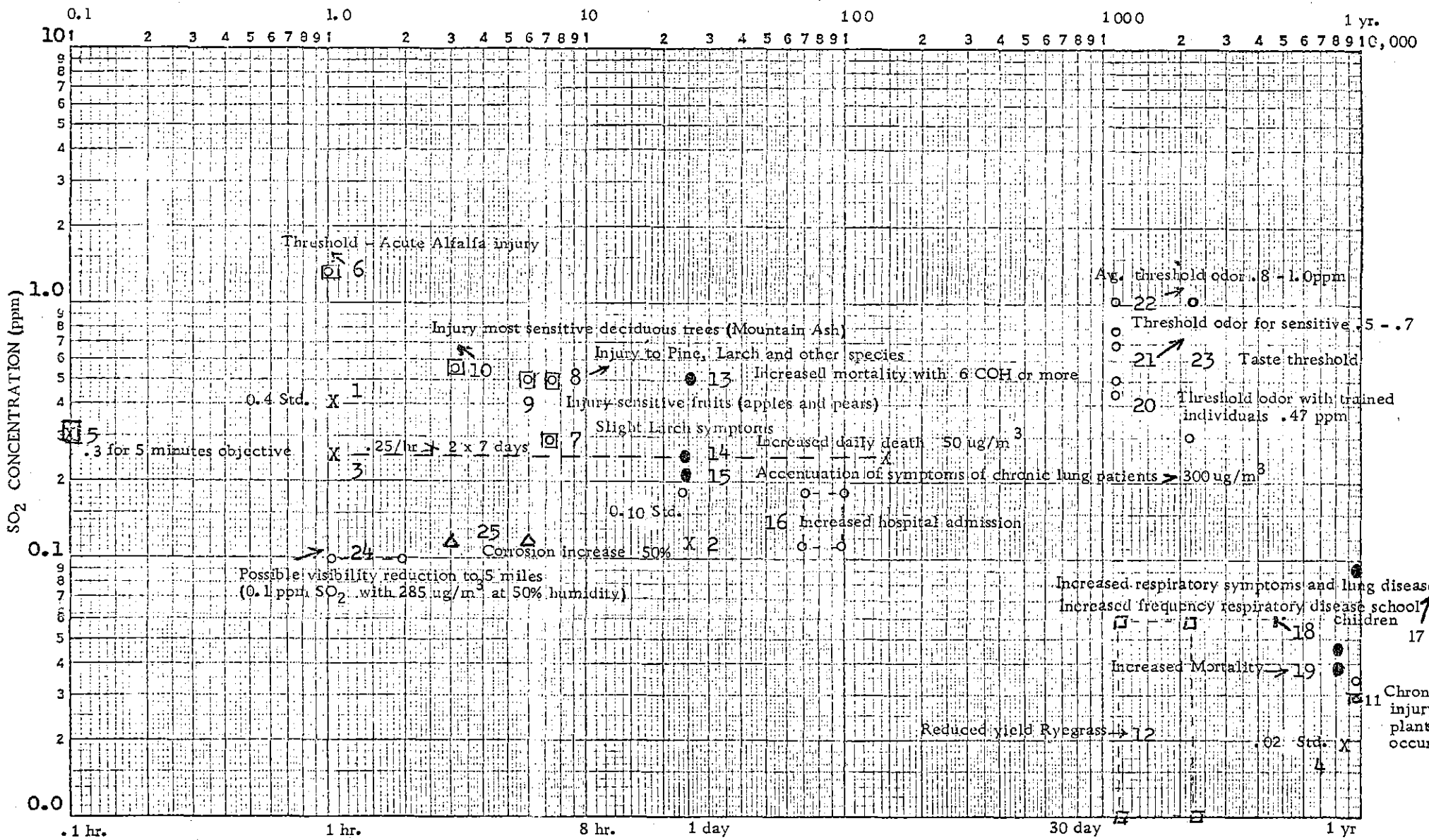
(2) Type station.

(3) Time span.

(4) Standard exceeded.

(5) Concentrations recorded.

TIME (HOURS)




SULFUR DIOXIDE EXPOSURE vs. EFFECTS

FIGURE 1

LEGEND:
X Standard [X] Objective
● Health Effects
[o] Vegetation Effects
Δ Material Effects
o Other Effects

EXPLANATION OF FIGURE 1

1. 1 hour standard of 0.4 ppm.
2. 1 day (24 hour) standard of 0.10 ppm .
3. 1 week standard, 0.25 ppm hourly average more than twice in 7 days.
4. Annual standard of 0.02 ppm.
5. Objective concentration of 0.3 ppm for not more than 5 minutes.
6. Threshold response of alfalfa to acute injury. (1) p5-15
7. Slight symptoms in larch. (1) p5-9
8. Injury to pine, larch and other species. (1) p5-9
9. Injury to most sensitive fruit varieties (apple and pear). (1) p5-9
10. Injury to most sensitive deciduous trees (mountain ash). (1) p5-9
11. Chronic plant injury may occur. (1) p10-22
12. Reduced yield in rye grass exposed to unfiltered air ($SO_2$ concentration of 0.01 to 0.06 ppm for 46-81 days). (1) p5-16
13. Increased mortality may occur (0.52 ppm $SO_2$ with 6 cohs or greater particulate). (1) p10-20
14. Increased daily death rate may occur (0.25 ppm $SO_2$ with $> 50$ ug/m$^3$ particulate). (1) p10-20
15. Accentuation of symptoms may occur in patients with chronic lung disease (0.21 ppm $SO_2$ with 300 ug/m$^3$ smoke). (1) p10-21
16. Increased hospital admission, absenteeism and mortality may occur (concentration of $SO_2$ and time of exposure not adequately defined). (1) p9-61
17. Increased frequency of respiratory symptoms and lung disease may occur ($SO_2$ range 0.037-0.092 with 185 ug/m$^3$ smoke). (1) p10-21
18. Increased frequency and severity of respiratory diseases in school children may occur ($SO_2$ annual average of 0.046 ppm with 100 ug/m$^3$ smoke). (1) p10-21
19. Increased mortality from bronchitis and lung cancer may occur ($SO_2$ annual average of 0.040 ppm with 160 ug/m$^3$ of smoke). (1) p10-21
20. $SO_2$ odor threshold (0.47 ppm) for trained individuals. No time limit. (1) p7-15
21. $SO_2$ odor threshold (0.5-0.7 ppm) for sensitive persons. No time limit. (1) p7-15
22. Average $SO_2$ odor threshold (0.8-1.0 ppm). No time limit. (1) p7-15

EXPLANATION OF FIGURE 1 (Cont'd)

23. Taste threshold for $SO_2$ (0.3-1.0 ppm). No time limit.

(1) p1-6

24. Possible visibility reduction to 5 miles (0.1 ppm $SO_2$ with 285 ug/$m^3$ particulate and 50% humidity). No time limit.

(1) p10-21

25. Corrosion rate for steel panels may be increased by 50% (0.12 ppm $SO_2$ with high particulate levels). No time limit mentioned.

(1) p10-21

FROM: AIR QUALITY CONTROL DIVISION

DATE: February 5, 1970

NOTICE:

AIR QUALITY CRITERIA AND PROPOSED AMBIENT AIR STANDARD FOR SULFUR DIOXIDE

The Department of Environmental Quality and the Washington State Air Pollution Control staffs have prepared the attached report "Criteria for Sulfur Dioxide Ambient Air Standard and Objective." The criteria was prepared to establish the proposed ambient air standard, and is being distributed at this time as a matter of public information and to allow for review and receipt of comments or statements.

The notice for a public hearing and the proposed ambient air standard will be distributed to you when the Environmental Quality Commission has authorized a hearing date. Statements or testimony will also be received at that hearing.

TO : MEMBERS OF THE ENVIRONMENTAL QUALITY COMMISSION

B. A. McPhillips, Chairman
Storrs S. Waterman, Member
E. C. Harms, Member
George A. McMath, Member
Arnold M. Cogan, Member

FROM : AIR QUALITY CONTROL DIVISION

DATE : November 27, 1970 for the December 4, 1970 Meeting

SUBJECT: RECEIPT OF VARIANCE GRANTED BY THE COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY TO MRS. MARJORIE KVAMME, BORING

Under the provisions of ORS 449.880, Regional Authorities are required to file a copy of variances granted with the Environmental Quality Commission. If the variance should not be renewed or if the variance extends beyond one year the Environmental Quality Commission can direct non-renewal or limit the variance to one year.

In this instance Mrs. Marjorie Kvamme, Boring, was granted a variance to burn certain land clearing debris. The variance was granted for a one-time burn with reasonable restrictions and expires on December 31, 1970.

Attached are: (1) a copy of the letter of transmittal, (2) a copy of the order adopted, and (3) a copy of the staff report.

RECOMMENDATION:

The variance be received and filed with the Commission.

Attachment

# COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY

1010 N. E. COUCH STREET PORTLAND, OREGON 97232 PHONE (503) 233-7176



5 November 1970



Environmental Quality Commission
1400 Southwest 5th Avenue
Portland, Oregon 97201

Attention: Mr. K. H. Spies, Director
Department of Environmental Quality

Gentlemen:

Please be informed that the Board of Directors at their regular meeting, 16 October 1970, considered an application from Mrs. Marjorie Kvamme, Route 1, Box 566, Boring, Oregon, for a variance from the Rules of this Authority to open burn certain land clearing debris on her property.

After due consideration of the information presented by Authority staff personnel and by Mrs. Kvamme, it was the decision of the Board to grant a variance subject to certain restrictions and conditions.

Enclosed is a copy of the Findings and Order for your review in accordance with ORS 449.880.

For the Program Director.

Very truly yours,

Jack Lowe

Jack Lowe
Administrative Director

JL:jl
Enclosure

COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY
1010 NE Couch Street, Portland, Oregon 97232

| | | |
|---|---|---|
| IN THE MATTER OF | ) | |
| | ) | |
| VARIANCE | ) | FINDINGS AND ORDER |
| | ) | |
| MARJORIE KVAMME, PETITIONER | ) | |

FINDINGS

I

On 28 September 1970 Petitioner filed a petition for a variance from Rule 6, Section 6.2 (3)(c)(i)(a), to burn certain land clearing debris in Clackamas County on property situated at Route 1, Box 566, Boring, Oregon.

II

That said proposed burning would not be detrimental to the public interest if said proposed burning is conducted pursuant to certain conditions.

ORDER

NOW, THEREFORE, it is hereby ordered that a variance be granted to Marjorie B. Kvamme from the date hereof through 31 December 1970 to open burn certain land clearing debris on property situated at Route 1, Box 566, Boring, Oregon, subject to the following conditions:

1. That all burning shall be performed under and in accordance with the provisions of permit issued by the Sandy Rural Fire Protection District.

2. Only the single pile of land clearing debris in existence on the above mentioned property on 28 September 1970 and only the material in the said pile on said date shall be burned.

3. At no time and under no circumstances shall the open burning permitted by this variance contain any garbage, asphalt, waste petroleum products, paint, plastics, rubber products or any substance which normally emits dense smoke, noxious odors or creates a public nuisance when burned.

4. At all times when burning is taking place, fire shall be worked in such a manner to produce the hotest fire practicable and reduce smoke to the lowest practicable minimum.

Entered at Portland, Oregon, the 16th day of October 1970.

N. James Pearson
Chairman, Board of Directors

# COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY

1010 N. E. COUCH STREET PORTLAND, OREGON 97232 PHONE (503) 233-7176

15 October 1970



MEMORANDUM

TO: Board of Directors

FROM: R. E. Hatchard, Program Director

SUBJECT: Variance Request - Mrs. Marjorie Kvamme
Route 1, Box 566, Boring, Oregon

Gentlemen:

Attached is a request for a variance from Section 6.2(3)(c) of the Columbia-Willamette Air Pollution Authority's Rules pertaining to open burning for landclearing purposes. In addition is a sketch of the approximate location of site and a copy of our letter inviting Mrs. Kvamme or a representative to attend this Board meeting and, if desired, make a statement in support of the request.

Staff Recommendation

It is our staff recommendation the variance request be denied.

Reasons for Denial

In accordance with variance consideration as outlined in Rule 9:

1. No special circumstances exist which would render compliance unreasonable due to a special physical condition. There is road access to the material and equipment could operate at the site to remove the material.

2. The air pollution effect would not be minimal. The material consists of brush and stumps mixed with considerable dirt. In its present condition, the dirt would strongly hinder good combustion and if a variance is granted, our staff would recommend the removal of the dirt prior to burning. The area surrounding the site is primarily farmland and smoke from the site would most likely effect the people living in the trailer court where the material is located.

3. Alternate methods of disposal are available. The material could be loaded and hauled to a disposal site; the nearest such site is located near Gresham.

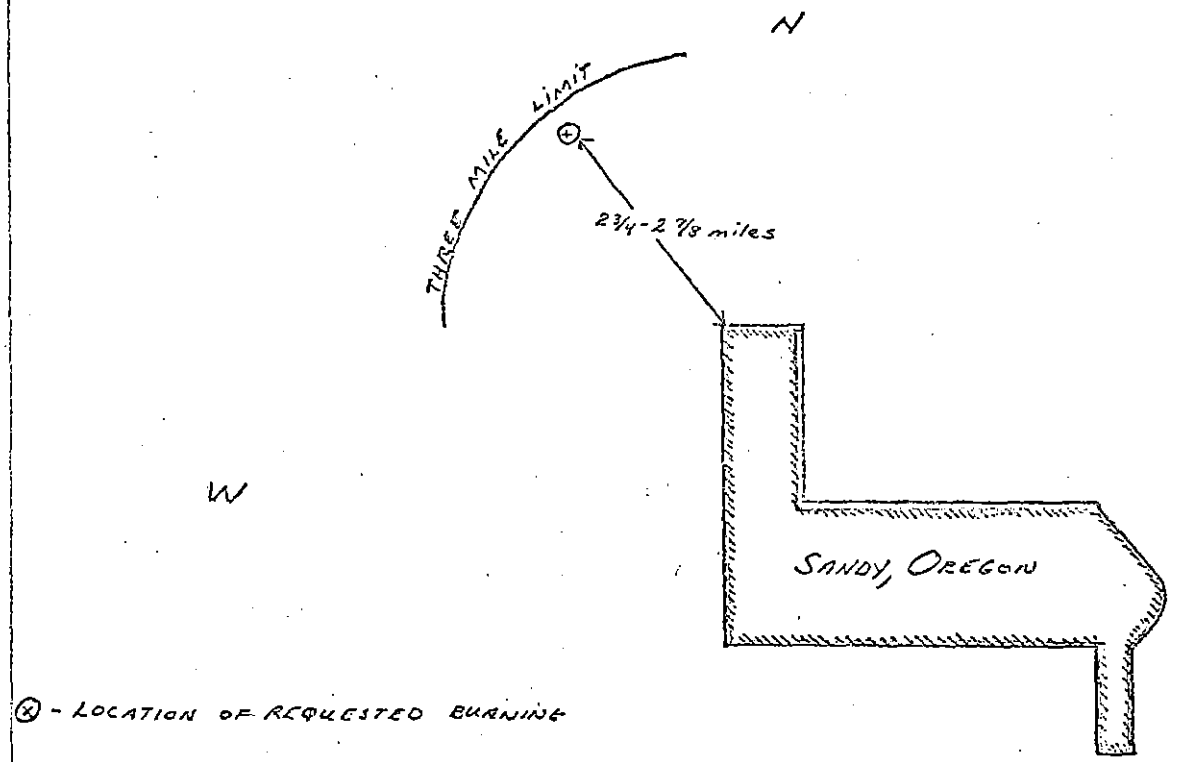
4. In considering the equities involved, no previous variances have been granted to other sources for this purpose. Open burning for landclearing purposes has been prohibited in this area since 1 January 1970 and to the best of our knowledge, no such burning has been done. However, you should be aware, residential burning is permitted at this area until 1 January 1971 and a number of nearby agriculture operations can burn on days when such permits are being issued.

Respectfully submitted,

R. E. Hatchard
Program Director

REH:whs
Enclosures

VARIANCE REQUEST - MRS. M. KVAMME
RT. 1 BOX 566
BORING, OREGON



TO : MEMBERS OF THE ENVIRONMENTAL QUALITY COMMISSION

B. A. McPhillips, Chairman
Storrs S. Waterman, Member
Arnold M. Cogan, Member
E. C. Harms, Jr., Member
George A. McMath, Member

FROM : AIR QUALITY CONTROL DIVISION

DATE : November 27, 1970 for December 4, 1970 Meeting

SUBJECT: STATUS REPORT ON AIR QUALITY IN BEND, DESCHUTES COUNTY

The Staff desires to acquaint the Commission with the problems relative to air quality in the Bend area and the programs instituted at this time regarding the abatement of air pollution from those sources.

Attached is a letter from Representative Al Ullman, and a petition with a cover letter from Mr. Jesse H. Smith, Sr., a resident of Bend, and one of those most affected by these sources.

The companies referred to in the petition are Brooks-Willamette Corporation and Brooks-Scanlon, Inc. The following is a brief description of the programs and schedules that the staff and companies have developed:

I. Brooks-Willamette Corporation

This company manufactures approximately 8.5 million square feet of particle-board on a 3/4" basis per month. On October 26, 1970, the company forwarded to the staff a copy of the study of emissions completed by their consultant, $CH_2M$. The company is currently in the first phase of a schedule which will bring emissions from all sources into compliance with the proposed board products regulations. These projects are:

1. The installation of a baghouse collector over the enlarged sander-dust storage binds, all of which is under construction at this time.

2. The installation of a multi-clone sanderdust collection system based on the completion of a simular program already in progress at the company facilities in Albany. This project to begin some-time in June or July of 1971.

The company will be furnishing the staff a complete comprehensive report on the engineering, delivery and installation schedules just as soon as this $CH_2M$ emission study has been completely evaluated by the consultant and their own engineering staff.

II. Brooks-Scanlon, Inc.

Brooks-Scanlon, Inc. manufactures kiln dried dimensioned lumber. For the past few years the company has had a tremendous amount of trouble with the installation of two (2) used water tube boilers. The troubles ended in a lawsuit which was settled out of court in October of this year. During

this period of time the company relieved one consultant and engaged the services of another. Since the new consultant has been on the job the company has experimented with several types of hogged fuel, methods of feeding and introducing this fuel into the boilers, and controls for modulating the underfire and overfire air damper response.

The letter dated November 24, 1970, which is attached, outlines what the staff feels is a reasonable approach at this time. The staff also believes that the ultimate results regarding compliance with current visible emissions for Special Control Areas can be achieved when the new controls are installed on the dry kilns, as per the first paragraph on page 2 of this letter.

SUMMARY

The staff is of the opinion that these two companies are proceeding in an orderly fashion to bring their operations into compliance with current and proposed regulations. The staff will present further reports to the Environmental Quality Commission regarding this situation as the need arises. Our District Engineer, Mr. C. Kent Ashbaker, and company officials recently met with Mr. Smith in Bend to explain the situation.

AL ULLMAN
2D DISTRICT, OREGON

To: HMP

COMMITTEE ON
WAYS AND MEANS

# Congress of the United States

## House of Representatives

Washington, D.C. 20515

October 28, 1970

KHS

State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECEIVED
NOV 2 - 1970
OFFICE OF THE DIRECTOR

Mr. Kenneth H. Spies
Department of Environmental Quality
State of Oregon
968 Portland State Office Building
Portland, Oregon

Dear Mr. Spies:

Last year my constituent, Mr. Jesse Smith, Sr. of Bend, contacted me regarding the air pollution that had been caused by several mills in the area.

Although the problem appeared to have been resolved temporarily, the pollution has recurred repeatedly in the past several months. Since the mills in Bend must comply with State pollution regulations, I would appreciate your review of this situation and your suggestions on a possible solution. You may want to contact Mr. Smith directly, and his address is 174 East Franklin, Bend.

Thank you for your consideration of this matter.

Sincerely,

Al Ullman, M. C.

AU:bc

cc: Mr. Jesse Smith, Sr.

ALLPINE PARTICLEBOARD

BROOKS-WILLAMETTE CORPORATION
P.O. BOX 1245 ● BEND, OREGON 97701 ● (503) 382-6001

October 26, 1970

State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECEIVED
OCT 28 1970
AIR QUALITY CONTROL

Mr. Hal Burkitt
Air Quality Control
P.O. Box 231
Portland, Oregon 97207

Dear Mr. Burkitt:

Enclosed is a copy of $CH_2M$ study of emission from Cyclones at the particleboard plant in Bend. At the bottom of page four there is a note refering to the improvement made to system #9 as a result of Carothers work. I wish it were all this simple but I am afraid it won't be. At least we have a starting point to improve from.

We have improved our water disposal to the extent that it is all going into dry holes before leaving our leased property. No more water is going over the hill toward the river.

We blew two tubes in the new boiler and had to run the old boiler at a higher rate to keep adequate steam in the plant. Mr. Gallaher from Corvallis is here now and we should have these tubes replaced and the #2 boiler running by Thursday of this week. Thursday we hope to clean #1 boiler and be back running both boilers at a lower rate by the end of the week.

Very truly yours,

BROOKS-WILLAMETTE CORP.

J. McK. Bosch

J. McK. Bosch
General Manager

JMB/kf
Enclosure
cc: Bill Swindells Jr.
Ken Ashbaker

To: NMP

KWS

174 East Franklin St.
Bend, Oregon 97701
November 17, 1970

Mr. Kenneth Spies
Department of Environmental Quality
968 Portland State Office Building
Portland, Oregon 97201

Dear Mr. Spies:

Re: Sawdust-Cinder Fallout
Bend, Oregon

This letter refers to Representative Al Ullman's letter of October 28, 1970 regarding the pollution fallout from local industry.

The Concerned Citizens of Bend have formulated a petition, a copy of which is attached, to request action by the Dept. of Environmental Quality. This petition with some 400 signatures at the present time is being circulated and will be forwarded to you when those concerned have had an opportunity to sign. Almost every business on Third Street (Hwy 97) through Bend is already represented on the petition.

We also at this time request that the pollution measuring device installed on the Court House in Bend be relocated, or an additional device installed, at a more adequate and revealing location such as Third and Franklin Streets. The Court House is located at the opposite side of Bend from the main source of pollution. The Franklin Street site would provide information on fallout affecting a majority of businesses and residential areas suffering from the fallout.

We will look forward to hearing from you and needless to say, we would welcome meeting with you here in Bend and acquainting you at first hand with the problem.

We feel that the time has come to take steps not only to eliminate the annoyance of fallout but to recognize the health factor involved.

Very truly yours,

Concerned Citizens of Bend

Jesse H. Smith Sr

Jesse H. Smith, Sr.

cc: Rep. Al Ullman
Sam Johnson
Gordon W. McKay

17

TO: Mr. Kenneth Spies
Department of Environmental Quality
968 Portland State Office Building
Portland, OR 97201

**********

We, the undersigned citizens of the City of Bend, Deschutes County, Oregon, request you to take such action as is necessary to stop the pollution from existing and future fallout of sawdust and soot from the mills of Brooks Scanlon, Inc. and Brooks-Willamette Corporation adjacent to Bend, Oregon.

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BROOKS-SCANLON, INC.
PO BOX 1111 BEND, OREGON 97701 PHONE: (503) 382-2511



November 24, 1970

State of Oregon
Department of Environmental Quality
1400 S. W. 5th Avenue
Portland, Oregon 97201

Attention: Mr. H. H. Burkitt

Gentlemen:

We have reviewed our power house operation relative to the smoke emissions and have initiated the following plan of action. This plan has been reviewed with Walter O. Stevens who is our steam generating consulting engineer.

First, we feel it is necessary to improve the operation of the smoke indicators. We will achieve this as follows:

1. The smoke indicator units will be shielded from the heat from the gas ducts since Bailey has informed us that excessive heat causes erratic operation of these units. This will be complete by December 7, 1970.

2. We will calibrate the smoke indicators by purchasing grids from Bailey which have the same opacity as the Ringlemann scale. The boilers will be shut down and the cams adjusted so that meters in the operating room read the same as the grid Ringlemann reading through all ranges of the Ringlemann scale. We will do this by January 1, 1971.

3. We will adjust the smoke indicators sensitivity for quicker response of overfire air. This will be complete by January 8, 1971.

4. We propose to establish the reliability of the smoke charts with the State Environmental Authority by setting up between ourselves and Kent Ashbaker a program of observing and recording the smoke emissions from the power house in some manner that can be correlated directly to our smoke charts. We propose to do this by January 22, 1971.

We feel that one of the major problems relative to producing smoke in the power house is a highly swinging load that the dry kilns present on the steam flow demand. We plan to put modulating valves and new controls on one kiln. We will observe the steam flow to this kiln prior to and after the installation of this new equipment and from this test will be able to determine if we will be able to level out the steam demand on the boilers from the dry kiln. If we do achieve this, we will then initiate a program to install this equipment on all of our kilns. We are not sure of the delivery times for the equipment to set up a test kiln, but will try to get it in operation in the next two months.

We feel we must make some improvements in our fuel delivery and fuel mix to the boilers. We have no definite program at this time by which we can achieve this, but are continuing to explore possibilities in this area.

Sincerely,

Leo Hopper

Leo Hopper
Production Manager

LH/sh

cc: Kent Ashbaker
Charles Cassingham
Dick Gervais
W. O. Stevens

KMS To: KMS NMB

BEND, OREGON
NOVEMBER 30, 1970

MR. KENNETH SPIES
DEPARTMENT OF ENVIRONMENTAL QUALITY
968 PORTLAND STATE OFFICE BUILDING
PORTLAND, OREGON 97201

DEAR MR. SPIES:

INDUSTRY POLLUTION-FALLOUT, BEND, ORE.

MR. KENT ASHBAKER HAS INFORMED US THAT YOUR AGENDA FOR FRIDAY, DECEMBER 4, INCLUDES THE POLLUTION PROBLEM WE ARE CONCERNED WITH HERE IN BEND.

WITH WEATHER CONDITIONS SUCH AS THEY ARE, WE ARE NOT ABLE TO ATTEND THIS SESSION AND WISH TO FOLLOW OUR RECENT LETTER TO YOU WITH A COPY OF THE BULLETIN ARTICLE WRITTEN BY ASSISTANT EDITOR, BOB GASTON.

WE ARE PROCEEDING TO OBTAIN FROM THE DEPARTMENTOF HEALTH ANY COPIES OF TESTS AND/OR REPORTS RELATIVE TO THE HEALTH HAZARDS OF THOSE PEOPLE DIRECTLY WORKING IN THE INDUSTRIES INVOLVED. WE DO NOT AGREE WITH THE STATEMENT ATTRIBUTED TO MR. ASHBAKER IN THE BULLETIN ARTICLE AND WE QUOTE, "PARTICLEBOARD PLANTS, THEREFORE, GREATLY REDUCE SMOKE AND CINDER PARTICLES, BUT, AT THE SAME TIME, CREATE AN ANNOYING, BUT NOT UNHEALTHFUL, SOURCE OF SAWDUST AND SANDER DUST."

MR. ASHBAKER STATED TO US TODAY THAT OUR PROBLEM IS A RELATIVELY MINOR ONE FOR YOU, BUT WE WOULD LIKE TO SAY QUITE EMPHATICALLY THAT THAT IS NOT THE WAY WE VIEW THE SITUATION. WE REALIZE THAT CERTAIN STEPS MUST BE TAKEN TO SOLVE SUCH PROBLEMS, HOWEVER, WE DO NOT WANT TO LOOK FORWARD TO THE FIVE YEARS THAT HAS BEEN ALLOWED BROOKS-SCANLON TO PARTIALLY SOLVE THEIR CINDER PROBLEM.

WE WOULD REQUEST THAT WHEN THE PETITION WHICH IS NOW CIRCULATING HAS BEEN COMPLETED AND SUBMITTED TO YOUR DEPARTMENT, THAT A MEETING HERE IN BEND COULD BE ARRANGED TO ALLOW THE GREAT NUMBER OF PEOPLE WHO ARE CONCERNED TO BE PRESENT.

VERY TRULY YOURS,

CONCERNED CITIZENS OF BEND

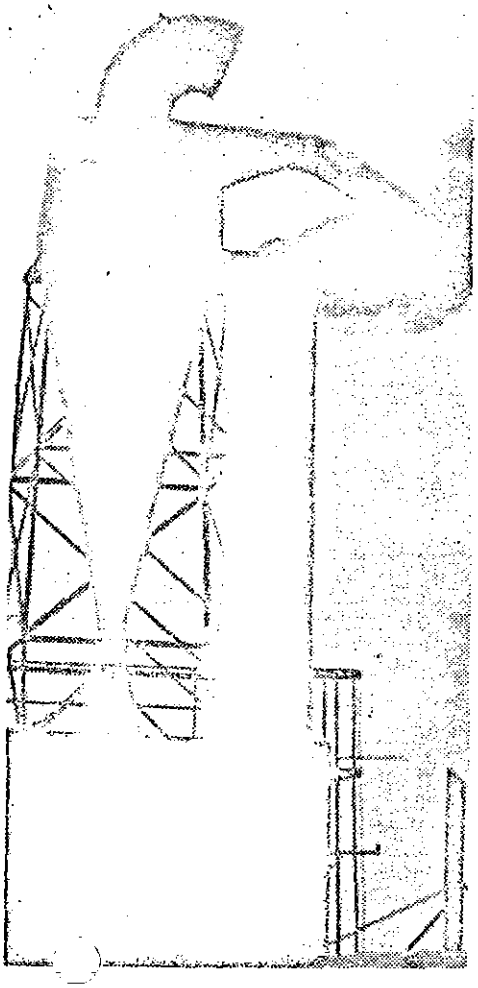
Jesse H. Smith Sr

JESSE H. SMITH, SR.
174 FRANKLIN STREET
BEND, OREGON 97701

State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECEIVED
DEC 1 - 1970
OFFICE OF THE DIRECTOR

In today's Bulletin
Tue Nov. 24 - 1970





Some Bend residents are unhappy about sawdust and soot fallout, but the offending companies are working to solve the problem. See staff writer Bob Gaston's full-page report on Page 9.



# Residents fume over fallout

## Sawdust, soot annoy many

By Bob Gaston
Bulletin Staff Writer

Sawdust fallout in Bend is keeping members of the John Huddleston family from entering their house through the front door — at the insistence of Mrs. Huddleston.

She wants her new $800 living room rug to stay looking new by keeping it free of sawdust, sander dust and soot that her family tracks in.

"I just told my husband and kids that I wasn't going to be cleaning our rug every day," she said.

She and her family live a 57 Sullivan Place, close to the Brooks-Willamette particleboard plant, source of the sawdust that sometimes coats her yard, house, car and children's swing set.

"My kids sometimes get all dirty playing on the swing set," she said. "And I can wash the car and then come out an hour later and there'll be soot and sawdust all over it."

Mrs. Huddleston said she noticed that the sawdust fallout increasing about four or five months ago. That's when Brooks-Willamette doubled its capacity.

Some mornings in the past few weeks she said the ground around her house was so thick with sawdust that she thought it had snowed.

Similar comments comparing the sawdust fallout to snow came from others interviewed by The Bulletin last week.

The fallout is causing the most anguish among residents and businessmen northeast of Brooks-Willamette and Brooks-Scanlon. Other areas apparently are unaffected.

Those interviewed agreed that the sawdust problem had become worse in the last few months, while the amount of soot and cinder fallout from Brooks-Scanlon's operation had tapered off. (An explanation of the Brooks-Scanlon's attempts to reduce soot and cinder fallout appears in another article on this page, as does an assessment of Brooks-Willamette's efforts to keep its sawdust out of the air.)

The fallout causes real day-to-day problems for some people in the path of it, like Ellen Heller, maid at the Rainbow Hotel on East Franklin Ave.

"Phooey! Don't talk sawdust to me. I get too mad," she says.

She's worked at the motel for seven years, but she and owners Mr. and Mrs. Earl Hoover say the volume of sawdust falling on them has definitely been greater in the last few months.

Mrs. Hoover, to prove her point, showed a room that had been cleaned the day before. The window sills were coated with a fine mixture of sawdust and black soot.

"The sawdust is like flour — it settles on everything," Mrs. Hoover said.

The flour-like substance that filters under windows and doors is sander dust from the particleboard plant. While the bulk of emissions from the particleboard plant is sawdust, the small sander dust particles seem to cause the most complaints, according to Brooks-Willamette plant manager John McKenna "Mac" Bosch.

Car dealers, who need to display a shiny, clean product, have been bothered by the sawdust fallout, too.

Floyd Holt of Murry and Holt Motors at Third and Franklin said that three weeks ago he hired an automatic car wash operator to wash all of his cars.

"And I'm not kidding you, the next day you could hardly see through the windshields," Holt said.

Holt said several Friday afternoons he's had all his cars washed. They are usually hosed down in the middle of the week, he adds.

His son, Jack, said a combination of soot and sawdust coats the cars.

"In a car with air conditioning, you can turn on the air conditioner and get a blast of soot and sawdust inside the car, too," he said. "It settles in the air vents."

The Holts agreed that the sawdust problem had been worse in the last few months, but better the last two weeks. Both said the amount of soot had tapered off.

Sales Manager Bob Wheeler at Bob Thomas Chevrolet-Cadillac said the sawdust fallout has definitely been worse the last few months. "Sometimes it's so thick that we'll track it into the dealership" he said.

Glen Leagjeld gets sawdust both at his business, his hearing aid center in the Bend Plaza, and his residence at 1204 E. Third St.

He says flour-like sawdust settles on the furnishings in the store.

"Our janitor says the sawdust and soot is into the heating system, too," Leagjeld said.

The north side of his home is coated with a permanent layer of soot and cinders put there in the summer of 1969 while his house was being painted.

"The painter did the north side of the house late in the afternoon," Leagjeld said. "The next morning I went out and saw that entire side coated with cinders. I was just sick."

Ralph Foxton and his wife, Irene, 19 Terminal Place, have been among the most vocal of those complaining about the fallout.

Mrs. Foxton says she feels strongly that the sawdust and cinders are a health hazard.

"We like to sleep with our bedroom windows open, but we can't. We have them closed and sawdust and cinders still filter through," she said.

She said the window sills throughout her house should be cleaned daily because of the soot and sander dust.

Those contacted by The Bulletin were unanimous in being genuinely upset, for varying reasons, about the sawdust and soot fallout. But none indicated that he or she was aware of what the two mills, or regulatory agencies, like the Department of Envornomental Quality, were doing to curb the fallout.

Three interviewed said they didn't know where the fallout was coming from and others erroneously blamed Brooks-Scanlon for the sawdust emissions.

## Equipment needs adjusting

# Brooks-Scanlon close to eliminating cinders

R.E. "Dick" Gervais, operations manager for Brooks-Scanlon, readily admits that his company produces a portion of the cinders and soot that sometimes rain on parts of Bend.

But he anticipates that by next spring emissions from Brooks-Scanlon will be within limits set up by the State of Oregon. Gervais adds that he believes the company has an obligation to give townspeople a timetable for solving the problem.

"We feel the air pollution problem is behind us," he said. "Most of the time now we are within state standards and the state feels we can do the job with the equipment we have."

When the emissions are within the standards, the sawmill will emit only a very small portion of the particles that now escape, Gervais said.

The cinders come from wood waste that is burned in the company's power plant, which produces steam and electricity for the mill. It's the only burning done at the plant now.

The new power plant was put into operation in September of this year, after having been shut down for more than a year during a legal hassle between Brooks-Scanlon and the designers of the plant, Cornell, Howland, Hayes and Merryfield (CH2M), a Corvallis engineering firm.

Brooks-Scanlon had sued CH2M for more than $1.9 million in general and special damages, charging, among other things, that the power plant cost more than twice CH2M's original estimate. The two firms settled out of court shortly after the trial began Sept. 28.

After being used initially in January of 1968, the new power plant was shut down for repairs the following March.

Since then Brooks-Scanlon has done about $500,000 worth of modifications to make the plant operable, Gervais said.

He isn't predicting an end to the emission problems until spring because the company has yet to go through a winter with the new power plant. Winter weather may mean more, and different, power plant adjustments than summer, spring or fall require.

The sophisticated plant, which uses electric eyes and television cameras to watch the burning opeation and measure the volume of particles being emitted through the stacks, also re-cycles partially-burned materials to be burned again.

Some of the wood turns into tiny charcoal chips its first time through. The charcoal, Gervais says, "is our best fuel." It burns like briquets, putting off plenty of heat.

The heat, in turn, produces steam that drives a turbine and a generator that produces electricity for the plant.

Gervais said Brooks-Scanlon produces its own electricity not so much to save money, but to eliminate the wood waste that is such a major problem for all sawmills.

The mill's old powerhouse, last modified in 1936, was used while the new one was shut down. It emitted more cinders than are presently escaping, and anti-sawdust and-soot petition signers contacted by The Bulletin said they had noticed a marked decrease in the amount of cinder fallout recently.

Gervais said Brooks-Scanlon decided to build the new power plant after the firm received a petition from townspeople about five years ago. The petition complained about cinder emissions.

A portion of the mill's planer shavings, some green sawdust and bark are burned in the power plant now.

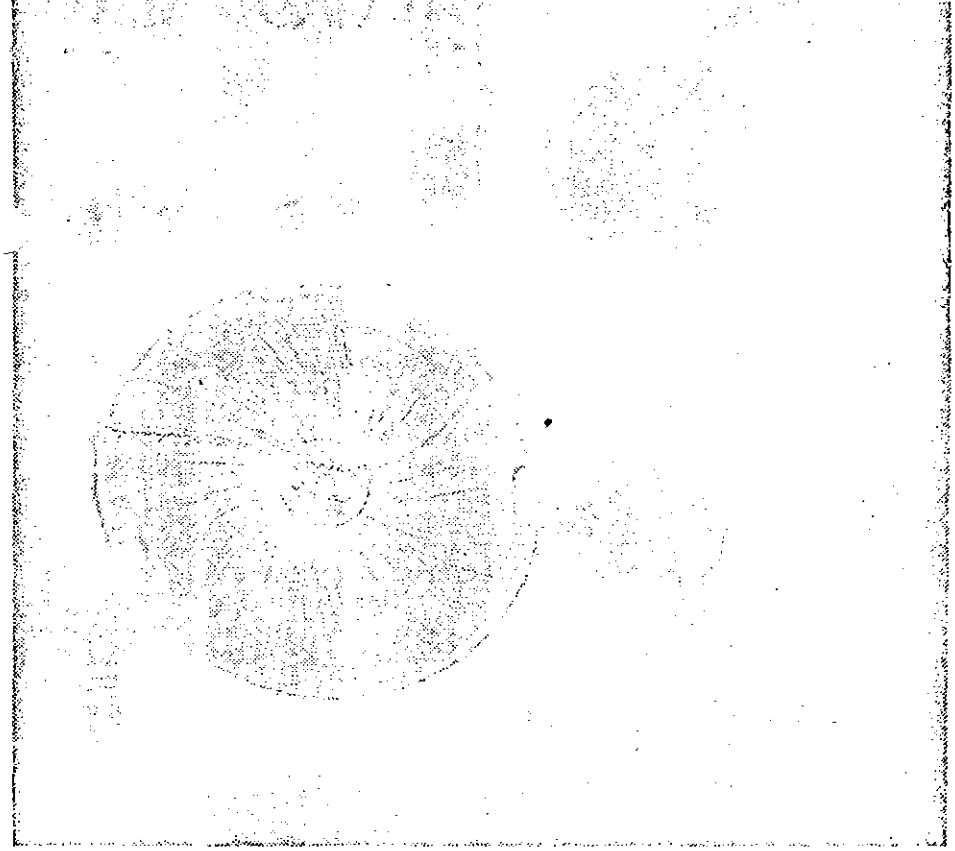
Gervais said the smallest particles are causing the fallout problem in the new plant. Oxygen is forced through the burners to help the wood waste burn completely, leaving no residue. But the light pieces now are blown up and out the two square "smoke stacks" without having a chance to burn completely. Gervais said the new stacks are really exhaust stacks, since they should be pumping out heat, not smoke.

"We're looking into the possibility of squeezing these light particles into pellets to burn them," Gervais said. A machine that pelletizes the particles for burning is in experimental stages.

Brooks-Scanlon tried the pellets last week, with a smoky results. But Gervais thinks purchasing machinery to turn the fine particles into pellets may be the answer, with adjustments in the power plant intruments.

"We've really taken two years longer than we should have to solve the problem," Gervais said, noting mechanical problems and rebuilding of the power plant as the main reasons for the delay.

"Brooks-Scanlon is a citizen of the Bend area, and we feel we have an interest in the total environment of the community," Gervais said.



Sophisticated electronic equipment in the Brooks-Scanlon power plant keeps track of particles being emitted through the two exhaust stacks, and records it on the chart shownhere. (Bulletin photo by Bob Gaston)

## To its sawdust emission problems

# Brooks-Willamette seeks solutions

Engineers hired by Brooks-Willamette recently determined the Bend particleboard plant is pumping about 425 pounds of wood particles into the air every hour.

The report has been submitted to the Portland office of the Department of Environmental Quality, which had requested it.

The particleboard plant is emitting sander dust — a very light flour-like substance that is a combination of wood and resin used to make the particleboard — and large quantities of bigger sawdust-like particles.

The light sander dust seems to be causing the most complaints among townspeople, according to John McKenna "Mac" Bosch, plant manager. It's more penetrating than the larger particles, slipping beneath doors and onto window sills.

The particles pour forth from cyclones, funnel-shaped pipes on top of the plant. Swirling air in the cyclones creates a vortex that transports wood shavings, which are combined with resins and chemicals, to huge presses to be compressed into particleboard. In the process the lighter particles fly out the top of the cyclones and into the air.

Bosch said there are also sawdust and sander dust emissions from the plant's dryers, which dry the raw material for the particleboard.

The entire particleboard industry is still experimenting with ways to curb its emission problems, which are by no means unique to the Bend plant.

It wasn't until this summer, when Brooks-Willamette doubled its plant capacity, that health officers and others, including Bill Ellis, chairman of PURE (Protect our Urban and Rural Environment), began getting many complaints about the sawdust fallout.

But Bosch said he had received some complaints from time to time long before the plant doubled its capacity.

Only last week Bosch met with PURE one night and the Bend Chamber of Commerce's Environmental Committee the next morning to explain the problem. He's well aware that people are concerned about the fallout.

He told both groups that the firm is taking measures now to capture part, but by no means all, of the fallout.

Brooks-Willamette will be spending about $50,000 to enlarge its sander dust bin, which collects sander dust, and install a small bag house to replace the sander dust bin cyclone. It should collect most of the sander dust now being emitted much like a vacuum cleaner picks up dust and dirt. The work, with good weather, should be done by March or April, Bosch said.

These measures, he noted, will halt the extremely high concentrations of fallout that have occurred from time to time during the last two months. But the plant has a total of 20 cyclones that emit particles, so the whole problem will not be solved by April.

Bosch told PURE and the chamber committee not to expect a wholesale clean-up until the end of 1971.

"By the end of next year we should be running with some kind of pollution control that will eliminate 80 to 90 per cent of what we're now kicking out," he said.

He noted that the Bend plant is awaiting experiments at a sister plant in Albany, Duraflake, which, like Brooks-Willamette, is managed by Willamette Industries. It is now experimenting with a water-wash system that rinses the small particles away instead of letting them escape into the air. Whether this will work or not won't be known for some time, Bosch said.

"A large sander dust bag house is proving 98 per cent effective in Albany," Bosch said, "but it's a tremendous fire

hazard. One spark can explode it."

He noted that the Bend plant has been averaging one fire every four shifts. The nature of particleboard makes fire inevitable, and Bosch isn't eager to have any more fire hazards tacked onto the plant.

Brooks-Willamette isn't emitting as [illegible] particles now as it was about six weeks ago because the firm took some immediate measures to control it and repaired machinery breakdowns that were contributing to the pollution.

"We went after our biggest sawdust producer right after we got the engineering survey," Bosch said. Adjustments were made on a large cyclone that was emitting 170 pounds of particles per hour.

Bosch told PURE that after the adjustments, engineers measured an output of only 33 pounds per hour, but he added that engineers must have tested "on a good day" to get the 33-pound reading.

Extemely heavy sawdust fallout observed by nearby residents and Third Street businessmen some mornings within the past six weeks were caused by Brooks-Willamette employes who didn't understand the operation of the sander dust bin, Bosch said.

While one of the firm's two boilers was down for repairs, the sander dust bin would fill up abnormally fast during peak sanding periods. Employes would then haul the collected sander dust to the city dump. Most of that excess would normally be burned, creating steam to operate plant machinery.

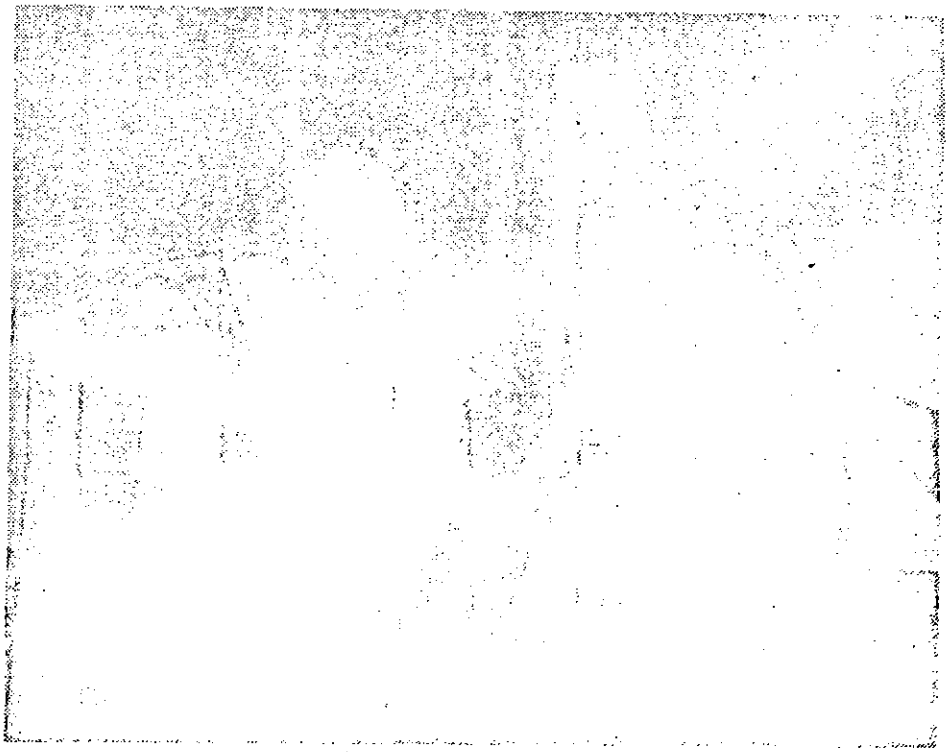
Employes unfamiliar with the sander dust bin would, after emptying it, inadvertently send sander dust straight out one of the cyclones by failing to re-open the sander dust bin so it could collect particles.

This almost always happened during night shifts, Bosch said, because no one could see the sander dust pouring into the air.

But with the second boiler working again to burn more of the sander dust, emissions should not again reach the heights they did about six weeks ago, Bosch said.

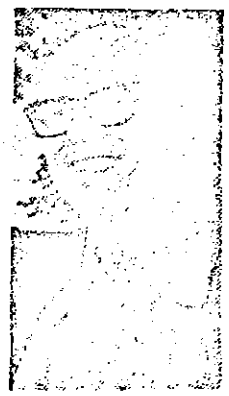
Ellis told Bosch, however, that they'd like to keep in touch with him.

Bosch drew laughter by replying, "The best way to keep in touch is to keep complaining."



Funnel-shaped cyclones on top of Brooks-Willamette's particleboard plant emit wood particles. The stacks emit mostly steam, which is not considered a pollutant.

# 'We call about once a week'



Ashbaker

Kent Ashbaker, Bend district engineer for the Department of Environmental Quality, has been keeping close track of Brooks-Scanlon's smoke problems, but he says Brooks-Willamette's sawdust emissions seem to be much more of a long-range problem.

The Brooks-Scanlon smoke problems, Ashbaker says, "have to get solved within a matter of weeks, not years."

Ashbaker took smoke readings on Brooks-Scanlon's powerhouse stacks Thursday morning and found both to be close to, but still in violation of, DEQ air emission standards.

Ashbaker can merely observe smoke and determine if it's violating standards. He gauges the smoke, by observing its density and color, against a Ringlemann scale, which grades smoke on a 1 to 5 basis, with 5 being the blackest, and most particle-laden, smoke.

Under DEQ regulations, emissions from a wood-fueled fires can't read more than 2 on Ringlemann.

Ashbaker's observations Thursday, which were taken every 15 seconds for 20 minutes, showed smoke from the east stack to average 2.4 on the scale, while the west stack averaged 2.75.

"So Brooks-Scanlon is not quite in compliance," Ashbaker said, "But the readings show the power plant is capable of meeting standards if it could be adjusted properly." He noted that the east stack has always been better than the west stack, even though both are burning the same material.

He said the Brooks-Scanlon problem is not worth taking drastic measures on, such as closing the plant down. He notes that the law states DEQ engineers must work with a company on pollution problems as long as the company is willing to co-operate. Brooks-Scanlon, he said, has been very co-operative.

"We'll keep bugging them and riding them until the problem is solved," Ashbaker added. "We call about once a week and ask them how they're doing."

He noted that complaints to his office about Brooks-Scanlon's cinders dropped off once the company shut down its old three-stack power plant in September and began using its new one after modifying it to the tune of $500,000.

But while complaints about Brooks-Scanlon have dropped off, those about Brooks-Willamette discharge of sawdust into the air have increased.

"Brooks-Willamette is really laying it out," Ashbaker said in commenting on the sander dust emissions.

Ashbaker hasn't taken any tests at Brooks-Willamette, but he said it's obvious the particleboard plant is violating standards with its sawdust and sander dust emissions.

The plant also emits puffs of black smoke about every 15 seconds. Ashbaker says he doesn't know if the smoke violates standards or not, since it's mixed with steam and hard to gauge.

"For some people the sander dust is a real nuisance," Ashbaker admits. But he says that Brooks-Willamette has "not been dragging its feet at all" in working to solve the problem.

The DEQ recently got an engineering report on emissions from the firm. The report, Ashbaker said, was in when the DEQ wanted it. It's now in the main office in Portland.

He said one citizen adamantly suggested that the particleboard plant be shut down until the problem is eliminated. But Ashbaker says, "I think that's a little drastic unless it's creating a health hazard."

Ashbaker commented that he thought emissions from automobiles were more of a health hazard than anything Brooks-Willamette is putting into the air.

The Brooks-Willamette probem won't be solved quickly or easily, Ashbaker indicates. The firm is experimenting with different devices to clear the air and the Bend plant has equipment on order to catch a portion of the fallout now.

He said he plans to ask the DEQ's Portland office to look at new attempts to solve particleboard plant fallout that are being tried throughout the nation.

The Brooks-Willamette problem is one shared by particleboard plants everywhere. A relatively new innovation, the particleboard industry takes wood shavings and sawdust — which sawmills once burned as scrap — and turns them into a useful and popular building product. Brooks-Willamette's Bend operation uses scrap from Brooks-Scanlon and mills in Redmond and Prineville — scrap once burned in wigwam burners still in use in the two smaller towns.

Particleboard plants, therefore, greatly reduce smoke and cinder particles, but, at the same time, create an annoying, but not unhealthful, source of sawdust and sander dust.

Ashbaker said Brooks-Willamette may not be looking at enough alternatives to its problem, since it is relying heavily on experiments with new anti-pollution machinery at a sister plant, Durafiake, in Albany. That's one reason he thinks the DEQ should look for more particleboard experiments throughout the nation.

# Petition protests air pollution

More than 500 persons, many of them owners, managers and employes of Third Street businesses, have signed a petition protesting sawdust and soot fallout from Brooks-Willamette's particle board plant and Brooks-Scanlon's sawmill.

The petition is addressed to Kenneth Spies, director of the Department of Environmental Quality. His office is in Portland. It asks him to do what he can to eliminate the air pollution.

Jess H. Smith Sr., 174 E. Franklin Ave., initiated the petition. He has three others helping him gather signatures in business and residential areas north and east of the two mills.

Smith, who is retired, has for many years complained about cinder fallout near his home.

Now, however, he's more concerned about the sawdust fallout, saying, "The big black cinders have pretty well stopped."

Smith gleefully claims signatures from more than 90 per cent of the Third Street business between Horn's Texaco station at 1590 S. Third St. and the Revere Street intersection.

Ralph Foxton, 19 Terminal Place, has been helping Smith collect petition signatures. He claims he's got 400, all from residents in his area.

"It's gratifying to know that people care about the problem" Foxton said. "I've only struck one that wouldn't sign."

Kent Ashbaker, district engineer for the DEQ, said Spies, if he gets the petition, will present it to the Environmental Quality Commission, a group of laymen that governs the operation of the DEQ.

Ashbaker said he doesn't know what effect the 500 or more signatures might have on the commission.

But he did say that the petition would "mean more if 100 people are there to present it."

TO : MEMBERS OF THE ENVIRONMENTAL QUALITY COMMISSION

B. A. McPhillips, Chairman
Storrs S. Waterman, Member
Arnold M. Cogan, Member
E. C. Harms, Jr., Member
George A. McMath, Member

FROM : AIR QUALITY CONTROL DIVISION

DATE : November 27, 1970 for the December 4, 1970 Meeting

SUBJECT: HUB LUMBER COMPANY, DOUGLAS COUNTY

At the July 25, 1969, meeting of the Environmental Quality Commission in the Douglas County Courthouse in Roseburg, the Commission passed a motion requiring Hub Lumber Company to furnish a satisfactory program for the phase-out of the wigwam waste burner at the August 29, 1969, meeting held in Portland.

The company did present a statement at this meeting in Portland through their attorney, which is attached, calling for a phase-out date within the next 12 to 15 months, (Page 5, Item #2).

Since this meeting the staff has continued to work with the company to insure that the deadline of December, 1970, would be met, and to try to operate the wigwam waste burner in compliance with current emission standards. Unfortunately, residue markets did not develop as rapidly as the company had pictured them at the August 1969 meeting. As a matter of fact, the markets deteriorated rather rapidly, especially particle board, and, as a result, the company has had more residues to burn than they did a year ago.

Because the deadline for phase-out is rapidly approaching, the staff requested that the company furnish a document as to their intent so that the matter could be presented before the Environmental Quality Commission.

In this letter, dated November 13, 1970, which is attached, Mr. Charles Teague outlines the steps taken to date, summarizes the alternatives that the company has, and then makes a proposal to the Environmental Quality Commission requesting an extension be granted to his original time schedule for phase-out.

Mr. Teague also has another problem, in that the company has an SBA loan which was made after the fire on April 16, 1968, destroyed the mill. Because of this the company is limited as to the amount of any capital expenditures in any one year based on the gross sales figure. At the present the company is producing approximately 1,200,000 board feet lumber scale, on a one 8-hour shift schedule per month.

This wigwam waste burner has been and still is a source of complaints from local residents.

RECOMMENDATIONS

Because of the problems associated with unmodified wigwam burners, the location of this burner relative to the residential area, and in fairness

to those companies who have either been required to modify or phase-out their wigwam waste burners previously, the staff recommends that the Commission require that the company either phase-out their wigwam waste burner or submit plans and specifications for modification in accordance with the criteria as developed by the Forest Research Laboratory at Oregon State University prior to April 1, 1971, so that modification could be completed by June 1, 1971.

Attachment

DOUGLAS FIR K.D. HEMLOCK CEDAR

145

# Hull Lumber Company

TWX RS-8081 POST OFFICE BOX 1346 PHONE ORCHARD 2-3385 ROSEBURG, OREGON

State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY

November 13, 1970

RECEIVED
NOV 17 1970
AIR QUALITY CONTROL

Environmental Quality Commission
State Office Building
1400 S.W. 5th - Suite 720
Salem, Oregon

Gentlemen:

We have encountered a real problem in the disposal of our bark and sawdust. We have seen this developing and have been in contact with Mr. McKenzie and later with Mr. Burkitt, and are requesting the granting of an extension until we can resolve our problem.

You will recall our case in which we agreed to certain conditions, mainly the elimination of our burner, but prior to this we were to install equipment to pull out our sawdust, also to make suggested improvements to the burner. We accomplished all of these improvements at a cost of many thousands of dollars.

Our present situation is this--our bark outlet has not developed as tentatively promised, and only a few months ago Forrest Industries stopped taking our sawdust due to a depressed particle board market. We have made a sincere effort to find new markets, north as far as Portland, south to Riddle, to the coast and of course, the Eugene area. We have been unable to uncover a market in our area.

We have investigated other burner situations and talked to many people knowledgeable on the subject. Also, we have investigated the prospect of land-fill projects, without success. This brings us back to our situation with three alternatives:

1. Close down the mill.
2. Remove and dump our sawdust and bark on some land,
3. Continue to use our burner until the time that satisfactory outlets for bark and sawdust are developed.

The first two alternatives would result in severe hardship. The most feasible solution would be the continued careful use of our burner. Therefore, we offer the following plan of operation for your approval. We believe the market on particle board will come back and this would again take care of our sawdust. In the meantime we will continue searching out a solution for the bark.

Continued - from page 1.

We will also continue to make some physical improvements on our burner in addition to improving its housekeeping and operation. We would generally follow the pattern of Georgia Pacific with their burners at Rogue River and Sutherland. We feel our burner now has good underneath blowing system which include the vents, dampers, etc. suggested by Mr. McKenzie. With other housekeeping solutions we should come close to meeting your standards for burner operation. We do not want to continue the use of our burner any longer than necessary and we look forward to the time when we can eliminate it altogether.

We would like to call your attention to some of the improvements pertaining to our mill accomplished over the years.

We phased out one burner completely and at that time made several changes and improvements recommended by Mr. McKnezie, such as, underneath blowing system, vents, etc. Further changes and additions toward improvements as suggested by Mr. McKenzie were made in 1969-70. Also in 1969-70 we installed at great expense equipment to pull out our sawdust.

We believe we have shown real effort, and believe both Mr. Burkitt and Mr. McKenzie will agree, and we believe it is to the best interest of all concerned that Hub Lumber Company be granted an extension on the basis of the afore-mentioned solution.

We hope you will agree and grant an extension at this time.

Yours truly,

Charles E. Teague

Charles E. Teague
President

TO: HAMPTON
HANCOCK-UTTE

STATEMENT OF HUB LUMBER COMPANY

BEFORE THE

ENVIRONMENTAL QUALITY COMMISSION

The Environmental Quality Commission, at its July 25 meeting in the Douglas County Courthouse in Roseburg passed a motion to the effect that Hub Lumber Company be required to furnish at the meeting of the Commission to be held in Portland on August 29, 1969, a satisfactory program for the phase-out of its wigwam waste burner. The motion further provided that unless there was a definite improvement in the operation of the burner by August 29, 1969, a hearing would be scheduled in which Hub Lumber Company would be required to appear and show cause why it should not be enjoined and prohibited from further use of the wigwam waste burner. This motion is divided into two parts, and these two portions of the motion will be separately discussed.

IMPROVEMENT IN OPERATION OF WASTE BURNER

July 11, 1969, status report from Air Quality Control Staff stated that by May 11, 1967, the burner was in compliance with the original wigwam waste burner regulation.

On April 16, 1968, a substantial portion of lumber company's mill was destroyed by fire, with the result that the mill was completely out of production until February 22, 1969, and did not return to full production until May 1, 1969. It is, of course, apparent that this company was out of production for more than one year during the best market conditions in the history of the lumber industry. While other mills were piling up profits and surpluses, this company was rebuilding its mill and was unable to take advantage of the favorable market. By the time Hub Lumber Company returned to production, the market had started to break, cars were in short supply, and the company was not able to operate at profit levels anywhere near those profit levels that would have been available during the time that the lumber market was high.

A. Woodruff
Presented by Warren ~~Woodworth~~,
Attorney
at EQC meeting 8/29/69

The present operation of Hub Lumber Company is such that only bark and sawdust are disposed of in the burner. Shavings and chips are disposed of without the use of the burners.

Since the July 25, 1969, meeting in Roseburg, employees of Hub Lumber Company have consulted on many occasions with H. W. McKenzie, of the staff of the Environmental Quality Commission. Mr. McKenzie has made certain suggestions concerning burner improvements, and Hub Lumber Company has cooperated with Mr. McKenzie in installing such improvements, and has ordered certain over-fire vents as specified by Mr. McKenzie to be installed in the burner. Members of Hub Lumber Company's management have also consulted with Mr. McKenzie concerning operation of the burner, and are constantly striving to improve their efficiency. In addition to consultations with Mr. McKenzie, personnel of Hub Lumber Company have also consulted with representatives of Medford Steel who are manufacturers of wood residue burners. Officers of Hub Lumber Company have carefully examined the Kogap burner in Medford that has recently received favorable publicity in the public press. The new mill constructed for Hub Lumber Company was engineered, designed and built by Northwest Materials Handling Co. in Eugene.

Hub Lumber personnel have also consulted with these engineers in an attempt to improve the efficiency of the burners. Hub Lumber Company submits that there has been improvement in the operation of the burner since the July 25, 1969, meeting, and believes that installation of the over-fire side vents specified by Mr. McKenzie will result in a substantial improvement in the operation of the burner.

PHASE-OUT PROGRAM

As indicated above, the wigwam waste burner maintained by Hub Lumber Company now disposes of bark and sawdust. Hub Lumber Company has developed a market for the sawdust that will eliminate this portion of the residue from the burner. It will be necessary

to have extensive engineering and design work performed in order to determine the equipment that will be necessary to handle the sawdust. Briefly, this will require a drop-out in the main conveyor to separate the sawdust from the bark, a feeding system to supply the sawdust to a blower, a blower and motor, blowpipes and a storage bin. Hub Lumber Company's superintendent estimates that it will take from 60 to 120 days to complete the engineering, design and the construction so that the sawdust may be separated from the residue going into the burner.

Hub Lumber Company's personnel estimates that 40 to 50 per cent of the residue now being disposed of in the burner consists of sawdust. Such disposal of sawdust is the principal source of fallout and suspended particulate matter in the emissions from the burner. Removal of the sawdust from the burning process will almost completely eliminate the problem of fallout and should materially reduce suspended particulate matter. The bark that will be disposed of in the burner after the sawdust is removed will not be susceptible to being caught in the draft and lifted out of the burner before combustion is complete.

While awaiting design, construction and installation of the bark separation facilities, Hub Lumber Company is complying with the request of Mr. McKenzie to shorten the conveyor and provide a chute that will place the bark and sawdust in the center of the fire and will thereby materially reduce the fallout emissions from the burner.

It is Hub Lumber Company's sincere desire to dispose of all of its residues without the necessity of burning. However, there are serious problems connected with the disposition of bark residues. These problems are principally those of engineering, constructing and installing necessary equipment to handle the bark and prepare it for disposition other than by burning, and the necessity of obtaining a market for the bark so that the same may

be disposed of without the use of the burner.

In order to prepare the bark residues for disposition other than by burning in the wigwam burner, it is necessary that there be substantial changes and additions in the conveyor system; that a hammer hog be designed to prepare the bark according to the specifications of the purchaser; that new conveyors be installed from the hammer hog to storage bins; and that storage bins of sufficient capacity to handle the bark produced by Hub Lumber Company be properly installed. Hub Lumber Company personnel estimate that it will cost about $35,000 to install the equipment necessary to handle the bark. Company personnel also estimate that it will take at least 120 days and perhaps as much as six months to have this equipment designed, manufactured, and installed.

At the present time, Hub Lumber Company has no adequate market for the bark residues. Many efforts have been made to locate such a market in the vicinity of Hub Lumber Company's mill but to no avail. However, changes in the operation of other industries in Douglas County make it reasonably clear that there will be a market for these bark residues within about one year. Hub Lumber Company therefore proposes to the Commission that it will, within 12 to 15 months, be disposing of its bark residues by a method other than burning in the wigwam burner.

In the meantime, Hub Lumber Company is exploring a possible market for a substantial portion of its bark residues. This market is located in Eugene, and it will entail substantial financial loss to Hub Lumber Company to transport its bark residues to Eugene unless some favorable arrangements can be made to minimize the cost of transportation. Unless transportation costs can be materially reduced, marketing the bark residues in Eugene would cause such financial loss as to be prohibitive. Hub Lumber Company is attempting to arrange transportation of its bark residues to Eugene as a "back haul" with truckers who are transporting shavings and chips

to Roseburg from the Eugene vicinity. If such arrangements can be made, then Hub Lumber Company proposes that it will, within six months, be disposing of the major portion of its bark residues other than by the burning process.

SUMMARY

Hub Lumber Company therefore submits the following "Phase-Out Schedule".

1. All sawdust will be removed from the mill residues and disposed of without burning within 120 days.

2. All bark residues will be disposed of without burning within the next 12 to 15 months.

3. In the event favorable arrangements can be made for transportation of bark residues to Eugene, the major portion of the bark residues will be disposed of without burning within a period of six months.

The Commission should be aware that at the time Hub Lumber Company's mill was destroyed by fire, serious consideration was given to relocating the mill facilities elsewhere. However, Hub Lumber Company had been back in production only about 60 days after installation of a barker and chipper; the planer had been substantially improved and modified about one year before the fire. The fire did not destroy the barker, chipper and planer, and it would have been economically foolish to have abandoned these new facilities in order to locate the mill elsewhere.

Hub Lumber Company had been a part of the Roseburg area industrial complex for many years. It is and has been a substantial contributor to the economy of the Roseburg community, and the loss of its contribution to the Roseburg community during the time it was shut down for rebuilding was substantial. The company's decision to rebuild on its present site was influenced in a large manner by the requests of the Roseburg Area Chamber of Commerce and by many Roseburg business and professional people who felt that Hub Lumber Company should not be lost to the Roseburg community.

At the time Hub Lumber Company commenced its sawmill operations on the present site, it was well outside the City of Roseburg and was not in a built-up residential or business area. Since that time the residential area, nearby business areas and nearby school have "grown up" around Hub Lumber Company's facilities. Hub Lumber Company personnel are fully aware that their operations have caused some inconvenience to its neighbors, and they sincerely desire to do all that is possible to eliminate this inconvenience. Hub Lumber Company submits that the foregoing statement and "phase-out schedule" is reasonable and that the same should be accepted by the Commission.

PUBLIC NOTICE

Notice is hereby given that the Environmental Quality Commission will conduct a public hearing at 2:00 o'clock p.m., Friday, December 4, 1970, in Room 36, State Office Building, 1400 S. W. Fifth Avenue, Portland, Oregon, with respect to the effect upon air and water quality of the construction and operation of the proposed Trojan Nuclear Plant, to be located in Columbia County, Oregon, by Portland General Electric Company, Pacific Power & Light Company and the City of Eugene, Oregon, acting by and through Eugene Water and Electric Board. The commission will also consider the application of the proponents for a certification of the facility under section 21(b) of the Federal Water Pollution Control Act.

Any person desiring to submit any views or data, orally or in writing may do so by attending the hearing or by writing to Kenneth H. Spies, Director, Department of Environmental Quality, State Office Building, 1400 S. W. Fifth Avenue, Portland, Oregon 97201, prior to the hearing.

PORTLAND GENERAL ELECTRIC COMPANY
ELECTRIC BUILDING
PORTLAND, OREGON 97205

H. H. PHILLIPS
CORPORATE COUNSEL

November 13, 1970

Environmental Quality Commission
Department of Environmental Quality
State Office Building
Portland, Oregon

Gentlemen:

Portland General Electric Company hereby applies for the issuance of a certificate in such number of counterparts as may be necessary in accordance with Section 21 (b) of the Federal Water Pollution Control Act as amended by the Federal Water Quality Improvement Act of 1970, to the effect that the State of Oregon acting by and through the Environmental Quality Commission and the Department of Environmental Quality has determined that there is reasonable assurance that any discharge from the Trojan Nuclear Plant located in Columbia County, Oregon into the Columbia River will be carried out in a manner which will not violate applicable water quality standards.

If there is need of additional information in support of this application, we will be happy to supply it.

Very truly yours,

Portland General Electric Company

By H H Phillips